Whose Parking Space Is It? Managing Residential Parking in the Context of Urban Growth: Case Study of Cambridge, MA

by

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ABSTRACT

In the context of urban growth, how can a city approach residential parking issues? Cambridge, MA is experiencing rapid growth in real estate development and investment, shifts in demographics and travel behavior. How do these changes impact residential parking? Questions such as, "Who has a right to a curbside space?", "How much should it cost?", and "How much regulation is desirable?" trigger antagonistic reactions in the best of times. This research illustrates the complexity of parking problems and provides a framework for breaking parking disputes down to their spatial, political and institutional issues.

Three multi-block sites in Central Square (CS), Area 4/Wellington-Harrington (A4) and East Cambridge (EC) are manually surveyed for parking supplies and utilization rates. 75-95% of on-street and 6-45% of off-street spaces are occupied during night counts. Total registered vehicles (2011) in CS, A4 and EC exceed on-street parking supply. This does not necessarily indicate a physical parking problem exists. But it does illustrate that under the assumption residents have an equal right to public space, eligible vehicle owners in practice have claim to only a fraction of a curbside parking space.

'No Intervention,' 'Parking as a Public Asset' and 'Priority to Locals' are ideologies used to explore interventions, which focus on changes to the residential parking permit program, shared parking uses and tie-ins to new development approvals. The most effective ideology is managing parking as a public asset. Increasing the residential parking permit price with an income based structure is strongly recommended, in addition to greater city efforts to collect data on current parking conditions and continued campaigning by city and community representatives to ensure local interests are represented in significant projects such as the Sullivan Courthouse redevelopment.

Parking disputes can invoke impassioned reactions in the sanest of individuals. Finding a solution that addresses spatial, political and institutional issues is challenging, requires accurate information, and a willingness to attempt, evaluate and learn from errors. But it can be done.

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CONTENTS

Chapter One: Overview

1.1 Introduction

How can and should Cambridge, MA manage residential parking in the context of urban growth? People, investment and real estate development are drawn to Cambridge's successful bio tech industries, flourishing start-up culture, and potent intellectual capital. An environment of vibrant, walkable and public-transit rich communities surrounding these assets gives Cambridge an additional locational advantage over similarly sized cities.

Seen as a desirable place to live and work, the city faces a scenario of urban growth.[1] The shape and scope of that growth is in flux but changes to the city's built environment are inevitable in the near future. The inevitability of change is driven by clearly expressed development and investment interest, a housing shortage, recent zoning amendments, and an openness to growth among some local stakeholders.

Cambridge's local government, developers and some communities are amenable to the prospect of new development, viewing urban growth as a tool to increase city revenue, revitalize vacant retail/commercial properties, spur regional economic growth and resolve an affordable housing shortage. With the positive potential of urban growth, however, comes possible negative impacts including accelerating gentrification, overwhelming city services, congesting roads and public transit, and aggravating tensions between old and new residents. This thesis tackles the topic of residential parking, a small but contentious and politically significant part of the broader conversation on growth.

Why focus on residential parking? For many communities facing development and an influx of new residents, the default reactions are anxiety and suspicion about increased competition for curb-side spaces and congestion. Ignoring the parking issue is not an option. A frank discussion is needed on the current and future state of residential parking, given the inevitability of urban growth and the responsibility of city government to meet the needs of all residents, old and new.

A wide and diverse pool of stakeholders must be factored in when approaching residential parking challenges. In addition to residents, there are property financiers, real estate developers, local businesses, and government officials and institutions. Real estate financiers, in seeking 'safer' investments, prefer higher ratios of parking in residential developments, particularly for market-rate condos. This financial pressure pushes developers to build parking supply in excess of what is cost-efficient and necessary for transit-accessible urban areas. In

[1] Cambridge CDD. "[In 2013,] 4.2 million square feet of major housing and commercial development projects broke ground and tenants occupied another 1.6 million square feet of major projects."

contrast to investors' preference for more parking, sustainability minded transportation planners see excessive parking supply as the bane of smart growth as it encourages auto-oriented travel and occupies valuable land. (Guo, 2013a; Weinberger, 2012) The City of Cambridge similarly seeks a minimal parking supply to maintain a livable environment but must also balance out the needs of developers to encourage growth.

Given this dynamic context of inevitable urban growth, an impassioned assortment of stakeholders and motives, and the constraints of Cambridge's current built environment, the stage is set for this thesis to ask, "What do we do about residential parking?"

Cambridge is a unique case study for residential parking. Much of its built form was established in an era preceding auto dominance and suburban style developments, and an off-street parking space is not available in every parcel. Its population is diverse, well-educated and growing. The city is economically prosperous with a burgeoning tax base. Political views lean left and a progressive plurality dominates social issues. Public transportation is readily accessible and its historic prevalence has supported and shaped urban growth. Cambridge is not representative of the United States or even of a greater part of urban America.

Yet on a finer scale, the neighborhoods and residential parking issues examined in this thesis are relevant in settings beyond Cambridge. The approach used to break down parking challenges into spatial, political and institutional issues, and develop effective interventions can be translated to other cities and parking disputes.

This thesis is organized as follows,

Chapter 1 provides an overview of the thesis, its objectives, methods, findings and recommendations.

Chapter 2 reviews existing research on residential parking including its connections to vehicle ownership and travel behavior, the consequences of excessive supply, contemporary best practices and identification of parking stakeholders.

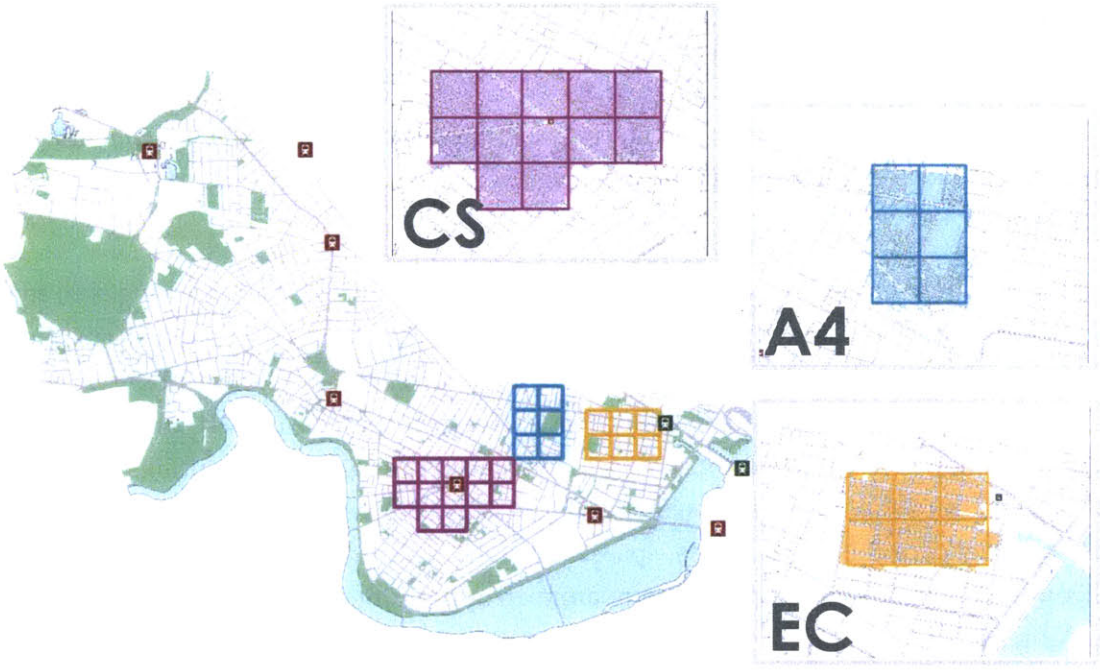
Chapter 3 describes the main study areas and methodologies. Current parking conditions are mapped. Greater contexts are analyzed such as socio-demographics, travel behavior and development patterns of the last ten years.

Chapter 4 summarizes the findings for CS, A4 and EC and selects key grid cells for block-level analysis. The finer analysis incorporates recent events and debates surrounding 10 Essex Street, Lawrence Street Hubway station, 424-430 Windsor (Lithuanian Church conversion) and the Sullivan Courthouse redevelopment proposal.

Chapter 5 breaks down parking and urban growth disputes into spatial, political and institutional issues. Ideologies for managing public property are used to explore parking interventions. Final recommendations conclude the chapter.

1.2 Case Study Neighborhoods

Three areas (CS, A4 and EC) in Cambridge, MA are the study sites for an in-depth analysis of parking conditions, patterns of development, sociodemographic change and travel behavior. The multi-block sites are located in neighborhoods commonly referred to as Central Square, Area Four/Wellington-Harrington and East Cambridge. For clarity and brevity, the study sites are referred to as CS, A4 and EC. These abbreviations serve to distinguish thesis sites from official Cambridge neighborhoods, which have similar names but reference different spatial boundaries. For scale reference, all grid cells, as illustrated in the maps below, are official MassGIS 250 meter by 250 meter grid cells. In subsequent maps including MassGIS grids, the 250 meter cells can be referenced as a distance scale.



Data Sources & Manual Counts

Data are pulled together from disparate sources including the US Census Bureau; Registry of Motor Vehicles (RMV) via MassGIS; Cambridge city departments of Assessing, Community Development and Traffic, Parking and Transportation; and manual counts of parking spaces and parked vehicles. Counts of on-street and off-street parking spaces (supply) were conducted during daytime hours. Only spaces that could be directly counted or estimated with visual

observations were recorded in GIS. Outside of the manual counts, parking space inventories for large lots and structures, as publicly available from Cambridge, were also included.

Residential parking utilization (demand) was measured at night with walking counts of parked vehicles. Vehicle counts were conducted between midnight and 5am, on Tuesdays, Wednesdays or Thursdays, time periods when residents and their vehicles would most likely be at home. Given time and manpower limits, only one utilization count was completed for each study area and each was conducted on a separate night. This limited approach is sufficient for the purposes of this thesis. But for future studies, a robust approximation of residential parking demand should include multiple nights of counts where each study area is surveyed during the same time period.

Discussion of data and methods used to study socio-demographic, property development, travel behavior and vehicle ownership patterns are available in Chapter 3.

1.3 Key Findings for CS, A4 and EC

Overarching themes bridge CS, A4 and EC. Demographics are clearly shifting with a surge in the 25 to 35 age group. Analysis of age brackets by sex between 2000 and 2010 suggests this shift represents an influx of younger adults with no children, rather than an aging of youth in the existing population. Real estate development has been very active but to varying degrees in each neighborhood.

Drive alone mode share has decreased between 1990 and the 2008 – 2012 ACS estimates but the degree of decrease has also varied by neighborhood. Non-auto modes such as public transit, walk and bike currently make up a healthy portion of commutes. There is a clear preference for on-street over off-street parking. In all neighborhoods, off-street spaces were left unoccupied despite greater competition for on-street spaces, as evidenced by high on-street utilization rates (CS 80%; A4: 95%; EC: 89%) It is unclear whether this is a result of personal preference or issues of lack of access/rights to existing off-street spaces. Likely, it is a combination of both. If rights to use existing off-street spaces is a problem, there are then opportunities for sharing facilities among parking users.

Finally, there are more registered vehicles in CS, A4 and EC than there are on-street spaces. Therefore, the number of vehicles eligible for a residential parking permit exceeds today's physical supply of on-street spaces (residential only and available to the public). This does not immediately indicate a physical parking problem exists. But it is a reality that must be acknowledged before effective parking interventions can be developed.

Further details on unique findings for CS, A4 and EC are available in Chapter 4. The following tables summarize key points.

Study Area: **CS**

Parking Spaces	
On-Street	2226
Off-Street	3585

Total Population	
Population (2000)	9200
Population (2010)	9070
% Change (00' to 10')	-1.4%

Vehicles	
Count (2014)	2820
Excise (2013)	2970
RMV (2011)	2900
% Change (**RMV** 08'-11')	-0.7%

Parked Vehicles	
On-Street	1789
Off-Street	1031

Working Population (18-66)	
Working Pop (2000)	7097
Working Pop (2010)	7409
% Change (00' to 10')	4.4%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Overall decrease

Parking Utilization	
On-Street	80%
Off-Street	29%

Age Group (25-35)	
% of Total Pop (2000)	27%
% of Total Pop (2010)	36%
% Change (00' to 10')	28.1%

Development Patterns	
Completed 2003-2013	333*
In Progress	88
Pattern	Recent development throughout the area with additional projects in pipeline

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Study Area: **A4**

Parking Spaces	
On-Street	1119
Off-Street	1420

Total Population	
Population (2000)	5777
Population (2010)	5312
% Change (00' to 10')	-8.0%

Vehicles	
Count (2014)	1694
Excise (2013)	1706
RMV (2011)	1748
% Change (RMV 08'-11')	11.5%

Parked Vehicles	
On-Street	1058
Off-Street	636

Working Population (18-66)	
Working Pop (2000)	4113
Working Pop (2010)	4083
% Change (00' to 10')	-0.7%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Unclear

Parking Utilization	
On-Street	95%
Off-Street	45%

Age Group (25-35)	
% of Total Pop (2000)	24%
% of Total Pop (2010)	30%
% Change (00' to 10')	14.6%

Development Patterns	
Completed 2003-2013	55*
In Progress	31
Pattern	Very little recent and in pipeline development

*CS and A4 subtotals BOTH include 277 Broadway and 199-209 Columbia Street, which are within 200 meters of both study areas.

Study Area: **EC**

Parking Spaces	
On-Street	1512
Off-Street	2335

Total Population	
Population (2000)	4354
Population (2010)	4044
% Change (00' to 10')	-7.1%

Vehicles	
Count (2014)	1696
Excise (2013)	1654
RMV (2011)	1642
% Change (RMV 08'-11')	5.4%

Parked Vehicles	
On-Street	1340
Off-Street	356

Working Population (18-66)	
Working Pop (2000)	3243
Working Pop (2010)	3243
% Change (00' to 10')	0%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Mix of unclear and slight decreases

Parking Utilization	
On-Street	89%
Off-Street	15%

Age Group (25-35)	
% of Total Pop (2000)	26%
% of Total Pop (2010)	31%
% Change (00' to 10')	11.9%

Development Patterns	
Completed 2003-2013	659
In Progress	912
Pattern	Primarily northeast and south of EC

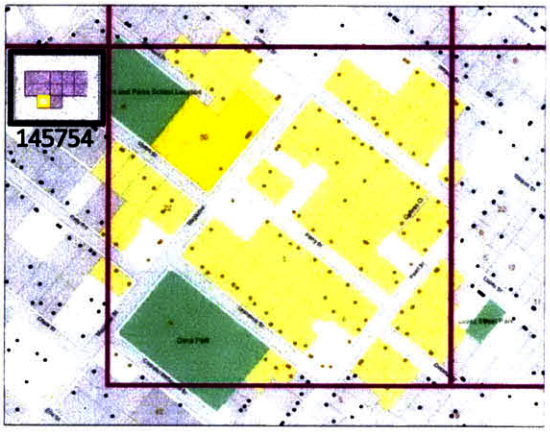
Block-Level Analyses

Block-level analyses are conducted on select MassGIS grid cells to study parking conditions at a scale analogous to residents' on-the-ground experiences. Selection of blocks is based on CS, A4 and EC findings and the location of significant projects and community debates. Below is a brief description of select cells and findings. Refer to Chapter 4 for detailed discussion and analysis.

In CS, two grid cells are examined. Cell 144124 contains the closest residential neighborhood to a recently approved development at 10 Essex Street. Cell 145754 has the greatest number of vehicles in CS and also includes recently debated Hubway station, which replaced three on-street parking spaces along Dana Park. Cell 144124 has a very low utilization rate with 75% of on-street and 25% of off-street spaces occupied at night. There is flex available in this cell's parking supply but open spaces are unevenly distributed. Some blocks are parked end to end while 100 meters away, open spaces proliferate. Herein lies a core issue in residential parking debates. Perception of a local parking problem depends on an individual's definition of what counts as local supply. For some residents, that may only include their home block or even just the few spaces in front of their residence. Given the project has on-site spaces, public transit is extremely accessible, and open capacity exists for on-street and off-street parking, the completion of 10 Essex Street is unlikely to produce a significant physical parking problem.

In 145754, most on-street spaces (93%) are occupied and off-street utilization (43%) is high compared to other observed neighborhoods. Increases in local vehicle registration and evidence of parking demand reaching on-street constraints lends credence to neighbors' protests that the

new Hubway station took away three much needed spaces. Cell 145754 appears to have a real spatial parking challenge but a high utilization rate by itself is not a problem; it indicates efficient use of existing spaces. However, the high on-street utilization rate is likely contributing to Dana Park residents' negative reactions to the taking away of spaces, particularly as they also perceive a lack of prior consultation. To rebuild trust between neighbors and city agencies, it may be worthwhile for Cambridge to absorb the costs of relocating the Hubway station to the interior of Dana Park and return three on-street spaces to local parking supply.



Study Area: **CS**

Grid ID: **10 Essex Street (144124)**

Parking Spaces	
On-Street	244
Off-Street	640

Parking Utilization	
On-Street	75%
Off-Street	25%

Vehicles	
Excise (2013)	240
RMV (2011)	182.7
% Change (RMV 08'-11')	7%

Total Population	
% Change (00' to 10')	-10%

Working Population (18-66)	
% of Total Pop (2000)	72%
% of Total Pop (2010)	78%
% Change (00' to 10')	-2%

Age Group 25-35	
% of Total Pop (2000)	24%
% of Total Pop (2010)	30%
% Change (00' to 10')	15%

Study Area: **CS**

Grid ID: **Dana Park (145754)**

Parking Spaces	
On-Street	365
Off-Street	262

Parking Utilization	
On-Street	93%
Off-Street	43%

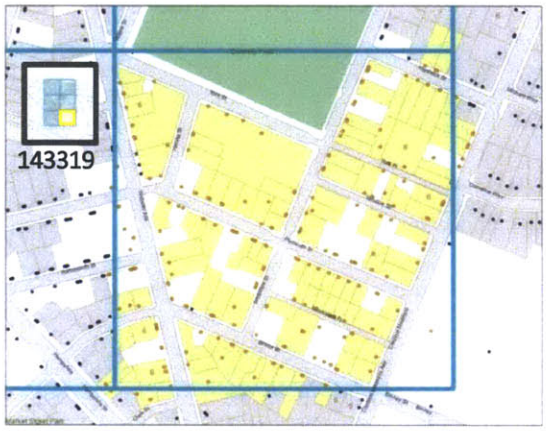
Vehicles	
Excise (2013)	251
RMV (2011)	270.9
% Change (RMV 08'-11')	15%

Total Population	
% Change (00' to 10')	3%

Working Population (18-66)	
% of Total Pop (2000)	77%
% of Total Pop (2010)	80%
% Change (00' to 10')	7%

Age Group 25-35	
% of Total Pop (2000)	26%
% of Total Pop (2010)	29%
% Change (00' to 10')	15%

In A4, cell 143319 has seen the area's largest growth (20%) in vehicle registrations from 2008 to 2011. Despite A4's high overall utilization rate and cell 143319's large registration growth, parking utilization is comparably moderate. The most recent parking-related debate in A4 involved the conversion of the Immaculate Conception Lithuanian Church at 424-430 Windsor to 14 affordable housing units, which is explored in detail in Chapter 4. This dispute referenced parking and congestion as point of dispute but the crux of some community pushback focused on other social issues, centered on perceptions of affordable housing. This dynamic highlights a major issue in understanding how to approach residential parking challenges in the context of urban growth. That is, in some of these development debates, is parking really the central concern?



Study Area: **A4**

Grid ID: **South of Donnelly Field (143319)**

Parking Spaces	
On-Street	284
Off-Street	252

Parking Utilization	
On-Street	82%
Off-Street	36%

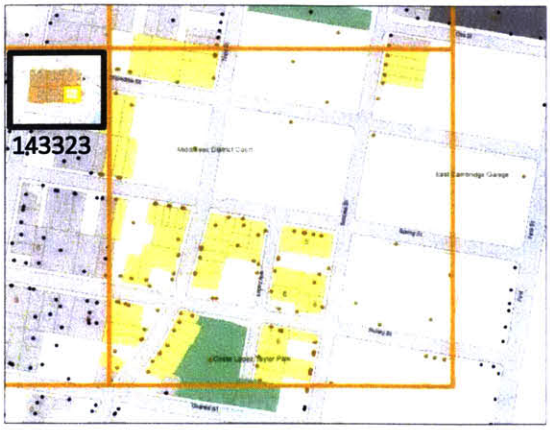
Vehicles	
Excise (2013)	411
RMV (2011)	323.4
% Change (RMV 08'-11')	20%

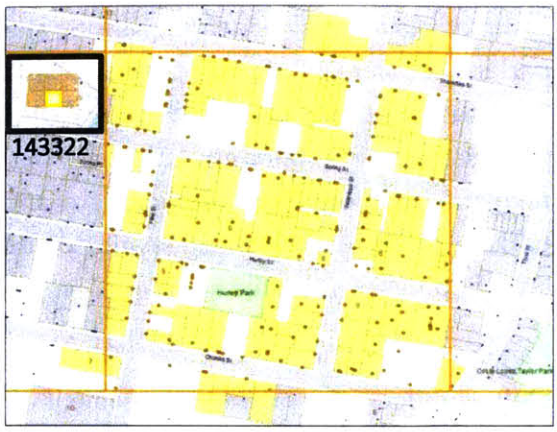
Total Population	
% Change (00' to 10')	-12%

Working Population (18-66)	
% of Total Pop (2000)	73%
% of Total Pop (2010)	80%
% Change (00' to 10')	-4%

Age Group 25-35	
% of Total Pop (2000)	25%
% of Total Pop (2010)	35%
% Change (00' to 10')	21%

The Sullivan Courthouse redevelopment is EC's most significant planning issue. As of completion of this thesis, the Cambridge Planning Board has not ruled on the developer's special permit application for a mixed use tower with 92 on-site parking spaces and 420 off-site in a yet to be decided location (likely First Street Garage or Galleria Mall). Block-level analysis is conducted on grid cells containing the courthouse (143323) and the dominantly residential neighborhood adjacent to it (143322). On-street parking utilization is unevenly distributed with residential streets nearly full while nearby mixed use and public streets remained empty.





Study Area: **EC**

Grid ID: **Sullivan Courthouse (143323)**

Parking Spaces	
On-Street	254
Off-Street	1451

Parking Utilization	
On-Street	48%
Off-Street	6%

Vehicles	
Excise (2013)	185
RMV (2011)	132.9
% Change (RMV 08'-11')	0%

Total Population	
% Change (00' to 10')	-24%

Working Population (18-66)	
% of Total Pop (2000)	80%
% of Total Pop (2010)	83%
% Change (00' to 10')	-21%

Age Group 25-35	
% of Total Pop (2000)	27%
% of Total Pop (2010)	33%
% Change (00' to 10')	-6%

Study Area: **EC**

Grid ID: **West of Courthouse (143322)**

Parking Spaces	
On-Street	315
Off-Street	351

Parking Utilization	
On-Street	95%
Off-Street	29%

Vehicles	
Excise (2013)	401
RMV (2011)	393.3
% Change (RMV 08'-11')	11%

Total Population	
% Change (00' to 10')	-11%

Working Population (18-66)	
% of Total Pop (2000)	74%
% of Total Pop (2010)	81%
% Change (00' to 10')	-2%

Age Group 25-35	
% of Total Pop (2000)	26%
% of Total Pop (2010)	32%
% Change (00' to 10')	8%

1.4 Spatial, Political and Institutional Challenges

The parking debates explored in CS, A4 and EC are broken down to spatial, political and institutional challenges. This breakdown helps to lay out the fundamental components of a parking dispute and helps in the crafting of feasible and effective interventions.

Spatial takes account of physical issues surrounding parking supply (on-street and off-street spaces) versus demand (local vehicles), as well as access to existing parking spaces (pricing, physical access and public awareness). Political takes on the differences in perceptions, opinions

and motives among residential parking stakeholders. A political challenge is the perception of a parking problem, which is separate and irrelevant to the existence of an actual spatial problem. An institutional perspective identifies the governmental and regulatory capacities required to address residential parking challenges. Institutional challenges would be a lack of staff, regulatory authority, technical capacity and other resources to mediate spatial and political parking problems. A detailed spatial, political and parking breakdown of CS, A4, EC and block-level findings is available in Chapter 5.

Parking Interventions

Different ideologies on the management of public property are used to formulate parking interventions.

1. Leave it to the streets (do nothing) – No intervention, leaving parking issues for individual parkers to resolve among themselves.
2. Public resource (manage as a public asset) – City government treats curbside spaces as a public good. Design of pricing and access to spaces is guided by city-wide goals.
3. Public resource with private rights (public spaces belong to 'locals') – City government assumes 'local' residents have first priority to curbside parking spaces in close vicinity to their home. Each resident assumes they have a right to a space. This ideology best represents current residents' expressed opinions about entitlement to on-street parking. Under current conditions where registered vehicles exceed on-street spaces, each resident in fact has the right to a fraction of an on-street space.

Parking interventions examined in this thesis can be broadly described as changes to the Residential Parking Permit program, shared parking uses and tie-ins to new development approvals. These interventions are within the means of Cambridge's local government and agencies. Changes to the RPP system include alterations to price, spatial limits, permit recipient eligibility and total quotas. Cambridge's current RPP program charges little for permits ($25), is applicable city-wide in RPP only streets, available to anyone with a Cambridge-registered vehicle, and has no quota in terms of total permits granted.

Shared parking arrangements use a single parking supply (garage, lot or curb spaces) to meet the needs of multiple parking user groups. For example, allowing access to only residents at night, then opening it up to non-residents in the daytime. Cambridge already employs shared parking measures at small scales, usually in areas of mixed land uses adjacent to residential areas. Tie-ins to new developments are measures and commitments required of a developer before he/she receives approval for a project. To manage parking concerns, measures could include requirements on new tenants to not own a vehicle or not participate in the RPP program. It could also include transportation demand measures including incentives for non-

SOV travel (free transit passes, Hubway, Zipcar, etc) and disincentives for driving (high parking fees). Each ideology pushes for the use of different interventions. For an expanded discussion on interventions recommended for each, refer to Chapter 5.

The following table summarizes how ideologies on managing public property generally address parking issues in CS, A4 and EC.

KEY N: Issue not addressed --: Issue somewhat addressed. Y: Issue fully addressed			Ideologies		
			No Intervention	Public Resource	Priority to 'Locals'
Parking Issues	CS	Spatial: Localized high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception lack of community input	N	Y	N
	A4	Spatial: Generally high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception affordable housing decreases neighboring property values	N	N	N
		Political: Perception area has too much affordable housing	N	N	N
	EC	Spatial: Localized high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception courthouse and proposal are inappropriate for residential area	N	--	N
		Political: Perception courthouse-related decisions have ignored the community	N	N	N

Evaluation Metrics

This thesis describes parking interventions in broad strokes and therefore does not contain the specific details required for a robust evaluation of interventions. However, evaluation is an important component in the implementation of any public policy. From spatial, political and institutional perspectives, evaluation metrics should target,

- Effectiveness (How far does it go to solve the problem?)
- Efficiency (What are the likely costs and to what benefit or profit?)
- Equity (Is it 'fair'?)

- Environmental responsibility (What are the likely environmental impacts of the intervention, direct and indirect?)
- Feasibility (Given current conditions and resources, how feasible is it politically and institutionally?)
    - Feasibility of Implementation (getting it started)
    - Feasibility of Maintenance (keeping it going for the long-term)

After an intervention is implemented, evaluation and incremental refinements of the policy are essential steps in resolving parking challenges.

1.5 Conclusions & Next Steps

Residential parking debates are complex and need to be approached from spatial, political and institutional perspectives. Failing to do so will leave policy makers blindsided by physical parking problems, challenges from stakeholders and/or limits on existing institutional capacity.

Parking is a public asset and should be managed as such. Of the three ideologies explored in this thesis, treating curbside parking supply as a public resource is the most effective stance to address spatial and political issues.

'Is it really about parking?' Urban growth and parking debates are not always driven by spatial concerns of parking supply versus demand. Some debates are rooted in deeper social anxieties. Parking interventions cannot change individuals' opinions on new people, developments and affordable housing. But understanding the real drivers of neighborhood protest can help policy makers evaluate their options.

RPP prices are too low. Increasing the price of residential parking permits on an income-based scale is one of the most important interventions the city of Cambridge can undertake in the near future. Raising the price of permits would alleviate many of the spatial parking challenges tied to high demand. This is a challenging task, particularly in light of today's very inexpensive permit price. It will require significant political capital on the part of government officials and documentation of the benefits of the increase.

Data, data, data. Cambridge needs an inventory of existing parking spaces, including non-metered on-street and off-street supplies. Limited data on parking supply hinders the development of effective parking interventions. Given the amount of information collected in a limited time frame by a single researcher, there are clear opportunities to inventory parking at a large scale using only minor city resources. It just has to be made a priority. A survey of parking utilization every 2-3 years in growing neighborhoods would provide important longitudinal data on local parking conditions, which can inform future policies and document the actual impacts of new developments.

Campaign. Another important next step is the continuation of proactive campaigning by city agencies, councilors, and neighborhood groups in complicated proceedings such as the Sullivan Courthouse redevelopment. Without pressure, the Commonwealth of Massachusetts will not go out of its way to accommodate the needs of the city or local residents. It is the responsibility of the city government and its citizens to advocate for their interests, particularly in a development proposal that has the capacity to reshape a neighborhood.

Residential parking debates can invoke impassioned reactions from even the sanest individual. Finding a solution that addresses spatial, political and institutional issues is challenging, requires accurate information, often multiple interventions and a willingness to attempt, evaluate and learn from errors. It can be done. The findings of this research illustrate the complexity of parking problems but also provide a framework for breaking parking challenges down to fundamental issues and developing effective interventions.

Chapter 2: Existing Literature

2.1 Residential Parking Research

Residential parking is a relatively contemporary area of research. Most parking-related studies have primarily dealt with commercial parking (available to the public for a fee or free) and employer-based parking issues. What has been studied in residential parking is the connection between the existence of and access to residential spaces with levels of auto ownership and travel mode choices. Rachel Weinberger's work connects the availability of off-street residential spaces with a proclivity to drive to work. (Weinberger, Seaman, & Johnson, 2009; Weinberger, 2012) A guaranteed space at home, thereby, increases the likelihood of a driving commute even between locations well provisioned with public transportation options. Zhan Guo's research has shown that the availability of free on-street parking is correlated with higher rates of private car ownership among households with access to off-street spaces. (Guo, 2013b)

2.2 Managing Residential Parking

In managing residential parking, street width standards, zoning laws and parking permit programs are the main policy interventions.

Street widths often include curbside parking lanes under the assumption that the additional width is necessary for the safe passage of emergency vehicles and that a market demand exists for curb spaces. (Institute of Transportation Engineers, 1997; Southworth & Ben-Joseph, 1995) Highway standards publications advise localities to decide by site and context on the necessity of building wider streets to accommodate on-street parking lanes. Yet a majority of US planning departments include parking by default in their standard residential street widths. (Ben-Joseph, 1995) This default inclusion of parking lanes is now being critiqued as contributing to an oversupply of parking at the loss of other land uses. Recommendations for reform include removal of parking mandates from local street standards and treating the issues of market demand for parking and traffic flow as separate issues of respectively site specific development needs and transportation needs. (Guo & Schloeter, 2013)

Zoning laws have predominantly applied minimum parking standards to different land uses. In the last decade, however, these standards have come under increased scrutiny. Minimum parking standards are based on fitted curve equations from the Institute of Transportation Engineers' (ITE) trip generation studies, which are now acknowledged as having a suburban land development bias. (ITE, 2008; Lee, Rees, & Watten, 2010) Similarly, there are issues with the verbatim application of ITE ratios in local codes despite ITE notations on the statistical insignificance of some of their fitted line equations. (D. Shoup, 1999) Urban planners and parking researchers today are largely pushing for using parking maximums in zoning code. Though elimination of zoned parking minimums is widely advocated for in progressive

planning circles, a survey of US planning officials reveals that removal of minimums still strikes many localities as too drastic. (Guo & Ren, 2013; D. C. Shoup, 1995; D. Shoup, 1999) These perceptions may slowly shift as more cities reform their parking standards and evidence of positive impacts become apparent. In London, a combination of removing a parking minimum and instituting a parking maximum contributed to a ~40% reduction in residential parking supply, indicating the previous parking minimum was forcing developers to build an oversupply of parking. (Guo & Ren, 2013)

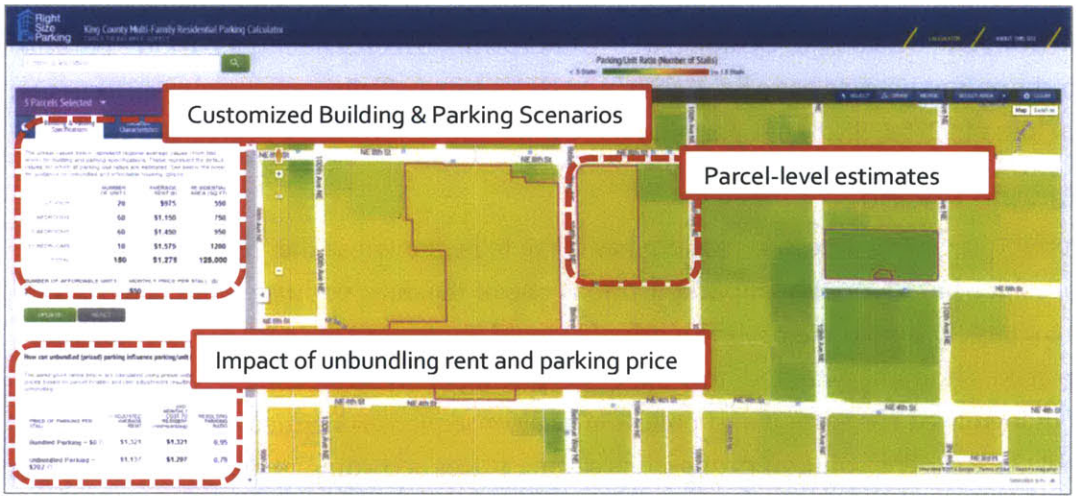
Residential parking permit programs are intended to ease parking problems for residents by limiting access to on-street spaces in residential areas to either only city residents (policy in Cambridge, MA) or to residents of a specific neighborhood. In New York City, half of households were found to be willing to pay for a residential parking permit program with the average price being $408 per year. But the willingness to pay varies by neighborhood on-street parking conditions and decreases with higher levels of car ownership and usage. (Guo & McDonnell, 2013) Recent work in Berkeley, California evaluated the efficiency and equity of the city's permit program. Residential on-street spaces were found to be under-utilized and the current regulations deemed inequitable to non-residents 'who have a justifiable right to the street.' (Moylan, Schabas, & Deakin, 2013) Underpriced (free) residential parking permits in Dutch shopping districts have been shown to be a source of substantial welfares losses with the annual loss of €275 (~$378) per permit. (van Ommeren, de Groote, & Mingardo, 2013)

2.3 Parking Pricing

The correct pricing of access to parking has come to be known as the 'right pricing' or 'performance-based' pricing of parking and is one of the most popular subjects in parking research, largely due to the prolific work of Donald Shoup and his acolytes (self-termed Shoupistas). Shoup has studied how the underpricing of on-street commercial parking can result in increased congestion and pollution as a consequence of added cruisers seeking cheap, available spaces. The solution proposed is setting prices according to demand to allow for a one or two available spaces per block. Funneling parking revenue into neighborhood improvements can improve the political palatability of higher parking prices (Kolozsvari & Shoup, 2003; D. Shoup, 2004, 2005, 2007) The momentum of ideas surrounding 'right pricing' of spaces has led to pilot programs such as San Francisco's SF Park program, which uses smart meters and parking sensors to measure utilization and accordingly adjust prices. (Kaufman, Formanack, Gray, & Weinberger, 2012)

SFpark embedded parking space sensor and smart parking meters

Seattle is using similar pricing concepts but with a low-technology approach that can be readily adapted to other cities. Using manually measured on-street parking conditions before and after 2011 parking rate changes (increases and decreases), they are establishing demand elasticities for different neighborhood types. In addition to improvements to the county's pricing strategies, this work has produced comprehensive tools such as the 'King County Right Size Parking Calculator,' a web-based application that estimates parking use for multi-family developments. (Center for Neighborhood Technology, 2013; Kaufman et al., 2012; Ottosson, Chen, Wang, & Lin, 2013; Rowe, 2013)

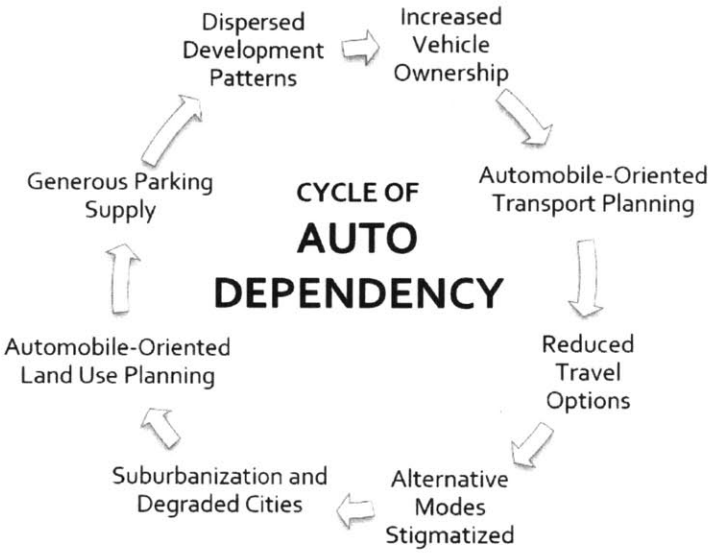


King County Right Size Parking Calculator (http://www.rightsizeparking.org)

2.4 Oversupply: Consequences & Solutions

Parking in all types has been built up to a point of excess, a widely acknowledged point among urban planning practitioners and academics. (Amos & Schlossberg, 2014; Ben-Joseph, 2012; Gebhart, 2013; McCahill & Garrick, 2010) Areas of local scarcity do exist but existing regulations and building standards have created in aggregate, an oversupply of parking. The oversupply has negative environmental consequences such as increasing runoff via impervious surfaces and exacerbation of the urban heat island effect. (Davis, Pijanowski, Robinson, & Engel, 2010; Höglund, 2004) Excessive parking also supports low-density development. By contributing to sprawl, the oversupply of parking creates built environments unaccommodating of non-auto

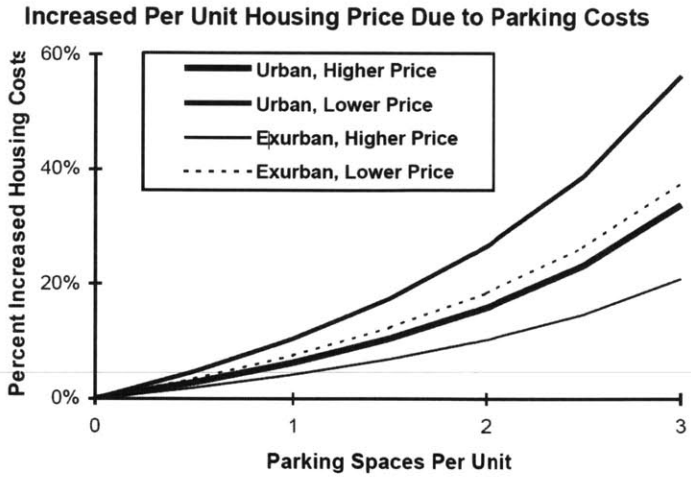
mode options, furthering a cycle of auto dependency and undercutting the competitiveness of public transit by changing the underlying cost structures of individual mode choices. (Litman, 2012; Weinberger et al., 2009; Willson, 1995)



Cycle of Auto Dependency (adapted from Litman 2013a)

Too much parking also impacts the cost of development as the aforementioned zoning-based parking minimums mandate a specific baseline of parking spaces irrelevant of context and even developers' own measure of what will actually be utilized. In this way, excessive parking negatively impacts social equity goals by increasing housing costs and creating obstacles to the development of affordable housing. (Cohen & Strickland, 2002; Litman, 2013b; Manville, n.d.)

Increase per Unit Housing Price Due to Parking Costs



'Shows parking costs as a percentage of housing costs for different construction and land costs. The percentage is greatest for lower price urban housing. This does not include additional indirect costs and non-market, such as reduced green space.' (Litman 2013b)

One possible reform is unbundling the cost of parking from the cost of housing. Unbundling has been shown to reduce parking demand by 10 to 20%. (Litman, 2013a)

In a San Francisco case study, the availability of both carsharing and unbundled parking in a building was found to affect residents' decisions to become carshare members. (ter Schure, Napolitan, & Hutchinson, 2012)

Sharing parking facilities can also reduce the overall amount of land used for parking. Among user groups with different peak parking demand periods (eg. commuters and local residents), sharing parking facilities can be an efficient time-based allocation of parking types. Research at the Urban Land Institute suggests that shared parking could reduce overall parking supply by 5 to 49%. (Kuzmyak, Weinberger, Pratt, & Levinson, 2003) Shared parking arrangements require a legally binding agreement approved by the local government. Some cities that have already created official allowances for shared parking, including Arlington County, VA; Portland, OR; San Diego, CA and Seattle, WA. (Johnson et al., 2011) But a recent parking stakeholder survey has revealed obstacles to successfully implementing shared parking, including a lack of guidance from local municipal codes and parking minimums that are too high. (Dyett & Bathia, 2012) Cambridge has made steps in the right direction with a new 'parking district' arrangement with developments at Northpoint. Multiple buildings and user types will be able to share use of single parking facilities, allowing for an efficient allocation of parking and an overall smaller supply. (Metropolitan Area Planning Council (MAPC), 2014; O'Brien, Manz, Chang, Ferrentino, & Salvucci, 2013) This is a departure from current regulations which stipulate off-street parking must be within 300 feet of the building being served for most non-residential uses and 3000 feet for specific institutional (educational) uses. (City of Cambridge, 2013a)

2.5 Stakeholders

A diversity of stakeholders and motives are involved in parking. Stakeholders include regulatory and public agencies such as local government officials, city planning and transportation departments; private entities including employers, developers, financiers and private parking operators; and public groups such as residents and neighborhood businesses. Motives can range from placating constituents, attracting business investment and real estate development, ensuring accessibility, achieving sustainability goals, increasing profit, reducing financial risk and guarding the status quo. Coordinating communication and cooperation across these parties is a complex endeavor but essential for achieving parking reforms. Existing research, however, is fairly limited on the subject of parking stakeholders. A recent study framed stakeholders and roles based on groupings of parking consumers, non-consumers, suppliers and governmental bodies. Their breakdown was based on a series of interviews with academics who have published interests in parking. (Beetham, Enoch, Morgan, & Davison, 2014)

Table 2. Car parking stakeholders according to group and role.

Organization of parking stakeholders according to group and role (Beetham et al., 2014)

Group	Role	Stakeholders	
Non-consumers	Individual non-user	Pedestrians	
		Cyclists	
		Public transport user	
Consumers	Individual user	Disabled people	
		Residents	Owners
			Renters
		Commuters	
		Employees/trade unions	
		Travellers	Business
			Leisure
		Shoppers	
		Visitors	
	Local business sector	Retailers	
		Employers	
		Financiers to developers	
Suppliers		Developers	
		Architects	
		Professional associations	
	Parking industry	Public transport providers	
		Parking operators	
		Parking entrepreneurs	
		Technology providers	
		Parking enforcers	
Governmental	National Regional Local	Officers	City planners
			Transport planners
			Traffic engineers
		Politicians	Councillors

Based on further interviews with stakeholder groups, the researchers consolidated stakeholders' perceptions of parking as either contributingly positively (+) or negatively (-) to specific value categories. For example, a (-) in the 'efficient use of land' category indicates the stakeholder believes parking is an inefficient use of land.

Table 6. The losses and gains of how stakeholders value car parking according to stakeholder groups.

Stakeholders' valuation of parking (Beetham et al., 2014)

		Parking stakeholders				
		Non-consumers	Consumers	Local business sector	Parking industry	Governmental
Significant ways that stakeholders value parking	Efficient use of land	–	+	+ / –	+ / –	+ / –
	Impact on public space	–		+ / –		
	Facilitates access		+		+	+
	Sustains economic activity		+			
	A commercial product			+		
	Revenue stream				+	+
	Convenience, safety and price				+	
	Part of an efficient transport system					+

An alternative approach of framing stakeholder groups and understanding their motives is through understanding their positions on different aspects of urban growth. This perspective-based approach is applicable to this thesis' focus on managing residential parking in the context of urban growth. Cara Ferrentino conducted a thorough analysis of Cambridge's complex history of parking policy development and identified stakeholder groups as differentiating into sets that are highly supportive of growth (termed the 'growth coalition'), hesitant about growth ('limited growth') or intent on encouraging growth but with specific directions and attributes ('planned growth'). (Ferrentino, 2013) Further details on the three groups are as follows,

Figure 0-3: Growth Groups in Cambridge Parking Policy History

	Growth Coalition	Limited Growth	Planned Growth
Growth should be:	encouraged to support tax base	limited, controlled	planned, managed
Livability as:	resulting from ample funds for city services and programs	low-density, neighborhoods, little traffic, affordability	density, mixed use, transit, walking, biking
Parking:	no caps or controls to avoiding harming development	caps on parking to limit total development	should be minimized; debate over whether parking cap is effective
Characterized by others as:	for growth at any cost	anti-growth	bureaucrats, technocrats

Cambridge parking stakeholders organized by perspectives on growth (Ferrentino, 2013)

Few people escape the issues surrounding residential parking. Thereby, everyone is a stakeholder in the ongoing debates on how best to manage residential parking in the context of urban growth. Yet the field is generally under-researched with a major obstacle being a lack of data. This thesis collects highly specific block-level data on parking supply and utilization in Cambridge and analyzes important greater contexts of sociodemographic and development trends. Based on this new information, knowledge of best practices and current research, specific interventions are proposed for case study neighborhoods. In taking these steps, this thesis beings greater insight to ongoing parking debates and provides new data for continuing residential parking research.

Chapter 3: Methodology & Data

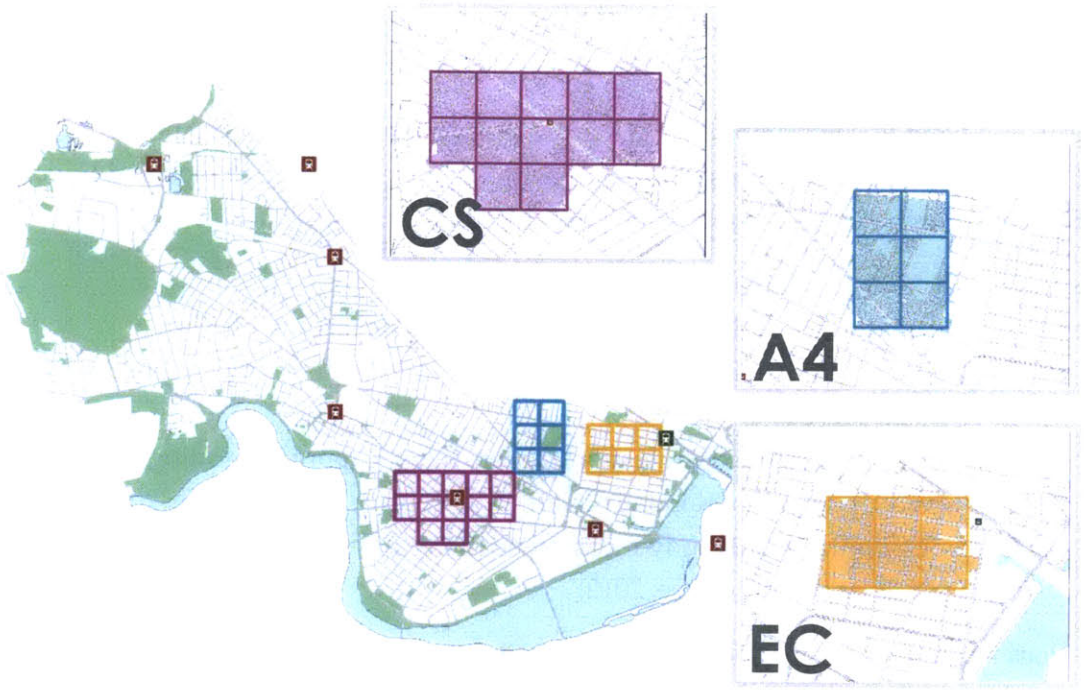
3.1 Case Study Neighborhoods

Three areas (CS, A4 and EC) in Cambridge, MA are selected as study sites for an in-depth analysis of parking conditions, patterns of development, sociodemographic change and travel behavior. Selection was based on the following considerations,

- Ensuring a diversity of residential and non-residential uses
- Inclusion of currently debated and/or recently approved developments
  - Sullivan Courthouse (EC)
  - 10 Essex Street (CS)
- Proximity to currently under consideration and/or recently approved zoning changes
  - Approved Upzoning of Kendall Square PUD-5 (City of Cambridge, 2013d)
  - Consideration of K2C2 Study recommendations for Central Square (Central Square Advisory Committee, 2012)

The multi-block study sites are located in neighborhoods commonly referred to as Central Square, Area Four/Wellington-Harrington and East Cambridge. Each is a moderately dense residential neighborhood with differing levels of non-residential activity. For clarity and brevity, the study sites are referred to as CS, A4 and EC. These abbreviations serve to distinguish thesis sites from official Cambridge neighborhoods which have similar names but reference different spatial boundaries. (Cambridge CDD, 2012)

For scale reference, all grid cells, as illustrated in the figures below, are official MassGIS 250 meter by 250 meter cells. In subsequent maps which include these grids, the MassGIS cells can be used as a distance scale.



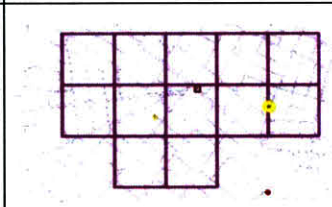
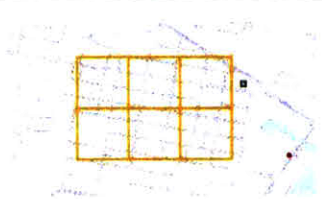
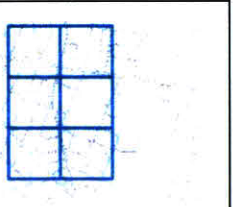
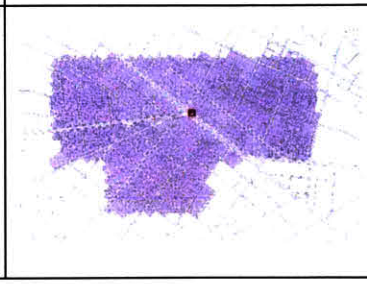
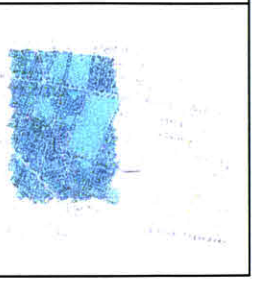
CS contains the Central Square T station with approximate boundaries lying just west of City Hall, south of Dana Park, north near Harvard Street and east at the Osborne Triangle. Of the three study sites, it contains the most active commercial uses and has the highest level of access to public transit including the T station and multiple bus lines. It also overlaps with neighborhoods examined in a recent K2C2 planning study, which recommended changing the zoning code in Central Square along Massachusetts Avenue to allow for higher built densities, reduced parking ratios, implementation of parking maximums and various other building requirements. (K2C2 Planning Study Team, 2013a) In CS, one of the most recently debated developments is 10 Essex Street, an infill project that will replace a parking lot at the corner of Essex and Bishop Allen Drive. Debate concerning its approval has centered on its planned height, amount of built residential parking and to a lesser extent from some community activists, its quantity of affordable units. (City of Cambridge, 2014b)

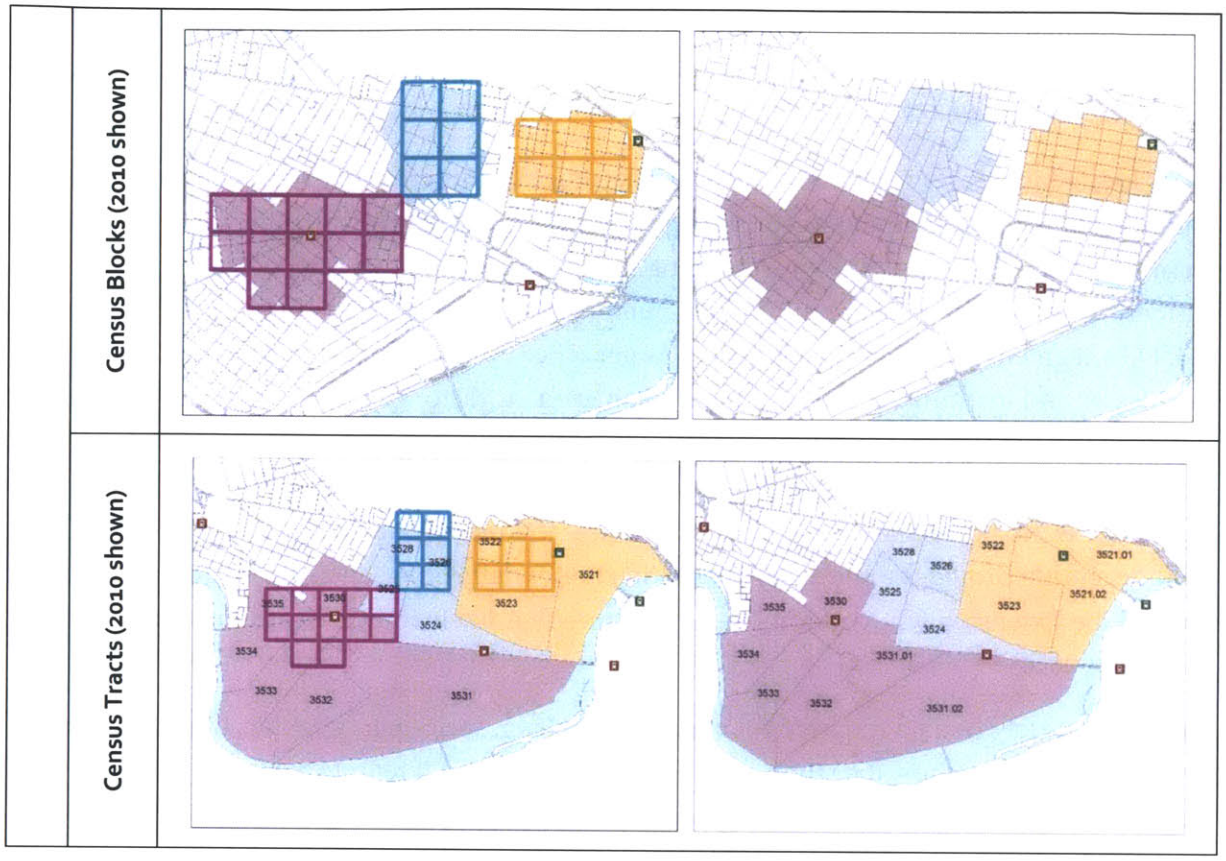
A4 is the most residential of the three sites. It includes blocks north of the Hampshire Street and Webster Avenue intersection, south of the Somerville/Cambridge border, east of the Elm Street and Hampshire Street intersection and just west of the Cambridge Street and Berkshire Street intersection. These are heavily residential blocks with most parcels dedicated to housing in the form of 3-5 story multi-family buildings. Cambridge Street has many small storefronts such as barber shops, general stores and restaurants. In comparison to CS's commercial activity on Massachusetts Avenue, A4's commercial section of Cambridge Street is less dense in terms of non-residential uses and is active for a shorter daily time period. Of the three sites, A4 is the

farthest from a T station and has the least amount of access to public transit. That being said, the northernmost edge of A4 is still within a 20-30 minute walk from Central and Kendall Square T stations while the 69, CT2 and 85 buses provide north-south and east-west connections.

EC is located just east of A4 and includes blocks roughly bordered by Charles Street to the south, Fulkerson Street in the west, Monsignor O'Brien Highway towards the north and the Cambridgeside Galleria developments along the eastern edge. At its core, EC is primarily residential with triple decker multi-family buildings but has greater commercial activity than A4. EC's segment of Cambridge Street has larger office buildings, and a greater variety of businesses and institutions. An additional commercial attractor is the shopping mall at Cambridgeside Galleria. EC is readily accessible to public transit with its adjacency to Green Line at the Lechmere T station, multiple bus lines and the EZRide Shuttle. The 80, 87 and 88 buses link EC to Somerville while the 69 connects it to Inman Square and Harvard Square. The EZRide shuttle provides a southerly connection to Kendall Square and MIT. With the upcoming Green Line Extension (GLX), additional urban growth is likely in EC. (Reardon, Martin, & Partridge, 2014)

Given the variety of data required for analyzing parking, socio-demographic, travel behavior and development trends, the study areas of CS, A4 and EC will refer to a variety of areas defined by different spatial units. For instance, information on parking is available per parking space whereas demographic information is only available at the census block level. Study area boundaries used in this thesis are illustrated in the below table.

		Study Areas		
		CS	EC	A4
Spatial Units	250 by 250 meter MassGIS grid			
	Tax Assessing Parcels			

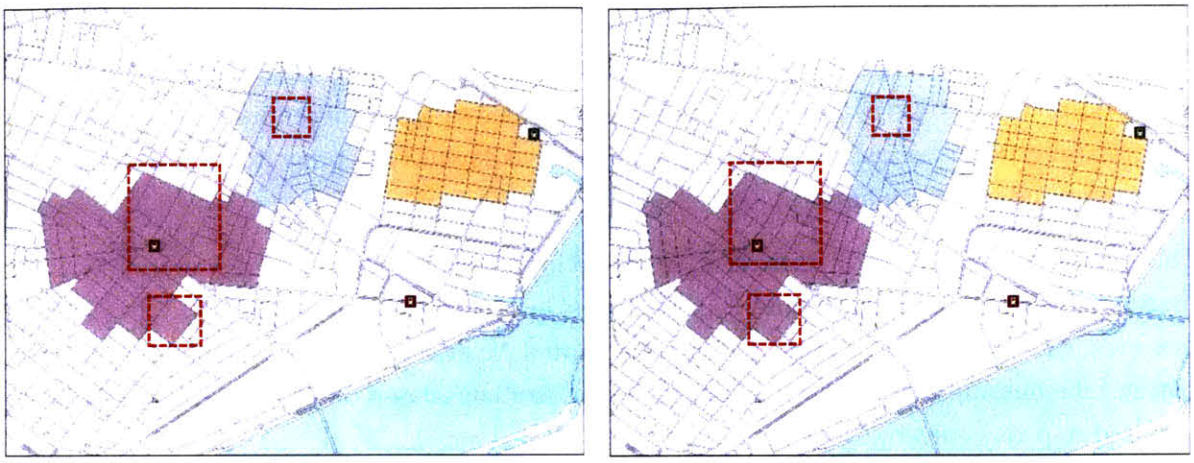


3.2 Data Sources

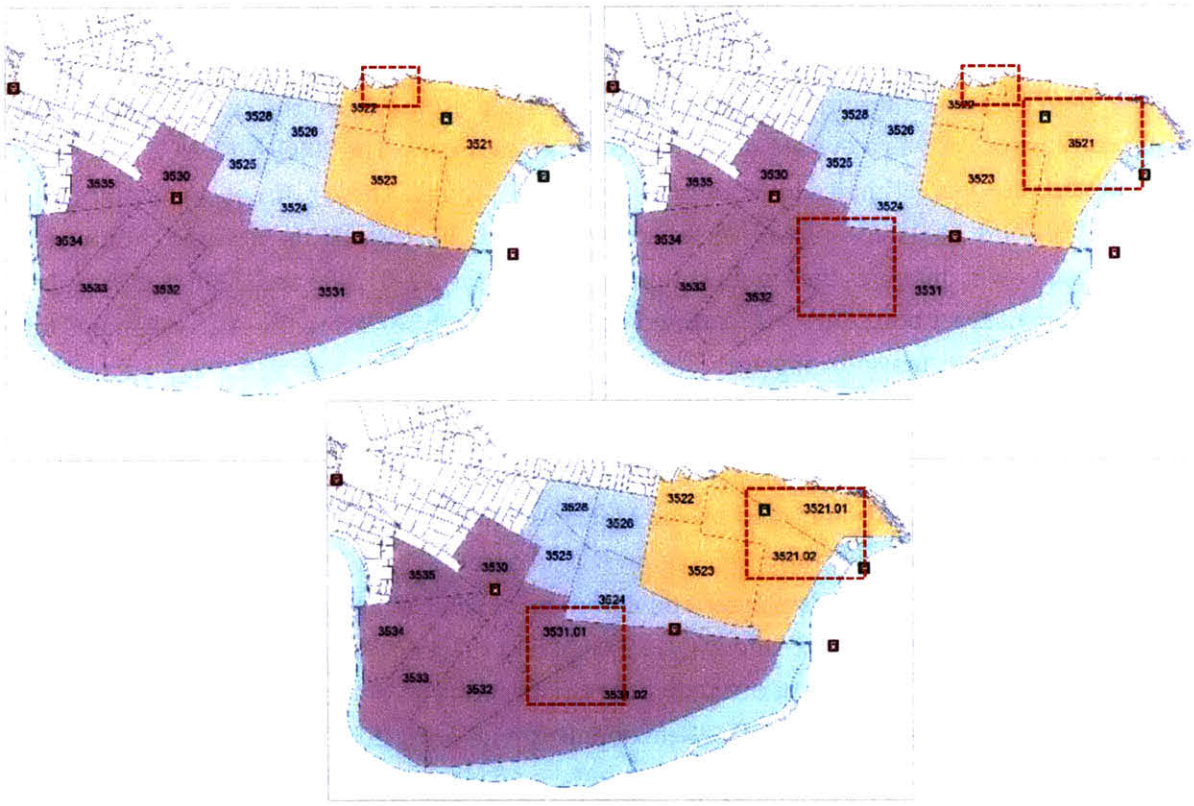
Data were pulled together from disparate sources including the US Census Bureau; Registry of Motor Vehicles (RMV) via MassGIS; Cambridge city departments of Community Development, Assessing, and Traffic, Parking and Transportation; and manual counts of parking spaces and parked vehicles.

3.2.1 United States Census Bureau

All Census data from Middlesex County were downloaded directly from the American Factfinder website <http://factfinder2.census.gov/>. Decennial Censuses (1990, 2000, 2010) and American Community Surveys (2008-2012) provide data for socio-demographic and travel behavior analyses. Boundaries of official spatial units such as blocks and tracts have changed over time. In making comparisons between different years, care was taken to select study areas that contain approximately the same boundaries year over year.



Census block study areas (left to right, 2000 and 2010) Differences in block boundaries are highlighted in red.



Census tract study areas (clockwise from left, 1990, 2000 and 2010)
Differences in tract boundaries are highlighted in red.

Decennial Census

The US Census Bureau conducts a full census of the population every ten years. It is the most complete count of American persons and households, with information on sex, age, race, Latino or Hispanic origin, household relationship, household type, household size, family type, family size group quarters, occupancy status, vacancy status and tenure. At the smallest unit, data are available by census block, which can then be aggregated into block groups, tracts, states and

other units. Population and household counts use census block study areas as illustrated above. However, the once a decade frequency of the census makes it unsuitable for capturing present day conditions in 2014. Thereby, this thesis uses sociodemographic decennial census data to understand general trends in population and age breakdowns rather than to take an exact measure of today's population.

The census is also a source of data on travel behavior. Commute mode and destination questions were part of the 1990 and 2000 censuses' long form surveys. (Cook, 2012) In 2010, however, the long form was replaced with the annual American Community Survey (ACS). In place of the missing 2010 long form survey, 5 year estimates based on 2008-2012 ACS surveys are used to proxy current travel behavior.

American Community Survey (ACS)

ACS is a source for up-to-date sociodemographic and travel behavior estimates. The Census Bureau conducts the ACS every year, sampling ~1% of the total population. Given the small sample, data contain a margin of error in the extrapolated estimates for the entire population. Multiple years of ACS surveys are combined for finer estimates. The 2008-2012 ACS 5 year estimates are used as estimates for commute mode splits today. These estimates, in combination with the 1990 and 2000 decennial censuses commute data, illustrate shifts in mode choice over time. As tract level data was the smallest unit available from 1990, 2000 and 2008-2012, study areas use census tract boundaries (illustrated above). All analyses using the ACS estimates take account of important margins of error.

3.2.2 Registry of Motor Vehicles

In early 2014, MassGIS released Massachusetts vehicle registration data from 2008-2011. This release was part of a datathon hosted by the Metropolitan Area Planning Council. The "37 Billion Mile Data Challenge" competition goal was to encourage creative uses of big, newly open transportation datasets. Passenger and commercial vehicle registrations were released, aggregated by MassGIS standardized 250 by 250 meter grid cells. Vehicle counts include fractions due to the reallocation of uniquely identifiable vehicles and unclear registration location vehicles among different cells. (Reardon, Brunton, et al., 2014) Total registrations were provided for every annual quarter. Quarter 4 totals were used for year over year comparisons. In Cambridge, locally registered vehicles are not the only vehicles primarily garaged within city boundaries. But lacking full annual walking censuses, official registrations from 2008 to 2011 provide the best insight on recent trends in vehicle ownership.

3.2.3 Tax Assessing

City of Cambridge Assessing Department regularly collect data on property parcels and is responsible for real estate valuations, property and excise taxes, and the maintenance of a

database of building/parcel information. As part of Massachusetts law, the tax assessor is required to list and value all real and personal property.

Excise Tax

Excise taxes are required for all vehicles registered in Massachusetts. Records include manually entered addresses and thereby contain inconsistencies in spelling and shortening of street types. Over 40,500 passenger vehicle excise tax records were retrieved with the help of Cambridge staff. Of these records, 38,473 had legible addresses in either 'Mailing Address' or 'Residential Address' fields and possessed a Cambridge zip code (02138, 02139, 02140, 02141, 02142). After address entries were standardized, 38,234 (>99%) of the valid Cambridge records were successfully matched and joined to GIS-based address points. Address points are geocoded to the exact door of residences and were available from Cambridge GIS. The mapping of excise taxes to address points provided an invaluable approximation of vehicle ownership in Cambridge. To check the accuracy of this process for capturing present day vehicles, the excise record-based counts are compared with vehicle registrations and manual night vehicle counts.

Assessing Database

The assessing property database contains data on valuations and other built characteristics. It is publicly available online at <http://www.cambridgema.gov/assess/propertydatabase.aspx> where queries can be conducted on specific addresses. This thesis utilizes the full FY2013 database, which is accessible from the MIT Rotch Library GIS Lab. Records for residential and condominiums are aggregated by parcel to summarize total counts of bedrooms and units. These counts were then mapped in GIS to Cambridge basemap parcel shapes. The tax assessing database provides the most current information on today's housing stock.

However, documentation is a significant problem. Official database field definitions and documentation of original data collection procedures could not be found. Thereby, errors found in assessing database records could not be resolved before the writing of this thesis. For instance, assessing records were discovered to contain inaccurate counts of off-street parking spaces. Inaccuracies were confirmed with comparisons to in-person parking space counts and Google Earth satellite imagery. Lack of definitions for what is considered a 'unit' and 'bedroom' was particularly troublesome. To approximate level of vehicle ownership per household, the assessing housing data is compared with vehicle ownership numbers from excise taxes, RMV registrations and manual counts. However, the resulting vehicle ownership ratios were much higher than expected. In consulting with Cambridge planning staff, it is surmised that the assessing database may be inconsistent in what is designated as a unit. For a multi-family building, the assessing records may record the entire building as a single unit. This would result in a severe undercount of households given the prevalence of multi-family buildings in CS, A4 and EC. Therefore, though this data provides the best estimate of current housing stock and is

still used in this thesis as a general approximation of vehicle ownership per household, caution and caveats must be placed on the applicability and accuracy of the final vehicles per household ratios.

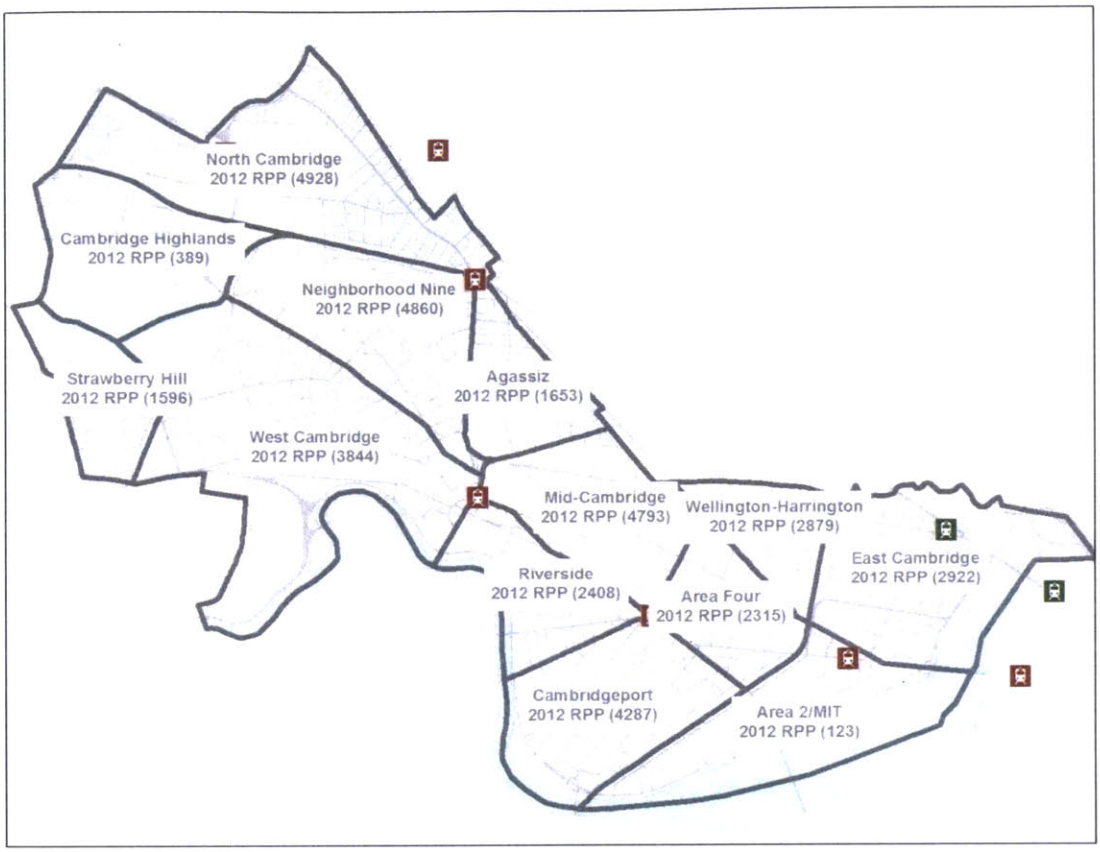
3.2.4 Traffic, Parking and Transportation (TPT)

Cambridge Department Traffic, Parking & Transportation (TPT) is responsible for public parking and traffic operations. It operates and enforces the Resident Parking Permit (RPP) program as well as maintains an inventory of registered off-street commercial parking.

Residential Parking Permit (RPP) Program

The purpose of the RPP program is to "ease parking problems in residential areas by making it illegal for non-resident commuters to park on residential streets." < http://www2.cambridgema.gov/Traffic/ResidentVisitor.cfm > In Cambridge, it is a city-wide permit, meaning a Cambridge citizen with a RPP permit can park in any Cambridge RPP only space. There are a few unique areas where parking is limited to specific communities but the majority of residential streets contain general RPP-only restrictions, which are active Monday through Saturday. Cambridge citizens must apply/renew a permit annually, a process which can be completed online or in person. Applications require proof of residency, vehicle registration and a $25 annual fee. Due to outmoded database technology, RPP data is difficult and time-consuming to retrieve. Every year, TPT requests RPP count summaries grouped by the Cambridge CDD neighborhood boundaries (refer to Appendix). At present, CDD neighborhoods are the finest spatial unit available for RPP totals. Use of RPP data is therefore limited in this thesis as CDD neighborhoods are too broad for block-level analysis.

Level of participation in the RPP program is assumed to be high amongst eligible Cambridge-registered vehicles given the low annual fee. Comparisons between RPP totals and multiple sources of vehicle counts supports this assertion. (3.4.3 Vehicle Ownership)



2012 Residential Parking Permit Totals, grouped by CDD neighborhood (Cambridge TPT)

Off-street commercial parking inventories

In the late 1990's the city of Cambridge implemented a Commercial Parking Freeze Ordinance, which was intended to limit the number of total commercial parking spaces. As part of this ordinance, an official inventory of commercial spaces was conducted. This thesis will not focus on the freeze implementation and subsequent issues with compliance but Cara Ferrentino's thesis on parking policy development in Cambridge is an excellent resource. (Ferrentino, 2013)

Commercial parking is considered parking that is available to the public for free or a fee. TPT provided the researcher with a list of currently registered off-street commercial parking spaces, which was included in this thesis' parking supply totals.

ADDED FACILITIES		OFF-STREET	
Parking Facility	Street Address	Public	Other
Private Lot (YMCA)	438 Green Street	86	20
Municipal Lot #6	38 Bishop Allen Drive	45	34
Municipal Lot #11	984 Cambridge Street	15	0
Private Lot	198 Third Street	8	0
Private Garage (Bent Realty Trust)	29 Charles Street	75	0
Municipal Lot #4	96 Bishop Allen Drive	18	0
Municipal Lot #5	84 Bishop Allen Drive	82	0
Municipal Garage	11 Spring / 51 First Street	1100	0
Private Garage (Monitor Building Public Garage)	2 Canal Park	50	127
Private Garage	78-90 First Street	2538	0
Private Lot (Barrister Trust)	201 Cambridge Street	15	0
Municipal Lot #14	15 Springfield St	30	0
Municipal Lot #8	375 Green Street	16	0
Municipal Lot #9	9 Pleasant Street	17	0
Municipal Garage	260 Green St	290	0
Private Garage	55 Franklin Street	500	502
Private Lot	45 Webster Avenue	0	0
Private Garage (1 Kendall Square Garage)	389 Binney Street / 205 B	1050	516
Municipal Lot #12	9 Warren Street	31	0

2013 Off-Street Commercial Parking Facilities in CS, A4 and EC (Cambridge TPT)

3.2.5 Community Development

Community Development Department (CDD) is Cambridge's planning agency. It manages affordable housing, conducts neighborhood scale and comprehensive planning, reviews large development projects, renovates green and recreational public spaces and plans non-auto oriented transportation infrastructure. Zoning and special permits fall under CDD's purview with its connection to the Planning Board. It also administers the Parking and Transportation Demand Management (PTDM) Ordinance, which aims to reduce city wide single occupancy vehicle travel and congestion by requiring developments to participate in a TDM plan and annual monitoring. PTDM is triggered when a project contains over a certain number of non-residential parking spaces. In addition to other city functions, CDD publishes a quarterly Development Log to track larger-scale residential and commercial project and maintains a GIS repository.

Development Log

The Development Log has been recording significant developments in Cambridge from 2003 to the present day. The Log contains development projects' address, name, developer, type of use, square footage, residential units and project status. Project status can be either completed, in

permitting or special permit granted. Criteria for inclusion in the Development Log are as follows,

- Commercial projects totaling over 50,000 square feet and any which have a significant impact on the neighborhood in which it is located.
- Residential projects of eight or more units that are new construction or rehab/renovation projects that alter the existing use either by adding to or subtracting from the existing number of units or square footage.
- All municipal projects in which a cross section of City departments may have an interest and all which are considered significant. (City of Cambridge, 2013b)

Though not a list of all developments in Cambridge, the Development Log provides a reasonable picture of recent urban growth and significant changes to come. Completed projects from 2003 to 2013 are mapped in different layers in GIS to understand the geographic distribution of urban growth in the last decade.

GIS File Repository

CDD GIS data is created and maintained for Cambridge public parks, playgrounds, and open space; zoning and zoning overlay districts; and demographic data drawn from the United States Census. Aerial imagery from 2010 was used by CDD to build detailed base maps of water bodies, pavement edges, buildings and other small features such as park benches and crosswalks. Additional manual counts were used to identify items like street trees, lamps and bike racks. Cambridge CityViewer is an online interactive map where users can explore layers of aerial imagery, transportation, development, zoning and points of interest. < http://gis.cambridgema.gov/map/Viewer.aspx> GIS data files are available for download from GitHub at < http://cambridgegis.github.io/gisdata.html> and from discs at the MIT GIS lab. Availability of CDD GIS files played a critical role in this thesis' successful mapping of parking, demographic and development data.

3.3 Residential Parking Analysis

Residential parking analysis is at the core of this thesis. The analysis seeks to answer some essential questions about the state of residential parking. How many residential parking spaces exist? What percent is utilized? How are parking spaces regulated? And for all of these questions, what is the breakdown between on-street and off-street?

3.3.1 Method Selection

At the beginning of this research, a variety of data sources and methods were attempted, troubleshot, and more often than not, put aside. The research process has inevitably included interesting tangents and dead ends.

GIS Buffer

In 2010, Eric Minikel (then MIT student) worked with Cambridge CDD to roughly estimate non-metered on-street parking spaces using GIS buffering techniques. (Minikel, 2010) The GIS estimates were compared with select manual counts in Riverside and East Cambridge. A multiplier of .91 was found to be necessary to scale the GIS estimates to actual spaces. Minikel helped provide documentation and GIS files from this prior work. Initial attempts were made to adapt Minikel's method to estimate off-street residential parking spaces. However, GIS buffering was found to be inadequate for accurately estimating off-street spaces in aggregate. The variable factors of tree cover, pavement markings, curb cuts, multi-tiered parking structures and underground garages could not be readily accounted for with Cambridge GIS layers, aerial photography and GIS techniques. The GIS buffering technique on on-street spaces was also too broad in scale to apply to block-level analysis.

Official Records

As described in the 3.2 Data Sources section, Cambridge Assessing and TPT departments have records of some off-street parking. However, assessing database records were found to have incomplete counts and TPT's inventories focused on commercial spaces. Both sources are limited in their application to residential parking. Neither would provide an off-street inventory at the level of detail and accuracy required for block-level studies.

Existing Studies

Past Cambridge parking studies were evaluated for possible inclusion in this thesis. In 2002, the Riverside Neighborhood Study examined housing and transportation conditions in specific Cambridge neighborhoods. (Stull and Lee Inc., 2003) Unfortunately the study areas were primarily in different geographic locations than CS, A4 and EC. It also did not contain a parking inventory at a level of detail needed. The K2C2 planning study looked closely at the Kendall Square and Central Square neighborhoods' development, demographics and transportation infrastructure. (K2C2 Planning Study Team, 2013b) Parking was part of the K2C2 planning study however it did not thoroughly cover on-street and off-street residential parking.

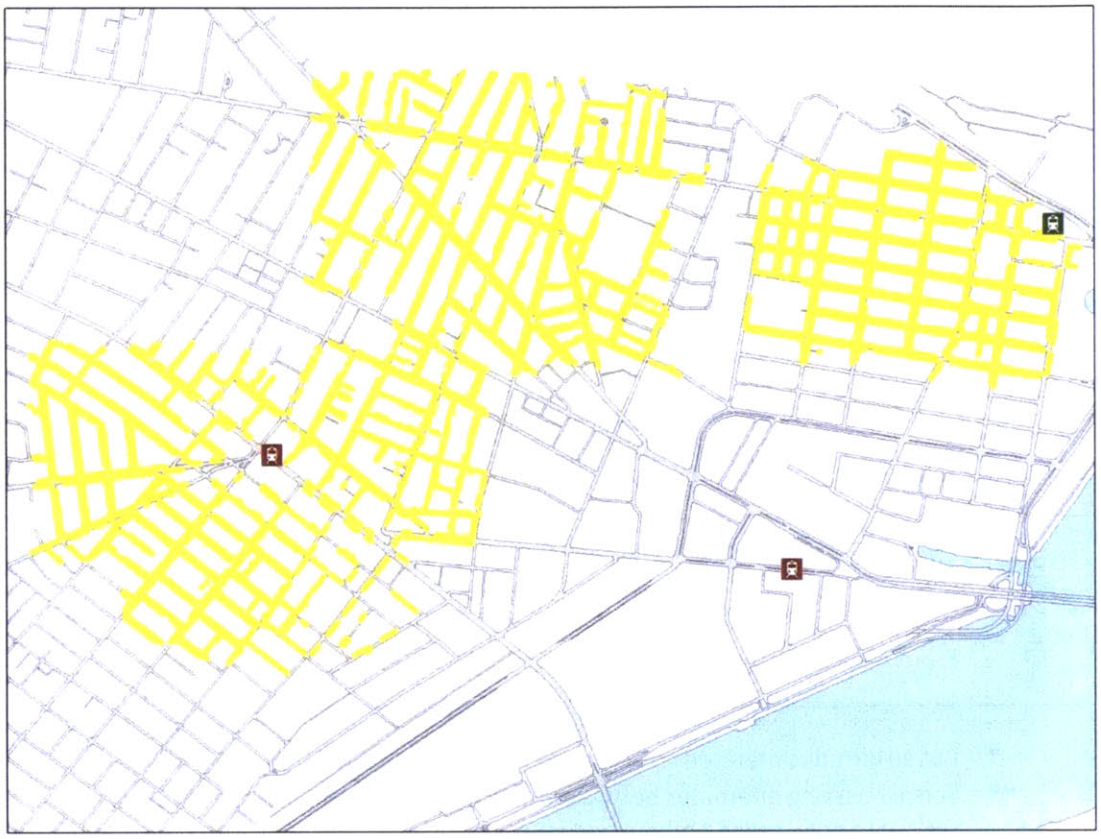
Manual Counts

Given the limitations of the GIS buffer, existing parking inventories and previous Cambridge studies, the last resort became the only option. Manual counts of parking spaces and parked vehicles were required.

3.3.2 Supply

Manual counts of on-street and off-street parking spaces (supply) in CS, A4 and EC were conducted during daytime hours. Only spaces that could be directly counted or estimated with visual observations were recorded in GIS. Any flat paved area that could be used for legal parking and fit a standard 4 door vehicle was counted as a space. The rationale behind these

classifications for a parking space stems from repeat observations of multiple vehicles parked end to end in single lane driveways. This demonstrates a willingness among many Cambridge residents to maximize use of all available flat space at the cost of efficiency in moving vehicles on and off their property. Outside of the manual counts, parking space inventories for large lots and structures, as publicly available from Cambridge, were also included.



Parking Space Counts (Map shows all counts, including areas outside of study sites)

Since parking spaces were only included if visually observed or verified from official sources, the inventoried off-street parking supply is a conservative estimate. There are likely off-street residential parking spaces that were not visible to the researcher during the manual counts nor registered in any official capacity. In contrast, the on-street space inventory is more accurate as most, if not all, curb spaces were visible from the street.

Residential Parking Supply (Spaces)				
Spatial Unit: MassGIS Grid Cells		Study Area (Grid)		
	Type of Parking	CS	A4	EC
ON-STREET	Residential Only	1816	952	1260
	Residential (Disabled) Only	13	19	21
	Available to the Public*	375	144	205
	Available to the Public (Disabled)*	22	4	7
	Zipcar	0	0	0
	Special**	0	0	19
	Total Spaces (ON-STREET)	*2226*	*1119*	*1512*
OFF-STREET	Residential Only	2697	1220	969
	Residential (Disabled) Only	4	7	2
	Available to the Public*	554	15	1198
	Available to the Public (Disabled)*	0	0	0
	Zipcar	13	3	1
	Other***	317	175	165
	Total Spaces (OFF-STREET)	*3585*	*1420*	*2335*
	TOTAL PARKING SPACES (ALL)	**5811**	**2539**	**3847**

% ON-STREET	From Residential Only Parking Spaces (includes Special**)	40.4%	44.2%	57.2%
	From ALL Parking Spaces	38.3%	44.1%	39.3%

* Public includes metered spaces and any spaces available free or for a fee.

** Special parking alternates between being available to the public and restricted to residents only, based on time and day.

*** Other includes employer-based and other business-owned parking that is restricted to employees and visitors.

In total, 6,418 on-street and 15,419 off-street spaces were mapped throughout Cambridge. Within the CS study area, there are 5,811 parking spaces (2,226 on-street and 3,585 off-street). In A4, 2,539 parking spaces were counted with 1,119 on-street and 1,420 off-street. In EC, the count totaled 3,847 parking spaces with 2,335 on-street and 1,512 off-street.

3.3.3 Demand (Utilization)

Residential parking utilization (demand) was measured at night with walking counts of parked vehicles. To measure vehicles owned and principally garaged in Cambridge, counts were conducted during the hours of midnight- 5am, on Tuesdays, Wednesdays or Thursdays, time periods when residents and their vehicles would most likely be at home. Counts occurred in

mid-April to early May 2014 when snow was no longer an issue and during days when street cleaning was not scheduled for the two days prior to or following the count. Given time and manpower limits, only one utilization count was completed for each study area and each was conducted on a separate night. This limited approach is sufficient for the purposes of this thesis. But for future studies, a robust approximation of residential parking demand should include multiple nights of counts where each study area is counted during the same time period. Like the off-street supply counts, the parking utilization counts are conservative as only vehicles that could be directly observed were recorded.

Parked Vehicle Counts (Map shows all vehicles, including areas outside of study sites)

Residential Parking Demand (Parked Vehicles)				
Spatial Unit: MassGIS Grid Cells		CS	A4	EC
# of Parked Vehicles	ON-Street	1789	1058	1340
	OFF-Street	1031	636	356
	Total Vehicles:	**2820**	**1694**	**1696**

In total, 5,173 on-street and 2,646 off-street parked vehicles were observed during night counts. Within CS, 2,820 vehicles were parked with 1,789 on-street and 1,031 off-street. A4 had 1,694

parked vehicles with 1,058 on-street and 636 off-street. In EC, 1,696 parked vehicles were observed with 1,340 on-street and 365 off-street.

Combining the manually inventoried parking supplies and parked vehicle counts produced the following utilization rates for CS, A4 and EC.

Residential Parking Utilization (Parked Vehicles Versus Spaces)			
Spatial Unit: MassGIS Grid Cells	CS	A4	EC
ON-Street	80%	95%	89%
OFF-Street	29%	45%	15%

A4 had the highest utilization rate with 95% of on-street and 45% of off-street spaces occupied. CS had the lowest on-street utilization at 80%. EC had high on-street utilization at 89% and a low off-street utilization of 15%, which can be attributed to large off-street parking facilities located in EC. As vehicles were only counted if observed and garages were not entered during the night counts, EC likely has the most severe undercount of parked vehicles. With this caveat, it is difficult to absolutely compare off-street utilization among the sites. But in general, A4 appears to have the highest demand for residential parking, CS the lowest and EC likely between the two.

3.3.4 Regulation

Residential parking regulation is primarily under the purview of Cambridge department of Traffic, Parking and Transportation (TPT). It grants residential parking permits and other traffic-related permits, TPT patrolling officers check compliance with RPP and other traffic laws, and issue parking tickets. Description of the RPP program is available under section 3.2.4 Traffic, Parking and Transportation. Total RPP's per CDD neighborhood are available from 2003 to 2012 (see Appendices).

In residential areas, the degree of parking enforcement and the level of compliance is unclear. Publicly available financial reports tally parking fine revenue collected from 1993 to 2014. (City of Cambridge, 2002, 2013c) However, without information on the hours logged in traffic patrols, the areas patrolled and the breakdown of types of fines, it is difficult to make any conclusions from these values. During the night manual counts, vehicles were observed parked in illegal spaces (in front of driveways and partially on sidewalks). But no tickets were observed and no ticketing officers seen. Cambridge's current RPP program targets outsiders and not residents so it is understandable enforcement effort would not be deployed in residential areas during hours when most on-street parked vehicles belong to locals (midnight-5am).

Revenues from parking permits, metered parking and parking-related fines are transferred to the city's Parking Fund, which is used to support City programs in accordance with Chapter 844 of the Massachusetts General laws. In June 2013, the parking fund balance totaled $15,853,757, which is dedicated to support specific programs. (City of Cambridge, 2013c)

3.4 Greater Context

Parking does not exist in a vacuum. It is part of a transportation system, a significant portion of American urban land use and a variable in individual travel mode choices. In addition to inventories of parked vehicles and parking supply, socio-demographic, property development and travel behavior contexts must be accounted for in order to decipher the nature and source of parking problems as well as to successfully plan potential interventions.

3.4.1 Socio-demographic

Changes in population and demographic makeup are measured with data from the 2000 and 2010 decennial censuses. CS, A4 and EC study areas for these population changes use boundaries defined by census blocks.

Population Change (2000-2010)

Spatial Unit: 2000 & 2010 Census Blocks	Population			Working Population (18-66)			Age Group (25 to 35)		
	2000	2010	% Change	2000	2010	% Change	2000	2010	% Change
CS	9200	9070	-1.4%	7097	7409	4.4%	2533	3246	28.1%
A4	5777	5312	-8.0%	4113	4083	-0.7%	1375	1576	14.6%
EC	4354	4044	-7.1%	3243	3243	0.0%	1133	1268	11.9%

% of Population in Age Group 25-35

Spatial Unit: 2000 & 2010 Census Blocks		2000	2010
CS	Female	29%	37%
	Male	26%	34%
	Total	**27%**	**36%**
A4	Female	25%	32%
	Male	23%	27%
	Total	**24%**	**30%**
EC	Female	23%	30%
	Male	29%	33%
	Total	**26%**	**31%**

Overall population in CS, A4 and EC has slightly decreased between 2000 and 2010 and yet the working age population (18-66) has grown. A closer analysis of the age breakdown in all three

sites strongly suggests the changes in population are not a result of a coming of age of youth in the resident population but instead is the result of an influx of adults ages 25 to 35 who at present, do not have children.

3.4.2 Travel Behavior

Travel behavior data is available from the American Community Survey (5 year estimate from 2012) and Decennial Census short form questions (1990, 2000). In the analysis of travel behavior, the areas of analysis must be based on census tract boundaries, not the blocks and grid cells used respectively for socio-demographic and vehicle registration analysis. Census tracts are larger than the grid, parcel and block-based study areas, therefore journey to work census information can only be used to understand general trends in travel behavior changes.

For 1990 and 2000 data, journey to work information is directly sourced from Cambridge's summary of mode splits for all of the city's census tracts. That report obtained 1990 data from Massachusetts' Central Transportation Planning staff, who received it directly from the Census Bureau. The Cambridge report developed 2000 data based on information from Parts 1, 2 and 3 of the 2000 Census Transportation Planning Package. (Cook, 2012)

For 2008-2012 estimates, information is obtained directly from the Census Bureau's American Community Survey (ACS) 5 year estimates. Three scenarios are used to cover the range of possible mode splits, given margins of error in ACS data. Drive alone mode split's margin of error range is used to differentiate scenarios because single occupancy drivers is the mode most directly connected to local parking demand.

The first scenario, 'Estimated Drive Alone,' uses the 5 year estimate for 2008-2012's drive alone and all other mode splits. The second scenario, 'Low Drive Alone,' uses the lowest value for drive alone mode and the highest values for all other modes, given their respective margins of error. This scenario shows the lowest drive alone commute mode share, given the ACS data. The third scenario, called 'High Drive Alone,' uses the highest value for drive alone mode share and the lowest values for all other modes. This scenario illustrates the highest SOV mode split possible for a tract given the ACS estimates. The table below demonstrates the change in drive alone mode from 1990 to 2008- 2012's estimates in the three scenarios.

CHANGE in Drive Alone Mode Share (1990 to 08-12)				
Spatial Unit: 1990 and 2010 Census Tracts		Scenarios (Based on 08-12 ACS 5-year Margins of Error)		
	Census Tracts	Estimated Drive Alone	LOW Drive Alone	HIGH Drive Alone
CS	3530	-29.1%	-36.8%	-14.4%
	3531	-36.2%	-43.9%	-18.5%
	3532	-40.7%	-51.2%	-18.8%
	3533	-29.5%	-39.2%	-9.3%
	3534	-39.9%	-54.9%	-8.8%
	3535	-24.9%	-39.1%	3.6%
A4	3524	-9.2%	-22.7%	19.0%
	3525	-15.6%	-27.4%	6.2%
	3526	-13.3%	-28.0%	17.5%
	3528	-8.6%	-22.9%	17.2%
EC	3521	-21.0%	-41.0%	34.4%
	3522	-43.7%	-54.2%	-6.3%
	3523	-29.9%	-42.2%	-5.5%

In the CS tract study area, drive alone mode share has unequivocally decreased from 1990 to 2012. Even in the 'High Drive Alone' scenario, SOV mode split dropped in the majority of tracts. Change in drive alone behavior in A4 tracts is less clear. Conclusions on A4's drive alone trends are not possible with existing data. Though the given ACS estimate for drive alone suggests a decrease, that conclusion is much less certain when combined with the margins of error in all modes. In EC tracts, travel behavior trends differ per tract. Drive alone has definitely decreased in 3522 and 3523, which encompass most of the EC study area. But 3521 has an unclear change in drive alone mode, which may be due to its large housing developments completed in the past 10 years.

To examine changes in all modes from 1990 to 2008-2012, the estimated values for 2008-2012 were compared to 1990 census data. In most tracts, non-auto modes (public transit, walk, bike) have increased in the past two decades. For tracts such as 3254 in the heart of Kendall Square, the decrease in public transit can be attributed to commercial and business activity growth, which increases the walking accessibility of jobs to Cambridge residents living in that tract.

CHANGE in Mode Share (1990 to 08-12)

Scenario: Estimated 08-12 ACS Values for All Modes

CS - Tracts (1990 to 08-12)	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3530	-29.1%	-6.9%	18.2%	8.9%	3.2%	-0.6%	6.3%
3531	-36.2%	-9.4%	0.8%	4.2%	34.3%	-0.4%	6.7%
3532	-40.7%	-9.2%	19.0%	8.0%	18.0%	1.4%	3.6%
3533	-29.5%	-4.5%	18.5%	9.1%	3.5%	1.6%	1.2%
3534	-39.9%	-1.8%	13.7%	8.1%	13.3%	3.8%	2.7%
3535	-24.9%	-5.5%	23.9%	7.1%	-9.7%	3.9%	5.2%

A4 -Tracts (1990 to 08-12)	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3524	-9.2%	0.9%	-6.8%	0.8%	12.9%	1.3%	0.0%
3525	-15.6%	3.2%	1.8%	6.2%	0.3%	0.0%	4.4%
3526	-13.3%	-13.4%	-2.6%	12.3%	13.8%	1.2%	2.0%
3528	-8.6%	-15.0%	1.2%	13.0%	8.4%	0.8%	0.4%

EC - Tracts (1990 to 08-12)	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3521	-21.0%	-4.4%	1.6%	3.1%	13.0%	0.7%	7.0%
3522	-43.7%	-10.3%	24.0%	13.4%	21.1%	0.0%	-4.4%
3523	-29.9%	-11.1%	8.2%	6.0%	27.1%	-1.6%	1.3%

Mode splits for all transportation modes in 1990, 2000 and 2008-2012 (estimated values and margins of error) are available in the appendices.

3.4.3 Vehicle Ownership

The measure of total vehicles in CS, A4 and EC is derived from Massachusetts' 2013 excise tax records, the MassGIS release of RMV registrations from 2008 to 2011, and the 2014 manual night counts of parked vehicles

Number of Vehicles			
Spatial Unit: MassGIS Grid Cells	Manual Counts (2014)	Excise Tax (2013)	Registered Vehicles (2011)
CS	2820	2970	2900
A4	1694	1706	1748
EC	1696	1654	1642

Surprisingly similar totals were found using the three data sources. Even acknowledging the differences in years of collection, the close range of vehicle totals suggests the excise tax records

are a reasonable estimate of vehicles in Cambridge and could serve as an important geographically detailed resource.

To estimate vehicles per household, units and bedroom totals from the assessing database were compared to the three sources of vehicle counts.

	Estimated Vehicles per Household					
Spatial Unit: MassGIS Grid Cells	Counted Vehicles (2014) per Bedroom	Excise Vehicles (2013) per Bedroom	Registered Vehicles (2011) per Bedroom	Counted Vehicles (2014) per Unit	Excise Vehicles (2013) per Unit	Registered Vehicles (2011) per Unit
CS	0.61**	0.61**	0.59**	1.30**	1.37**	1.34**
A4	0.76**	0.76**	0.78**	1.59**	1.60**	1.64**
EC	0.68**	0.68**	0.68**	1.47**	1.44**	1.43**

**Ratios are OVERESTIMATES of vehicles/household, based on conversations with Cambridge planning staff.

As noted in 3.2.3 Tax Assessing, units and bedrooms are likely undercounted. Therefore the above values are overestimating the number of vehicles per household in CS, A4 and EC.

Estimation of vehicle ownership change over time relied on the 2008 to 2011 RMV registrations. These were the only available longitudinal vehicle ownership data points.

Spatial Unit: MassGIS Grid Cells	Registered Vehicles (Passenger + Commercial)				
	2008 (Q4)	2009 (Q4)	2010 (Q4)	2011 (Q4)	% Change 2008 to 2011
CS	2920.36	2798.31	2932.13	2899.62	*-0.7%*
A4	1567.03	1486.09	1648.84	1747.99	*11.5%*
EC	1558.54	1464.52	1595.2	1641.94	*5.4%*

RMV registrations from 2008 to 2011 indicate a strong growth in vehicle ownership in A4, a slight decline in CS and minor growth in EC.

3.5 Development Patterns

Housing is analyzed with 2000 and 2010 Census data as well as 2013 Cambridge tax assessing records. Census data, as stated earlier, is available at census block levels. Tax assessing records on the other hand are aggregated at parcel level, a smaller spatial unit. Assessing records are listed by residential homes (includes multi-units) as well as condominiums. Information from residential and condominium housing units were aggregated to their relevant parcels. Of the 10,644 tax parcels, 10,598 were successfully correctly joined with housing data.

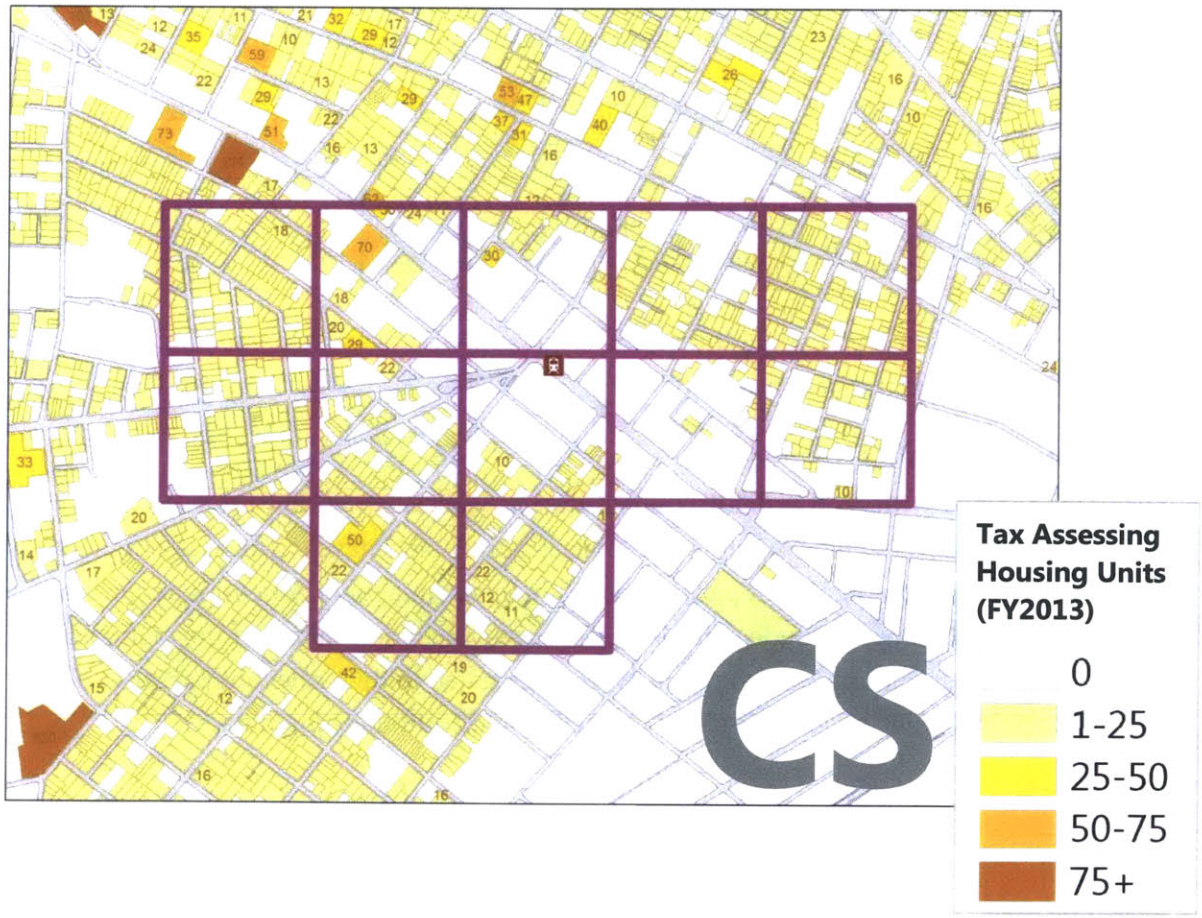
3.5.1 Current State

The best estimate available for current housing stock comes from FY2013 tax assessing data. However, as noted earlier, these unit and bedroom counts are likely underestimates of total housing stock.

Estimated Housing in 2013		
Spatial Unit: 2013 Tax Assessing Parcels (centroid located within MassGIS Grid Cells)	*Dwelling Units*	*Bedrooms*
CS	2161*	4901*
A4	1067*	2241*
EC	1151*	2423*

*Values are UNDERESTIMATES of total households, based on conversations with Cambridge planning staff.

The following maps show estimated housing units in 2013 within and surrounding CS, A4 and EC. Parcels with ten or more units are labeled with total units.




A4
EC
Tax Assessing
Housing Units
(FY2013)
0
1-25
25-50
50-75
75+

3.5.2 Recently Completed & In Progress

Projects completed between 2003 and 2013 were mapped by year of completion. Maps of accumulated growth and a list of all project statuses in 2013 are included in the appendices.

New Developments in Cambridge (2003-2013)				
			Gross Floor Area	Residential Units
Study Area (Within 200m of Grid boundaries)	CS	In Progress and/or Completed Projects:	1,706,265*	421*
		COMPLETED Projects 2003-2013:	975,748*	333*
		In Progress Projects:	730,517	88
	A4	In Progress and/or Completed Projects:	123,357*	86*
		COMPLETED Projects 2003-2013:	78,514*	55*
		In Progress Projects:	44,843	31
	EC	In Progress and/or Completed Projects:	2,412,237	1,571
		COMPLETED Projects 2003-2013:	1,367,608	659
		In Progress Projects:	1,044,629	912
	ALL	TOTAL CS, A4 and EC PROJECTS:	4,215,787**	2,056**
		COMPLETED Projects 2002-2013:	2,395,798**	1,025**
		In Progress Projects:	1,819,989	1,031

* CS and A4 subtotals BOTH include 277 Broadway and 199-209 Columbia Street, which are within 200 meters of both study areas.

** Totals include a SINGLE count of 277 Broadway and 199-209 Columbia Street.

CS has seen steady residential housing development throughout its neighborhoods. Nearly all have been multi-family units with most sized between 10 and 45 units. In the near future, there are an additional ~80 housing units planned for sites close to the Central Square T station.

A4 has experienced far less development activity. Between 2003 and 2010, only a handful of smaller multi-family (<15 unit) buildings were constructed just on the periphery of the study area. The largest projects were completed in just the last three years, two multifamily (11 unit and 19 unit) buildings. In 2013, only about 30 housing units are in progress and they lie outside of the core of A4 (grid).

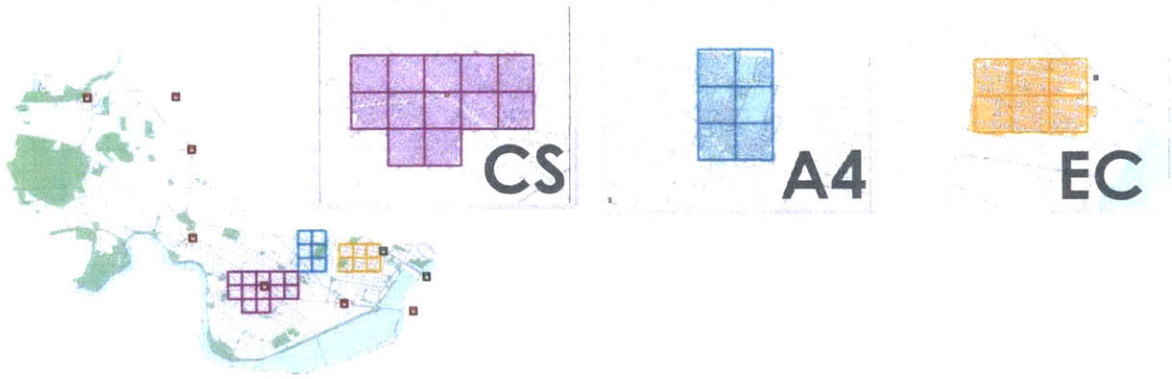
The primary EC area (grid) has seen no completed developments between 2003 and 2013. But surrounding neighborhoods have experienced rapid urban growth. To the northeast, North Point has added hundreds of new housing units in its mixed use development. To the south, major commercial and residential developments have risen around and within the technology hub of Kendall Square. A large 392 unit residential building is currently under construction at the northeast corner of EC. In the near future, the biggest item of debate in regards to urban growth will be centered on the fate of the Sullivan Courthouse (see details in Chapter 4).

Chapter 4: Key Findings & Block-Level Analysis

CS, A4 and EC have distinct neighborhood characteristics and consequently, unique parking challenges. Select blocks are closely analyzed to tease out these differences. Block selection is based on parking, sociodemographic, vehicle ownership and travel behavior data, considered in hand with the location of significant projects and community debates. Block-level analysis describes parking conditions at a scale analogous to residents' on-the-ground experiences. A close up examination also provides insight on how best to mediate development and parking issues.

But narrowing in on a smaller geographic area will compound any preexisting inaccuracies in data. Any information that proved troublesome during the full CS, A4 and EC analyses, such as tax assessing units and bedrooms, would have their errors magnified in block level studies. Therefore, assessing data are not included and direct comparisons are conducted only on data with very similar spatial unit boundaries. Block-level analysis focuses on parking utilization (spaces versus parked vehicle counts), vehicle counts by excise and registrations, and sociodemographic trends.

General Themes



Overarching themes bridge CS, A4 and EC. Demographics are clearly shifting with a surge in the 25 to 35 age group. Analysis of age brackets by sex between 2000 and 2010 suggests this shift represents an influx of younger adults with no children, rather than an aging of youth in the existing population. This trend is likely to have continued into 2014, as Cambridge's pace of business growth and development has remained on the same path from 2010 to the present day. Real estate development has been very active but to varying degrees in each neighborhood. The city has been and will continue to be attractive for new development. Urban growth, in that sense, is inevitable. Drive alone mode share has decreased between 1990 and the 2008 – 2012 ACS estimates but the degree of decrease has also varied by neighborhood. Non-auto modes such as public transit, walk and bike currently make up a healthy portion of commutes.

For residential parking, there is a clear preference for on-street over off-street. In all neighborhoods, off-street spaces were left unoccupied despite greater competition for on-street spaces, as evidenced by high on-street utilization rates (CS 80%; A4: 95%; EC: 89%) It is unclear whether this is a result of personal preference or an issue of lack of access/rights to existing off-street spaces. Likely, it is a combination of both. If rights to use existing off-street spaces is a problem, there are then opportunities for sharing facilities among parking users.

Though residential areas have ample unoccupied off-street spaces from midnight to 5am, whether these spaces can be readily taken advantage of is a separate issue. Parking observations bring up the question, "If on-street competition increases, do residents have access to off-street parking in the vicinity of their home? Unoccupied off-street spaces exist but can these spaces be readily utilized if additional vehicles and/or residents increase competition for curbside parking?

Finally, there are more registered vehicles in CS, A4 and EC than there are on-street spaces. Therefore, the number of vehicles eligible for a residential parking permit exceeds the physical supply of on-street spaces (residential only and available to the public). Acknowledgement of this reality is important for the creation of feasible and effective parking interventions.

4.1 CS

Study Area: **CS**

Parking Spaces	
On-Street	2226
Off-Street	3585

Total Population	
Population (2000)	9200
Population (2010)	9070
% Change (00' to 10')	-1.4%

Vehicles	
Count (2014)	2820
Excise (2013)	2970
RMV (2011)	2900
% Change (**RMV** 08'-11')	-0.7%

Parked Vehicles	
On-Street	1789
Off-Street	1031

Working Population (18-66)	
Working Pop (2000)	7097
Working Pop (2010)	7409
% Change (00' to 10')	4.4%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Overall decrease

Parking Utilization	
On-Street	80%
Off-Street	29%

Age Group (25-35)	
% of Total Pop (2000)	27%
% of Total Pop (2010)	36%
% Change (00' to 10')	28.1%

Development Patterns	
Completed 2003-2013	333*
In Progress	88
Pattern	Widespread with projects in pipeline

*CS and A4 subtotals BOTH include 277 Broadway and 199-209 Columbia Street, which are within 200 meters of both study areas.

From 2003 to today, urban growth in CS has been steady and evenly distributed. In spite of the steady growth, CS distinguishes itself among the study sites with a very low vehicle ownership and the lowest rates of parking utilization (80% on-street and 29% off-street). In terms of parking management, CS has areas of special on-street parking which alternates based on day and time between being residential permit only and open to the public. This innovative sharing arrangement could be expanded to other neighborhoods with multiple parking user groups whose peak demand periods do not fully overlap. CS also contains a number of municipal parking lots and facilities, which are owned and managed by city agencies. Control of a large inventory of off-street spaces can be an important tool for the city to manage the cost of and access to local off-street parking supply.

CS has seen the most dramatic demographic shift among the study areas with a surge in 25-35 year olds from 2000 to 2010. Appendices include a detailed breakdown of age groups by sex for all three study areas. Blocks of bright blue and light yellow (indicating growth as percentage of the population) are observed predominantly in the 25-35 age brackets. Travel behavior has also shifted for all CS census tracts, with a significant drop in drive alone mode. The most striking drop between 1990 and the 2008-2011 estimates occurred in census tract 3534 (see Appendices). Even considering the highest drive alone range based on the ACS 5 year estimates' margin of error, there was still at minimum drop of 25% in single occupancy vehicle mode share.

In CS, issues likely to impact future residential parking conditions include,

1) Decision on upzoning: K2C2 planning study recommended the upzoning of Central Square to allow for taller and denser developments along Massachusetts Avenue.
2) Pipeline projects: Temple Street Apartments (40 affordable units), 10 Essex Street (41 market and 5 affordable units) and other in progress projects.

Based on these issues and analysis of CS as a whole, two grid cells are selected for block-level study. Grid cell 144124 contains primarily residential blocks just northeast of 10 Essex Street. New 10 Essex residents with Cambridge-registered vehicles and RPP permits would likely seek on-street spaces in grid 144124, putting them in competition with existing residents. The second grid cell (145754) was selected for its notably high number of 2011 registered vehicles and is also the location of a recent community furor over a bike share station. In April 2014, a Hubway (bikeshare) station was installed alongside Dana Park on Lawrence Street, replacing three on-street parking spaces. (City of Cambridge, 2014d)

4.1.1 10 Essex Street (144124)

Study Area: **CS**

Parking Spaces	
On-Street	244
Off-Street	640

Grid ID: **10 Essex Street (144124)**

Parking Utilization	
On-Street	75%
Off-Street	25%

Vehicles	
Excise (2013)	240
RMV (2011)	182.7
% Change (RMV 08'-11')	7%

Total Population	
% Change (00' to 10')	-10%

Working Population (18-66)	
% of Total Pop (2000)	72%
% of Total Pop (2010)	78%
% Change (00' to 10')	-2%

Age Group 25-35	
% of Total Pop (2000)	24%
% of Total Pop (2010)	30%
% Change (00' to 10')	15%

Compared to parking utilization rates observed for CS, A4 and EC, grid cell 144124 has a very low utilization rate with 75% of on-street and 25% of off-street spaces occupied at night. There is flex available in this grid cell's parking supply. A future increase in residents and/or vehicles would likely not leave anyone endlessly cruising for spaces. However, open spaces are unevenly distributed. Some street blocks are parked end to end while 100 meters away, open spaces proliferate. Herein lies a core issue in residential parking debates. Perception of a local

parking problem depends on an individual's definition of what counts as local parking supply. For some residents, that may only include their home block or even just the few spaces in front of their residence.

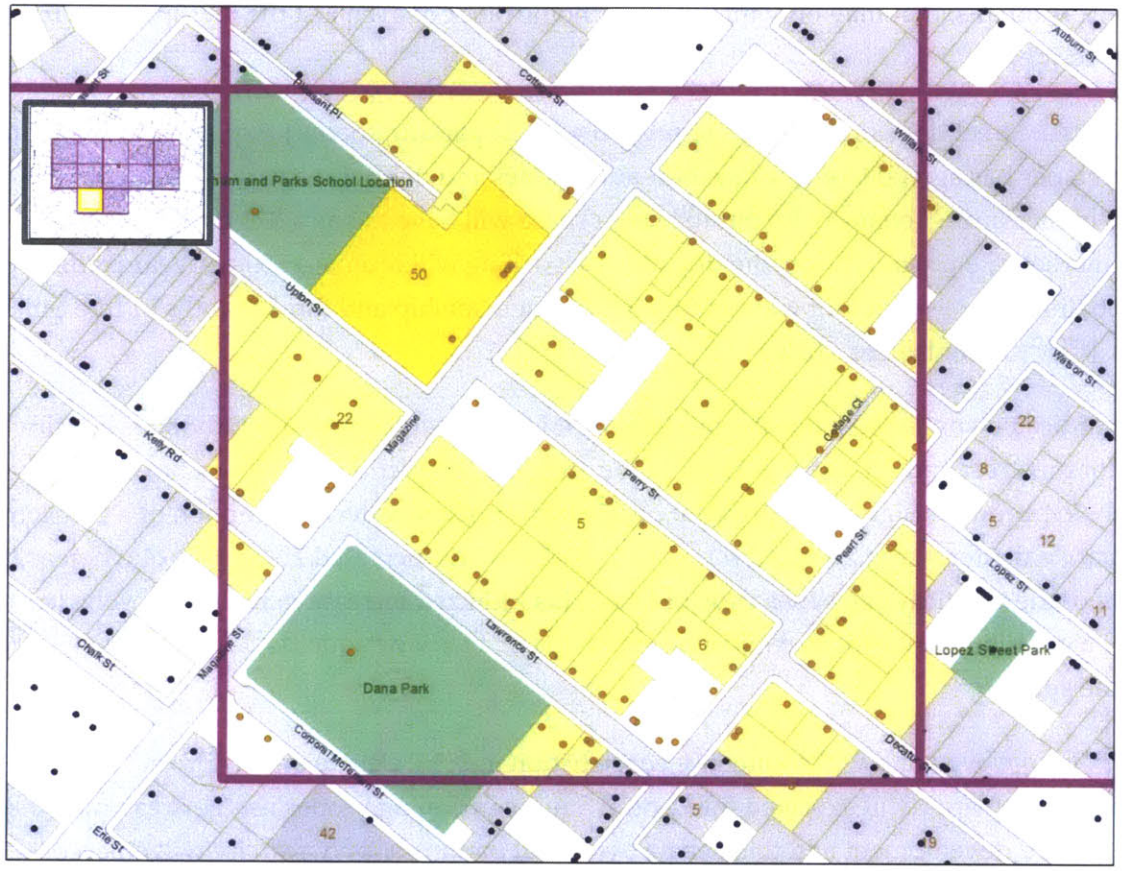
The 10 Essex Street development was approved with 23 parking spaces (.5 spaces per unit) and the developer has agreed to encourage non-auto modes and discourage parking use with a variety of measures. Tenants who opt to lease a space will have to pay a $20 monthly penalty above market rate prices. Those who do not lease parking will receive a $50 per year credit for bike repairs, a free year of Hubway rentals, Zipcar membership and three months of free MBTA passes. (City of Cambridge, 2014c)

Given dedicated spaces exist on-site, public transit is extremely accessible, and open capacity exists for on-street and off-street parking in the area, the completion of 10 Essex Street is unlikely to produce a significant physical parking problem. However, perception of a problem is a separate matter. From 2008 to 2011, vehicle registrations increased 7% in 144124 whereas the entirety of the CS study site saw a drop of 1.4%. This localized increase in registered vehicles may be a contributing factor in residents' perception of a parking squeeze despite evidence of available spaces.

10 Essex is approved and will commence construction in 2014. Debate on this project is largely settled. But with approval expected for Central Square upzoning proposals, the area will likely see continued development and this debate over local parking supply scarcity will emerge again. The city's control of municipal lots and facilities can be a key tool in mediating on-street competition concerns. Individual parking prices in the municipal lots can be tailored to either placate existing residents with cheaper off-street parking or arrange sharing arrangements between new developments and the city.

In one possible scenario, the city could work with a developer to reserve municipal off-street parking for new tenants at or below market price. The developer would be permitted to build less parking on site if he/she commits to allocate free off-street parking access only to new tenants who do not participate in RPP. The landlord works with the city to verify tenants do not participate in RPP before granting access (ID card) to the municipal parking facility. Tenants who do not own a car receive other non-SOV benefits. The developer wins in not having to pay the high costs of building on-site parking. The city has a way of easing existing residents' concerns that new tenants will directly compete with them for on-street spaces. New tenants have access to off-street parking if they desire it and there is a market incentive for them to take the free off-street space over the RPP. Increasing the overall price of RPP is an additional crucial intervention which would enhance the effectiveness of this scenario.

4.1.2 Dana Park (145754)



Study Area: **CS**

Grid ID: **Dana Park (145754)**

Parking Spaces	
On-Street	365
Off-Street	262

Parking Utilization	
On-Street	93%
Off-Street	43%

Vehicles	
Excise (2013)	251
RMV (2011)	270.9
% Change (RMV 08'-11')	15%

Total Population	
% Change (00' to 10')	3%

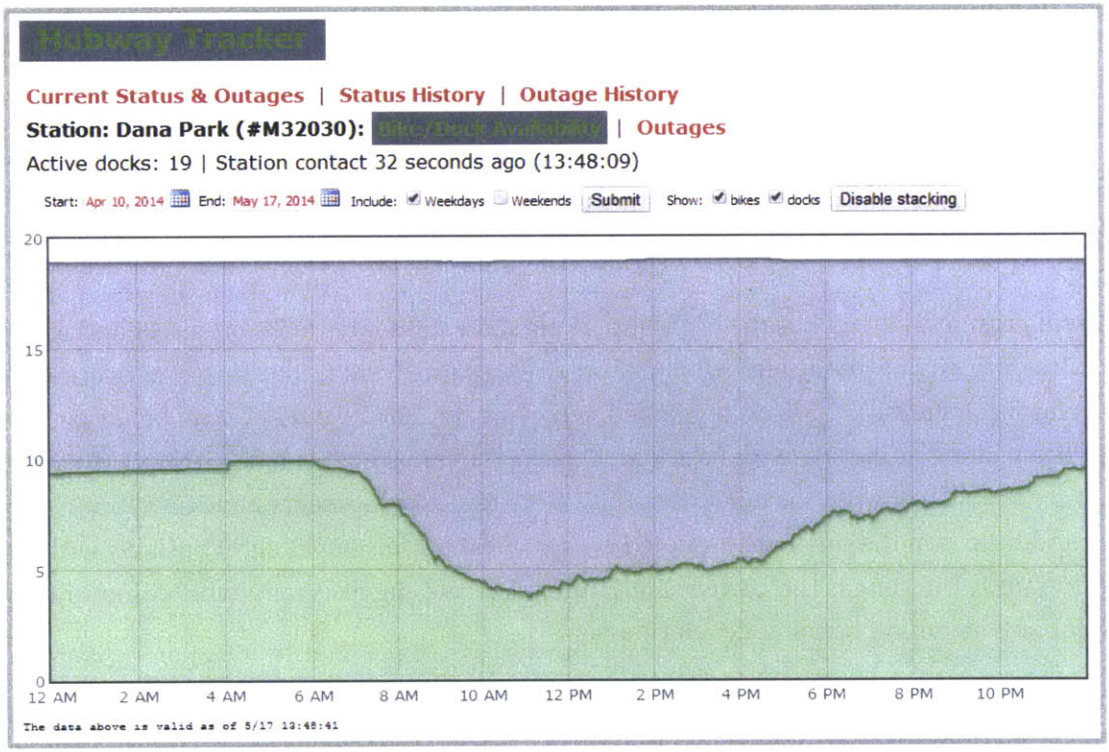
Working Population (18-66)	
% of Total Pop (2000)	77%
% of Total Pop (2010)	80%
% Change (00' to 10')	7%

Age Group 25-35	
% of Total Pop (2000)	26%
% of Total Pop (2010)	29%
% Change (00' to 10')	15%

Parking utilization rates in 145754's corner of CS differ significantly from 144124. Most on-street (93%) spaces are occupied and off-street (43%) utilization is high compared to other observed neighborhoods. Vehicle registrations have grown significantly from 2008 to 2011 (15%) whereas CS as a whole has seen only a slight decrease (-0.7%). Increases in local vehicles and evidence of parking demand reaching on-street capacity constraints lends credence to neighbors' protests that the Lawrence Street Hubway station took away three much needed spaces. (Dana Park

neighborhood residents, 2014) City officials are revisiting this issue and the entire process of engaging with neighbors on the subject of Hubway station siting. (Levy, 2014b) Cell 145754 appears to have a real spatial parking challenge but a high utilization rate by itself is not a problem as it indicates efficient use of existing spaces. However, the high on-street utilization rate is likely contributing to Dana Park residents' negative reactions to the taking away of spaces, particularly as they also perceive a lack of prior consultation.

On-street spaces are public property and it is fully within the city's rights to replace curbside spaces with a Hubway station. Based on data gathered since its launch (April 10th to May 17th), the station is successfully serving a local commuting demand. The below figure shows average bikes available (green) by time of day on weekdays. The Lawrence Street Hubway station is regularly serving as the home end of some daily commutes.



But to rebuild trust between neighbors and city agencies, it may be worthwhile for Cambridge to absorb the costs of relocating Lawrence Street station to the interior of Dana Park and returning the three parking spaces to the neighborhood. For future Hubway placements in dominantly residential neighborhoods, an enhanced strategy of outreach and active incorporation of feedback could prevent another costly relocation.

4.2 A4

Study Area: **A4**

Parking Spaces	
On-Street	1119
Off-Street	1420

Total Population	
Population (2000)	5777
Population (2010)	5312
% Change (00' to 10')	-8.0%

Vehicles	
Count (2014)	1694
Excise (2013)	1706
RMV (2011)	1748
% Change (RMV 08'-11')	11.5%

Parked Vehicles	
On-Street	1058
Off-Street	636

Working Population (18-66)	
Working Pop (2000)	4113
Working Pop (2010)	4083
% Change (00' to 10')	-0.7%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Unclear

Parking Utilization	
On-Street	95%
Off-Street	45%

Age Group (25-35)	
% of Total Pop (2000)	24%
% of Total Pop (2010)	30%
% Change (00' to 10')	14.6%

Development Patterns	
Completed 2003-2013	55*
In Progress	31
Pattern	Very little recent and in pipeline development

*CS and A4 subtotals BOTH include 277 Broadway and 199-209 Columbia Street, which are within 200 meters of both study areas.

A4 is primarily residential and has the highest parking utilization rates (95% on-street and 45% off-street). The majority of public and RPP only on-street spaces were full during night counts. A4 saw the largest increase (11.5%) in registered vehicles from 2008 to 2011. Travel behavior change for drive alone mode share was unclear. Development has not been occurring with the same intensity as in CS or even the outskirts of EC. Very few developments have been built since 2003 and little is in the pipeline. As noted earlier, most parcels are already built up with 3-5 floor multi-family buildings. The current high utilization rate suggests inevitable community pushback for any incoming housing developments.

Examples of such pushback can be found in the community responses to the 2007-2012 conversion of the Immaculate Conception Lithuanian Church at 424-430 Windsor to 14 affordable housing units. (Cambridge Community Development Department, n.d.) Opposition to this project listed parking and density as concerns but as the debate progressed, it became clear that some heated reactions were directed at the 'affordable' part of the development. Neighbors stated they preferred market-rate development over affordable in the belief that it would improve their homes' property values. (Fugueiredo, 2008)

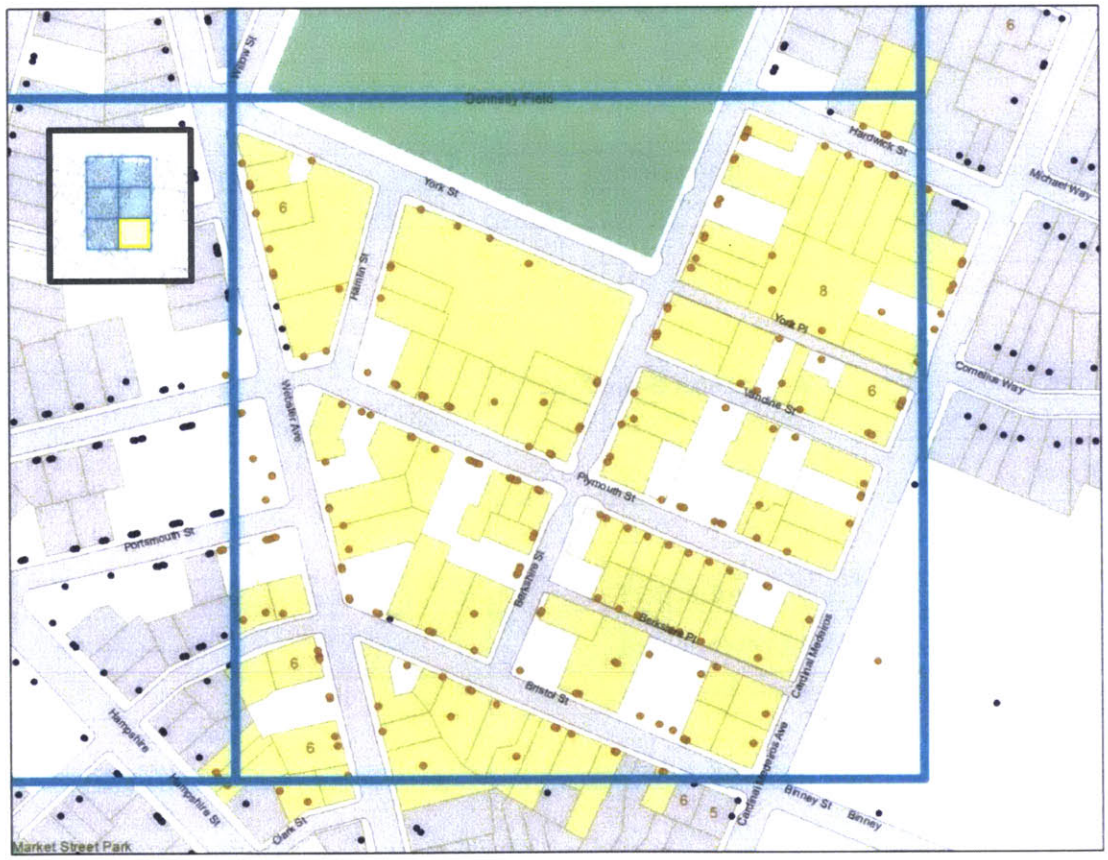
This dynamic highlights a major issue in understanding how to approach residential parking challenges in the context of urban growth. That is, in some of these development debates, is

parking really the central concern? Parking utilization in 2007 for A4 is unknown. But given today's high utilization and growth in registered vehicles (08'-11'), it is reasonable to assume on-street parking utilization in 2007 ranged from moderate to high. Scarcity of on-street spaces was probably a real issue in 2007.

Yet the crux of the community pushback focused on political issues and clashing ideologies of where affordable housing should be located. As political and not physical competition concerns were at the heart of the disputes, attempts to address parking and density alone would not have placated protesters. It is unclear if any affordable housing proposal would have been agreeable to the most vocal opponents.

The conversion was completed in 2012 and all 14 affordable units are occupied. Fervor has died down over this issue with hints of self-reflection among the opposition. (Marie, 2014) There are no significant development proposals in the pipeline for the area. To study the potential for future parking challenges, block-level analysis focused on the grid cell with the largest growth in registrations. Grid cell 143319 in the southeast corner of A4, just below Donnelly Field, had a 20% increase in vehicle registrations from 2008 to 2011.

4.2.1 South of Donnelly Field (143319)



Study Area: **A4**

Grid ID: **South of Donnelly Field (143319)**

Parking Spaces	
On-Street	284
Off-Street	252

Parking Utilization	
On-Street	82%
Off-Street	36%

Vehicles	
Excise (2013)	411
RMV (2011)	323.4
% Change (RMV 08'-11')	20%

Total Population	
% Change (00' to 10')	-12%

Working Population (18-66)	
% of Total Pop (2000)	73%
% of Total Pop (2010)	80%
% Change (00' to 10')	-4%

Age Group 25-35	
% of Total Pop (2000)	25%
% of Total Pop (2010)	35%
% Change (00' to 10')	21%

Despite a high rate of growth in registered vehicles (20%) from 2008 to 2011, parking utilization in cell 143319 (82% on-street; 36% off-street) was markedly less than A4 (95% on-street; 45% off-street) as a whole. Very little development has occurred in these blocks and no projects were in the pipeline as of 2013. There has been a larger increase in 25-35 years olds as a proportion of total population (from 25% to 35%) when compared to the rest of A4 (from 24% to 30%). Yet the demographic shift and vehicle growth do not seem substantial enough to spark parking related debates in the near future. Grid cell 143319's comparably low utilization rates and its lack of in pipeline projects suggests relative stability in parking conditions.

4.3 EC

Study Area: **EC**

Parking Spaces	
On-Street	1512
Off-Street	2335

Total Population	
Population (2000)	4354
Population (2010)	4044
% Change (00' to 10')	-7.1%

Vehicles	
Count (2014)	1696
Excise (2013)	1654
RMV (2011)	1642
% Change (RMV 08'-11')	5.4%

Parked Vehicles	
On-Street	1340
Off-Street	356

Working Population (18-66)	
Working Pop (2000)	3243
Working Pop (2010)	3243
% Change (00' to 10')	0%

Drive Alone CHANGE	
1990 to 08'-12' estimates	Mix of unclear and slight decreases

Parking Utilization	
On-Street	89%
Off-Street	15%

Age Group (25-35)	
% of Total Pop (2000)	26%
% of Total Pop (2010)	31%
% Change (00' to 10')	11.9%

Development Patterns	
Completed 2003-2013	659
In Progress	912
Pattern	Primarily northeast and south of EC

On-street utilization is moderately high in EC. Most public spaces (of which there are a significant amount around the courthouse and along Cambridge Street) were unoccupied whereas RPP only spaces occupied during the night counts. The area has a large supply of off-street parking with multiple facilities, which contributes to the extremely low observed off-street utilization rate (15%). A significant EC finding is its tremendous growth in walking mode share. Journey to work data for census tract 3523 is analyzed in the appendices. In tract 3523, walking mode share grew from 3.6% in 1990 to, at minimum, 20.5% in the 2008-2012 5 year estimate (30.7% estimate with a margin of error equal to a range of 20.5%-44.3%.) As noted in the Chapter 3's development analysis, the increase in walking is likely due to urban growth at the periphery of EC in Kendall Square and Northpoint.

EC's biggest ongoing development and residential parking debate is the redevelopment of the Sullivan Courthouse at 40 Thorndike Street. In 1974, the State of Massachusetts built and opened the Edward J. Sullivan courthouse and jail, which was met with great community derision at its design and height (22 concrete stories in a predominantly 3-5 story residential neighborhood). ("Tatters of a new courthouse," 1974) In 2010, due to the high projected costs of removing extensive asbestos, the State looked to sell the building to the City of Cambridge, who declined. (Parker, 2010) In 2012, the courthouse was sold to Leggatt McCall Properties (LMP) to be redeveloped as a commercial and office complex. (Ross, 2012) LMP's current proposal is for a mixed use development with ground floor retail, offices and 24 dwelling units (4 affordable) in the tower, 92 on-site parking spaces and 420 leased off-site parking spaces in a yet to be decided location. (Leggat McCall Properties, 2013) Development plans were released after a purchase-and-sale agreement was signed between LMP and the State, triggering opposition to the opaqueness of the entire process and the lack of community and city input. (Carlone, Mazen, Toomey, & McGovern, 2014; Levy, 2014a; Mcmorrow, 2014)

Community response has been primarily negative with protests to the building height, impacts on local congestion and noise, and other wind, lighting and glare issues. There are, however, some neighbors who acknowledge that redevelopment in some form would be better than leaving the building as it is. (City of Cambridge, 2014a; James Diman Green Condominium Association, n.d.; MetaCambridge, 2014; Neighborhood Association of East Cambridge, n.d.) In terms of the off-site leased parking, LMP initially planned to lease spaces in the city-owned First Street Garage. However, in response to community opposition, which applied pressure to the

City Manager and City Council, LMP began discussions with the Galleria Mall parking garage. (Hawkinson, 2014a) The planning board's decision on LMP's special permit application has been delayed until June 2014. Debate and official proceedings are ongoing.

Selection of grid cells for further analysis focused on the Sullivan Courthouse, by far the most significant development issue in EC. The grid cells containing the courthouse (143323) and the dominantly residential neighborhood just west of it (143322) are analyzed at block-level.

4.3.1 Sullivan Courthouse (143323)

Study Area: **EC**

Grid ID: **Sullivan Courthouse (143323)**

Parking Spaces	
On-Street	254
Off-Street	1451

Parking Utilization	
On-Street	48%
Off-Street	6%

Vehicles	
Excise (2013)	185
RMV (2011)	132.9
% Change (RMV 08'-11')	0%

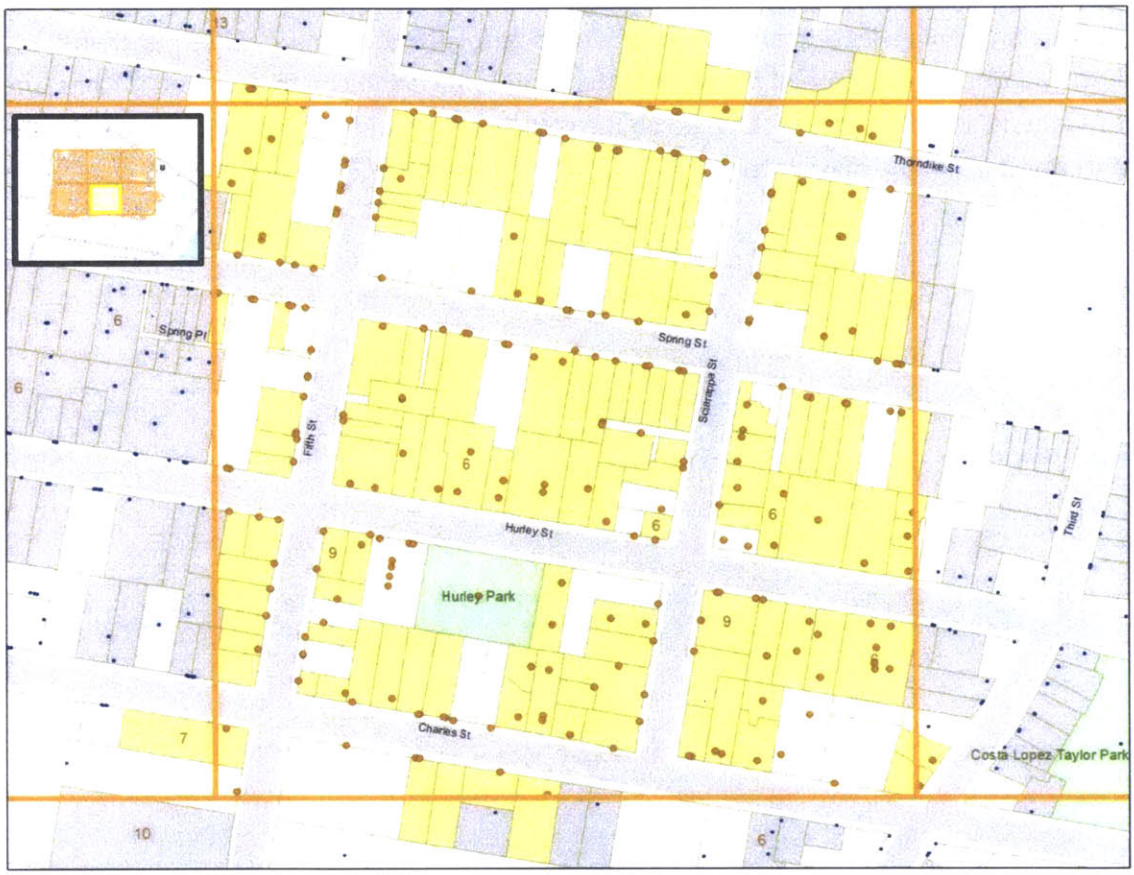
Total Population	
% Change (00' to 10')	-24%

Working Population (18-66)	
% of Total Pop (2000)	80%
% of Total Pop (2010)	83%
% Change (00' to 10')	-21%

Age Group 25-35	
% of Total Pop (2000)	27%
% of Total Pop (2010)	33%
% Change (00' to 10')	-6%

Much of grid cell 143323 is dedicated to non-residential uses including the courthouse, multiple industrial buildings and parking facilities. This contributes to very low parking utilization rates (48% on-street; 6% off-street). A few blocks are entirely devoid of housing. As a result, parking conditions and demographic changes in grid 143323 are not useful for understanding parking challenges as experienced by most EC residents. Therefore, a second block-level analysis is conducted on the dominantly residential neighborhood (143322) adjacent to the courthouse.

4.3.2 West of Courthouse (143322)



Study Area: **EC**

Grid ID: **West of Courthouse (143322)**

Parking Spaces	
On-Street	315
Off-Street	351

Parking Utilization	
On-Street	95%
Off-Street	29%

Vehicles	
Excise (2013)	401
RMV (2011)	393.3
% Change (RMV 08'-11')	11%

Total Population	
% Change (00' to 10')	-11%

Working Population (18-66)	
% of Total Pop (2000)	74%
% of Total Pop (2010)	81%
% Change (00' to 10')	-2%

Age Group 25-35	
% of Total Pop (2000)	26%
% of Total Pop (2010)	32%
% Change (00' to 10')	8%

Parking utilization in 143322 is high with 95% of on-street and 29% of off-street spaces occupied. From 2008 to 2011, vehicle registrations have grown by 11%. The high parking utilization rate suggests that any new development would incur community protest on the basis of on-street competition. However, on-street parking scarcity, in spite of the high utilization rate, is notably not the main nor most impassioned concern in the courthouse debate. In this dispute, offers of resident parking benefits or commitments to deter new tenants from owning cars and/or parking on-street would probably not be enough to win LMP community support for their current proposal. LMP's biggest parking-related challenge is the location of its 420 off-site spaces. City owned First Street garage was the first choice and the city solicitor issued an opinion stating such a leasing arrangement would be legal. (Hawkinson, 2014b) But after widespread opposition applied pressure to the City Council and city manager, LMP has turned to the Galleria as an alternative. Debate on the courthouse continues. Parking is a part of the conflict but it is not the main focus.

Chapter 5: Challenges, Interventions & Next Steps

The parking debates explored in CS, A4 and EC are broken down to spatial, political and institutional components. This breakdown reveals the underlying dynamics of a parking dispute and helps in the crafting of feasible and effective interventions.

5.1 Spatial, Political and Institutional Challenges

Spatial takes account of physical issues surrounding parking supply (on-street and off-street spaces) versus demand (local vehicles), as well as access to existing parking spaces (pricing, physical access and public awareness). **Political** takes on the differences in perceptions, opinions and motives among residential parking stakeholders. A political challenge is the perception of a parking problem, which is separate and irrelevant to the existence of an actual spatial problem. An **institutional** perspective identifies the governmental and regulatory capacities required to address residential parking issues. Institutional challenges would be a lack of staff, regulatory authority, technical capacity and other resources to mediate spatial and political problems.

5.1.1 CS

Spatial parking issues in CS exist only at a small scale. CS, as a multi-block study area, does not have a spatial parking problem with only 80% of on-street and 29% of off-street spaces occupied at night. But at the level of an individual grid cell (Dana Park - 145754) and street block (individual blocks near 10 Essex Street), there are areas where localized parking demand is approaching supply constraints.

Political issues in CS deal with topics of community engagement, ideologies on density and preferences for the 'feel' of a neighborhood. Debates surrounding upzoning have revealed a diversity of opinions on what residents envision for a future Central Square. (City of Cambridge, 2012, 2013e) In the case of 10 Essex Street, residents perceive new developments as inevitably contributing to on-street competition, in spite of mitigation measures put forth by the developer. In the debate near Dana Park, neighbors perceive a lack of community input in the siting of the Lawrence Street Hubway station. Though the city conducted outreach prior to installing the station, recent protests indicate a need for better tactics in engaging neighbors.

Many institutions play a role in CS parking and development disputes. The Cambridge Planning Board grants special permits and makes rulings on zoning code proposals. They were pivotal in the approval of 10 Essex and will be the principal decision makers on the outcome of the Central Square upzoning proposal. Issues of on-street parking supply and demand are connected to the management of the RPP program. Administered by the Cambridge Traffic, Parking and Transportation department, the RPP program is the primary institutional intervention in the regulation of curbside spaces. Cambridge Community Development

department produces long term planning and zoning guidelines and has been a key organizer of the K2C2 planning study.

A 'time will tell' institutional capacity question is whether Cambridge can hold the 10 Essex Street developer to his commitments to incentivize non-auto mode choices and penalize parking use among new tenants. In spite of the protest, the Lawrence Street Hubway issue is a successful demonstration of existing institutional capacity. Cambridge agencies reacted to and are learning from the community dispute, revisiting the Lawrence Street station placement and their own outreach strategies.

5.1.2 A4

A4 as a whole faces a parking challenge of current demand nearing supply constraints (95% on-street and 45% off-street utilization rates). However, those conditions do not extend to every subarea. Grid 143319 has greater flex in its available parking supply (82% on-street; 36% off-street) in spite of having the area's largest vehicle registration growth (20% from 2008 to 2011).

Political issues in A4 were highlighted in 2012 during the Lithuanian Church conversion to affordable housing. Opposition voiced concerns on spatial problems such as density, increased congestion and on-street parking competition. Based on 2014 counts and vehicle registration trends, parking utilization surrounding the church in 2007 were likely at least moderately high (75%+). Yet in public forums and letters to the City, neighbors' complaints were primarily motivated by other social issues. Some residents felt their area had enough affordable housing and assumed additional affordable units would decrease their own property values. The political problems in this development dispute stemmed not from perceptions of parking conditions but rather from differing ideologies concerning where affordable housing should be built.

With no major planned developments and resident only streets lining the majority of blocks, the most active institution in A4 is the Cambridge Traffic, Parking and Transportation department who enforces the RPP program.

5.1.3 EC

EC faces a spatial residential parking issue of starkly uneven distributions of parking demand and supply. Most blocks with RPP only spaces were fully parked whereas nearby public on-street spaces remained unoccupied. There are very small areas of high localized demand, primarily on resident-only blocks. Possible reasons for residents not utilizing nearby open capacity include personal preference for parking on a home block, lack of awareness of available spaces, and lack of rights to access the open space (ownership, time or price limits).

Political issues in EC center on the Sullivan Courthouse redevelopment. Community pushback against the current LMP proposal reference increased congestion and parking competition as concerns. Yet it is the physical design and height of the proposal which is triggering the most fervent opposition. In this scenario, spatial parking issues are real yet the driving force of the debate is the nature of the development itself.

Can the existing institutional structures and processes push the Sullivan courthouse redevelopment towards a solution that meets Cambridge's economic and livability goals, is amenable to the community and financially profitable to the developer? LMP appears to have the legal grounds for its current proposal in terms of the building's exemption from zoning codes and its initial parking plan to lease spaces in municipal facilities. (Hawkinson, 2014b) But the debate continues and at the writing of this thesis, it is unclear how the momentum of protesting residents and city councilors will influence the Planning Board's decision on LMP's special permit application.

5.2 Parking Interventions

5.2.1 Fundamentals

Some key points and current conditions must be clearly stated before delving into specific parking interventions. Excessive parking is environmentally, economically and socially detrimental. Given Cambridge's high land values and goal of maintaining a vibrant, walkable environment, building additional parking spaces is not a viable intervention.

Registered vehicles (2011) in CS, A4 and EC exceed the existing supply of on-street spaces. This does not immediately indicate a spatial parking problem as off-street supply exists and night counts verify the availability of some on-street spaces. It does, however, show that vehicles eligible for a residential parking permit outnumber existing of on-street spaces (including RPP only and available to the public). The reality of eligible vehicles surpassing on-street supply must be acknowledged before effective parking interventions can be developed.

On-street parking in Cambridge is primarily public property, thereby under the purview of the city government. Different ideologies exist for the management of public property and can be used to formulate parking interventions.

1.) Leave it to the streets (do nothing) – No intervention, leaving parking issues for individual parkers to resolve among themselves.
2.) Public resource (manage as a public asset) – City government treats curbside spaces as a public good. Design of pricing and access to spaces is guided by city-wide goals.
3.) Public resource with private rights (public spaces belong to 'locals') – City government assumes 'local' residents have first priority to curbside parking spaces in close vicinity to

their home. Each resident assumes he/she has a right to a space. This ideology best represents current residents' expressed opinions about entitlement to on-street parking. Under current conditions where registered vehicles exceed on-street spaces, each resident in fact has the right to a fraction of an on-street space.

5.2.2 Types of Interventions

Parking interventions examined in this thesis can be broadly described as changes to the Residential Parking Permit program, shared parking uses and tie-ins to new development approvals. These are interventions that are within the means of Cambridge's local government and agencies.

Changes to the RPP system include alterations to price, spatial limits, permit recipient eligibility and total quotas. Cambridge's current RPP program charges little for permits ($25), is applicable city-wide in RPP only streets, available to anyone with a Cambridge-registered vehicle, and has no quota in terms of total permits granted.

Shared parking arrangements use a single parking supply (garage, lot or curb spaces) to meet the needs of multiple parking user groups such as restricting access to only residents at night and permitting non-residents in the daytime. Cambridge already employs shared parking measures at small scales, usually in areas of mixed land uses adjacent to residential areas.

Tie-ins to new developments are measures and commitments required of a developer before receiving approval for a development project. To manage parking issues, measures could include requirements on new tenants to not own a vehicle or not participate in the RPP program. It could also include transportation demand measures including incentives for non-SOV travel (free transit passes, Hubway, Zipcar, etc) and disincentives for driving (high parking fees).

5.2.3 Application to Study Areas

A quick summary of the challenges found in each study area.

- CS has localized high demand (which is not a significant spatial issue but contributes to community sensitivity to new developments), neighbors perceive new developments will increase congestion and on-street competition, and decisions on station placement had insufficient community input.
- A4 has generally high demand, some neighbors are concerned about density, congestion and parking. There are those who perceived affordable housing would decrease their own values and that the neighborhood was receiving a disproportionate bulk of Cambridge's affordable housing.

- EC has localized high demand (like CS, is not a spatial issue but contributes to sensitivity), neighbors perceive new development will create congestion and on-street competition, and that the courthouse and current redevelopment proposal are not appropriate for the neighborhood. Current residents and city councilors also perceive that historically, the construction and eventual sale of the courthouse has not considered the needs and concerns of the neighborhood.

No Intervention

Under the first ideology of no intervention on parking, the RPP system as it exists today is assumed to continue. Likely outcomes in each study area are described below.

CS

Localized high demand persists. 10 Essex is approved with no stipulations. New tenants move in with unclear ramifications on local congestion and on-street parking. Existing residents around 10 Essex Street are dissatisfied because no action has been taken which indicates their concerns were heard and good effort was made to try and mitigate issues. Existing residents around Dana Park are similarly dissatisfied because of lack of reaction to their protests.

A4

Generally high demand continues. Conversion to affordable units is completed with no development stipulations and unclear ramifications on local congestion and parking competition. Community is angry for similar reasons as CS but with additional concerns over affordable housing and property values.

EC

Localized high demand continues. Current LMP proposal is approved. New residential and non-residential tenants move in with unclear ramifications on local congestion and on-street parking. Residents of EC are dissatisfied for reasons similar to CS and A4 with less emphasis on property values and greater emphasis on maintaining a generally residential feel to the area. Continuation of the negative perception that courthouse related decisions have historically ignored community and city needs.

Parking as Public Asset

Under the ideology where the city treats curbside spaces as a public resource and manages it thus, a variety of interventions can be pursued.

CS

Localized high demand can be mediated with increased prices on residential parking permit. To ease community concerns about increased competition and congestion, a neighborhood-based RPP could be established with spatial boundaries that would not permit the new developments' residents to park on contested blocks. Development tie-ins could commit the developer to TDM

measures and other disincentives to SOV (currently accepted approach). Restrictions on eligibility for residential parking permits could exclude tenants of the new development. Though implemented in Boston, this legality of this site-specific RPP exclusion may be contested in court. To ease perceptions of lack of community input in CS, the Lawrence Street Hubway station can be relocated to the interior of Dana Park, returning street spaces to local supply. Better outreach strategies can be developed for the future siting of stations in highly residential areas.

A4

In A4, high demand found throughout the area could be eased with increased prices for residential parking permits. To ease community concerns about parking competition and congestion, interventions as described above for CS can be implemented. Shared parking uses could also reduce parking cruising times by efficiently allocating existing spaces between residential needs and commercial/office (proposed) needs. Beyond removing affordable housing entirely from the development, there are few parking-related interventions which can deal with individuals' reactions to affordable housing. These concerns and assumptions are rooted in individual biases.

EC

In EC, as in CS and A4, easing localized high parking demand requires increasing the price of residential parking permits. To address the concerns of increased parking competition and congestion, the same interventions as described in CS and A4 can be implemented. To address perceptions that the current LMP proposal is not appropriate for the neighborhood, Cambridge Planning Board could reject LMP's application for a special permit and request a redesign. Creating a proposal amenable to neighbors is, however, still primarily under the control of the developers. Finally, there is little the city government can do to mitigate historically negative feelings regarding community input on Courthouse decisions because Commonwealth of Massachusetts has been the controlling institution.

Priority to 'Locals'

Key assumption in the priority to 'locals' ideology is every citizen has an equal right to curbside spaces within the vicinity of their home. Since there are more residents than spaces, this results in each citizen having a right to a certain percentage of curbside space. If the residential parking permit program were designed to reflect this reality, each permit would in fact grant rights to only a portion of a whole parking space. A complete inventory of Cambridge on-street spaces would be required as well creation of a formal or informal white market to permit the trading and selling of fractional rights to a space. Residents who do not use a curbside space receive a financial gain, and those who do are paying a market driven price for the right to a full space. Regular surveys would be required to measure the local population and/or registered vehicles.

To analyze CS, A4 and EC under this ideology, working age persons serves as the pool of eligible citizens.

In the priority to 'locals' ideology, local government involvement is required to manage a new system of allocating spaces. Compared to 'Parking as a Public Asset', however, the role of local government is less proactive in intervening on perception and spatial issues.

CS

If every CS resident has an equal right to CS' local supply of ~2200 on-street spaces, then each resident (~9000 working age residents in 2010) has a right to a roughly 1/3 of a space. If only persons with registered vehicles are considered, then each eligible vehicle owner (2900 RMV in 2011) has a right to ¾ of a space. The impact of charging a market-driven price for the right to use a curbside space would reduce overall demand, thereby easing CS' localized demand issues by either persuading residents to make use of their existing off-street spaces or to not own a car in Cambridge. It would not however address the perception issues tied to new development and competition, nor the issue of public input on Hubway station location.

A4

If every resident (~4000 working age persons in 2010) has a right to A4's local supply of ~1100 on-street spaces, then each resident has a right to roughly ¼ of a curbside space. If only considering persons with eligible vehicles (~1700 RMV in 2011), then each has a right to approximately 2/3 of a space. The impact of implementing this ideology through the RPP program would be a decreased demand for on-street spaces, as described in CS. It would not, however, deal with perception issues around new development and affordable housing impacts.

EC

If each resident (~3200 working age persons in 2010) has an equal right to EC's on-street supply of ~1500 spaces, then each resident has a right to approximately ½ of a space. When only considering eligible vehicles (~1600 RMV in 2011), then each eligible vehicle owner has the right to a little less than an entire space (90%). As in CS and A4, this intervention reduces overall demand for parking, easing localized high demand issues. It does not address perception issues tied to the current courthouse proposal.

Summary

The approach that best addresses spatial and political parking challenges uses the ideology of treating curbside spaces as a public resource and implements measures as discussed above. However, this ideology also requires the largest institutional capacity. Existing city agencies and government officials would need to commit resources, time and political capital to

implement changes to the RPP program, structure shared parking uses and require new developments to commit to specific TDM measures and other programs.

The no intervention ideology requires no additional institutional capacity but also does not address any of the identified parking challenges. Priority to 'locals' best represents the residents' current expressions of entitlement over nearby on-street spaces. But it presents significant challenges in implementation. It requires an overhaul of the RPP program, an inventory of existing spaces and regular collection of data on residents and registered vehicles. There is the added complexity of a new formal or informal white market for residents to exchange and purchase rights to spaces. This ideology best expresses residents' valuation of spaces but the novelty of the approach and upfront data requirements make it an unlikely choice for Cambridge in the near future.

KEY N: Issue not addressed --: Issue somewhat addressed. Y: Issue fully addressed			Ideologies		
			No Intervention	Public Resource	Priority to 'Locals'
Parking Issues	CS	Spatial: Localized high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception lack of community input	N	Y	N
	A4	Spatial: Generally high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception affordable housing decreases neighboring property values	N	N	N
		Political: Perception area has too much affordable housing	N	N	N
	EC	Spatial: Localized high demand	N	Y	Y
		Political: Perception new development leads to congestion and parking competition	N	Y	N
		Political: Perception courthouse and proposal are inappropriate for residential area	N	--	N
		Political: Perception courthouse-related decisions have ignored the community	N	N	N

5.2.4 Evaluation Metrics

This thesis describes parking interventions in broad strokes and therefore does not contain the specific details required for a robust evaluation of interventions. However, evaluation is an

important component in the implementation of any public policy. From spatial, political and institutional perspectives, evaluation metrics should target,

- Effectiveness (How far does it go to solve the problem?)
- Efficiency (What are the likely costs and to what benefit or profit?)
- Equity (Is it 'fair'?)
- Environmental responsibility (What are the likely environmental impacts of the intervention, direct and indirect?)
- Feasibility (Given current conditions and resources, how feasible is it politically and institutionally?)
    - Feasibility of Implementation (getting it started)
    - Feasibility of Maintenance (keeping it going for the long-term)

Post-implementation, continued evaluation and learning from the effects of an intervention are important steps in the long-term resolution of parking challenges.

5.3 Conclusions & Next Steps

Residential parking debates are complex and need to be approached from spatial, political and institutional perspectives. Failing to do so will leave policy makers blindsided by physical parking problems, challenges from stakeholders and/or limits on existing institutional capacity.

Parking is a public asset and should be managed as such. Of the three ideologies explored in this thesis, treating curbside parking supply as a public resource is the most effective stance to address spatial and political issues. However, as stated earlier, it requires substantial commitment, institutional capacity and coordination among city agencies, government officials, private developers and community groups.

'Is it really about parking?' Urban growth and parking debates are not always driven by spatial concerns of parking supply versus demand. Some debates are rooted in deeper social anxieties. Parking interventions cannot change individuals' opinions on new people, developments and affordable housing. But understanding the real drivers of neighborhood protest can help policy makers evaluate their options. A detailed understanding of current parking conditions can also identify communities particularly sensitive to parking issues, such as residential blocks with high existing localized demand.

RPP prices are too low. Increasing the price of residential parking permits on an income-based scale is one of the most important interventions the city of Cambridge can undertake in the near future. Raising the price of permits would alleviate many of the spatial parking challenges tied to high demand. This is a challenging task, particularly in light of today's very inexpensive permit price. It will require significant political capital on the part of government officials and

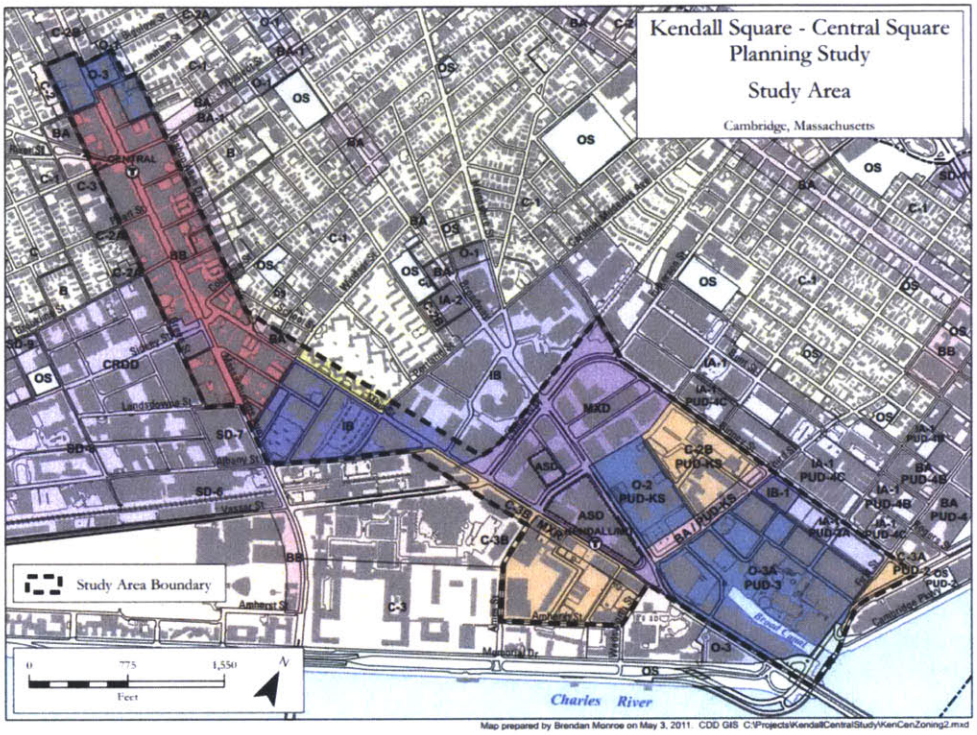
documentation of the benefits of the increase. The city also needs to instill in the population an expectation that the price of a permit will increase with time, laying the groundwork for necessary future increases. Under a blanket price increase, lower income households would be disproportionately affected. Implementing an income-based pricing structure can offset this inequity.

Data, data, data. Cambridge needs an inventory of existing parking spaces, including non-metered on-street and off-street supplies. Limited data on parking supply hinders the development of effective parking interventions. Given the amount of information collected in a limited time frame by a single researcher, there are clear opportunities to inventory parking at a large scale using only minor city resources. It just has to be made a priority. On-street parking is a public resource and as such, mapping this supply should receive the same effort applied to previous city mappings of address points, tree wells, curb cuts, park benches and light posts. Given the rapid progress of development in many parts of Cambridge in the last ten years, city planning would benefit from regular surveys of parking utilization. A survey every 2-3 years in growing neighborhoods would provide important longitudinal data on local parking conditions, which can inform future policies and document the actual impacts of new developments.

Campaign. Another important next step is the continuation of proactive campaigning by city agencies, councilors, and neighborhood groups in complicated proceedings such as the Sullivan Courthouse redevelopment. Without pressure, the Commonwealth of Massachusetts will not go out of its way to accommodate the needs of the city or local residents. It is the responsibility of the city government and its citizens to advocate for their interests, particularly in a development proposal that has the capacity to reshape a neighborhood.

Residential parking debates can invoke impassioned reactions from even the sanest individual. Finding a solution that addresses spatial, political and institutional issues is challenging, requires accurate information, often multiple interventions and a willingness to attempt, evaluate and learn from errors. It can be done. The findings of this research illustrate the complexity of parking problems but also provide a framework for breaking parking challenges down to fundamental issues and developing effective interventions.

APPENDICES


Kendall Square - Central Square
Planning Study
Study Area
Cambridge, Massachusetts
Study Area Boundary
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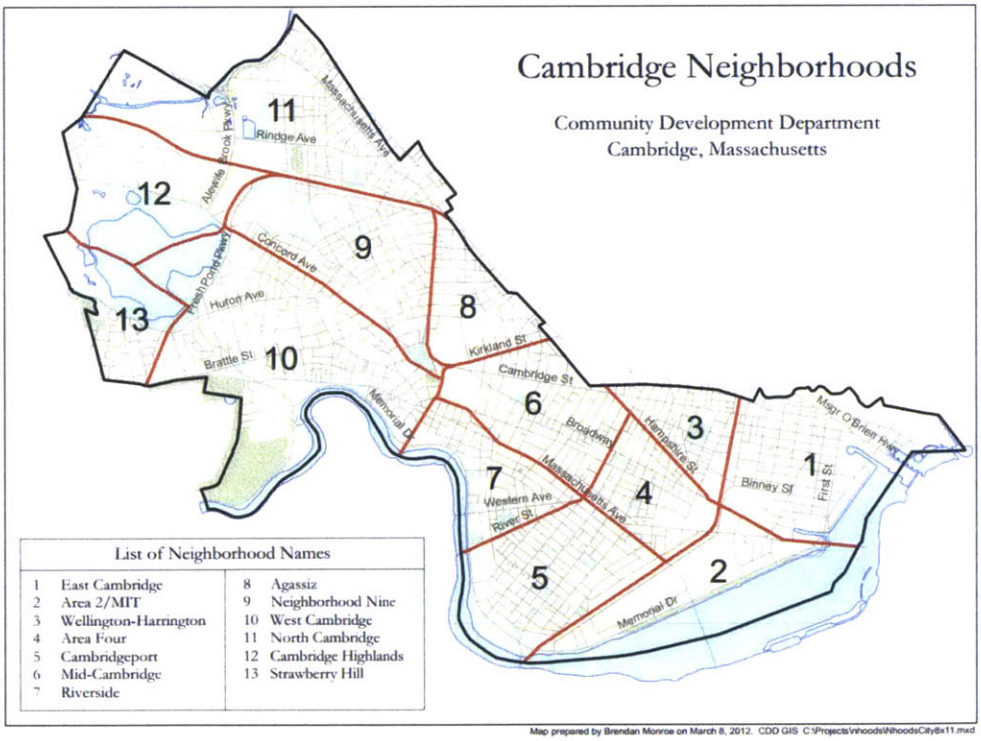
775
1,550
Feet
N
Charles River
Map prepared by Brendan Monroe on May 3, 2011. CDD GIS C:\Projects\KendallCentralStudy\KenCenZoning2.mxd


Cambridge Neighborhoods
Community Development Department
Cambridge, Massachusetts
List of Neighborhood Names
1 East Cambridge
2 Area 2/MIT
3 Wellington-Harrington
4 Area Four
5 Cambridgeport
6 Mid-Cambridge
7 Riverside
8 Agassiz
9 Neighborhood Nine
10 West Cambridge
11 North Cambridge
12 Cambridge Highlands
13 Strawberry Hill
Map prepared by Brendan Monroe on March 8, 2012. CDD GIS C:\Projects\nhoods\NhoodsCity8x11.mxd

Cambridge CDD Neighborhoods: Residential Parking Permits

	District	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	East Cambridge	2758	2696	2643	2773	2873	2778	2864	2966	3007	2922
2	MIT (includes U Park)	67	75	70	98	120	92	91	125	129	123
3	Wellington Harrington	3201	3080	2946	2930	2856	2961	2906	3003	2919	2879
4	Area 4	2502	2472	2326	2210	2171	2221	2279	2333	2375	2315
5	Cambridgeport	4529	4379	4261	4289	4246	4284	4405	4398	4365	4287
6	Mid-Cambridge	5494	5336	5112	5052	5020	4950	4960	5015	4872	4793
7	Riverside	2590	2538	2436	2419	2431	2367	2438	2467	2372	2408
8	Agassiz	1882	1812	1748	1688	1679	1680	1692	1733	1696	1653
9	Area 9	5269	5313	5086	5026	4860	4864	4861	5033	4958	4860
10	Area 10	4127	4055	3936	3860	3885	3840	3807	3835	3844	3844
11	North Cambridge	4964	4860	4744	4813	4811	4869	4972	5097	4969	4928
12	Cambridge Highlands	325	329	297	274	297	407	419	342	357	389
13	Strawberry Hill	1611	1597	1503	1520	1536	1597	1562	1636	1585	1596
14	North Point (was Area 1)								197	194	199
46	Area 4 or 6	102	103	97	103	106	104	104	116	101	117
55	dorms/group quarters	508	443	396	429	410	364	360	426	362	330
57	area 5 or 7	153	144	163	159	162	153	161	185	190	201
68	area 6 or 8	131	115	118	112	113	108	95	96	98	90
75	formerly non-res	271	315	273	84	180	486	366	36	63	81
91	area 9 or 10	576	571	551	502	480	514	507	497	464	473
910	Area 9 or 10 (3 concord Ave)		567		33	34			30	32	33
	SUBTOTAL	**41,060**	**40,800**	**38,706**	**38,374**	**38,270**	**38,639**	**38,849**	**39,566**	**38,952**	**38,521**

Source: Cambridge Transportation, Parking & Traffic Department (2013)

CS

CS-Tracts (1990)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3530	100.0%	46.3%	9.0%	23.9%	2.4%	15.3%	1.0%	2.1%
3531	100.0%	48.6%	11.6%	20.0%	3.1%	15.3%	0.4%	1.0%
3532	100.0%	65.6%	13.3%	11.2%	2.1%	6.7%	0.0%	1.0%
3533	100.0%	52.8%	10.3%	11.5%	0.0%	19.4%	0.0%	6.0%
3534	100.0%	73.4%	7.5%	8.1%	0.0%	10.6%	0.5%	0.0%
3535	100.0%	55.8%	8.4%	9.7%	0.0%	22.1%	0.0%	4.0%

CS-Tracts (2000)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3530	100.0%	52.9%	7.4%	23.4%	1.9%	11.6%	1.1%	1.6%
3531	100.0%	41.9%	7.9%	26.1%	3.8%	17.8%	1.2%	1.2%
3532	100.0%	62.1%	10.7%	18.1%	1.2%	4.8%	0.8%	2.3%
3533	100.0%	46.1%	5.8%	8.8%	2.0%	16.1%	0.0%	21.0%
3534	100.0%	71.0%	7.6%	10.0%	1.7%	5.5%	0.0%	4.2%
3535	100.0%	64.7%	7.1%	11.9%	0.5%	7.0%	0.5%	8.2%

CS-Tracts (2008-2012 5 Yr estimates)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3530	100.0%	17.2%	2.1%	42.1%	11.3%	18.5%	0.4%	8.4%
3531.01	100.0%	10.6%	1.0%	35.4%	4.5%	39.3%	0.0%	9.2%
3531.02	100.0%	14.0%	3.2%	7.8%	9.9%	58.7%	0.0%	6.4%
Equivalent of old 3531 (3531.01 + 3531.02)	100.0%	12.4%	2.2%	20.8%	7.3%	49.6%	0.0%	7.7%
3532	100.0%	24.9%	4.1%	30.2%	10.1%	24.7%	1.4%	4.6%
3533	100.0%	23.3%	5.8%	30.0%	9.1%	22.9%	1.6%	7.2%
3534	100.0%	33.5%	5.7%	21.8%	8.1%	23.9%	4.3%	2.7%
3535	100.0%	30.9%	2.9%	33.6%	7.1%	12.4%	3.9%	9.2%

CS-Tracts (2008-2012 5 Yr estimate) – Margin of Error							
	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3530	11.4%-24.4%	0.6%-3.9%	30.1%-57.2%	4.5%-19.9%	9.6%-29.6%	0.0%-2.5%	4.0%-13.9%
3531.01	4.3%-19.6%	0.0%-2.9%	21.0%-55.7%	0.3%-10.3%	22.3%-63.2%	0.0%-2.7%	3.9%-16.7%
3531.02	6.5%-25.8%	0.0%-8.7%	3.1%-15.1%	4.0%-19.1%	32.3%-100.2%	0.0%-2.5%	1.5%-14.1%
Equivalent of old 3531 (3531.01 + 3531.02)	5.5%-22.8%	0.0%-5.9%	11.4%-34.9%	2.3%-14.8%	27.7%-82.2%	0.0%-2.6%	2.6%-15.4%
3532	17.4%-34.7%	0.4%-8.9%	16.5%-48.0%	5.5%-16.0%	13.0%-39.8%	0.0%-4.6%	2.1%-7.7%
3533	15.7%-34.4%	2.4%-10.9%	14.9%-52.0%	4.0%-16.4%	13.0%-37.4%	0.0%-5.0%	3.1%-13.1%
3534	22.5%-47.5%	2.4%-9.9%	12.9%-33.2%	4.2%-13.1%	13.0%-37.8%	0.0%-11.3%	0.3%-6.0%
3535	19.9%-45.6%	0.7%-5.8%	22.6%-48.2%	1.7%-14.2%	6.1%-20.8%	0.0%-11.1%	5.2%-14.4%

A4

A4 – Tracts (1990)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3524	100.0%	34.1%	3.5%	34.5%	4.2%	23.8%	0.0%	0.0%
3525	100.0%	40.5%	5.9%	26.5%	4.6%	19.4%	1.4%	1.5%
3526	100.0%	42.8%	18.5%	16.9%	1.9%	19.9%	0.0%	0.0%
3528	100.0%	41.1%	18.7%	21.9%	1.2%	14.6%	0.0%	2.2%

A4 – Tracts (2000)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3524	100.0%	22.5%	10.5%	33.0%	2.0%	24.2%	5.2%	2.6%
3525	100.0%	28.0%	3.7%	37.2%	7.8%	16.4%	1.9%	5.0%
3526	100.0%	43.2%	10.8%	17.2%	2.2%	23.8%	1.3%	1.5%
3528	100.0%	43.7%	9.7%	18.1%	5.4%	20.9%	0.0%	2.2%

A4 – Tracts (2008-2012 5 Yr estimate)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3524	100.0%	24.9%	4.4%	27.7%	5.0%	36.7%	1.3%	0.0%
3525	100.0%	24.9%	9.1%	28.3%	10.8%	19.7%	1.4%	5.9%
3526	100.0%	29.5%	5.1%	14.3%	14.2%	33.7%	1.2%	2.0%
3528	100.0%	32.5%	3.7%	23.1%	14.2%	23.0%	0.8%	2.6%

A4 – Tracts (2008-2012 5 Yr estimate) – Margin of Error							
	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3524	13.8%-40.7%	1.2%-8.9%	16.2%-44.0%	1.5%-9.9%	19.3%-61.2%	0.0%-7.1%	0.0%-1.5%
3525	15.8%-35.7%	3.4%-15.8%	19.7%-38.5%	5.8%-16.8%	12.0%-28.9%	0.0%-4.6%	3.1%-9.3%
3526	17.3%-46.9%	1.0%-10.8%	7.4%-24.1%	6.8%-24.8%	19.4%-54.3%	0.0%-4.7%	0.0%-5.7%
3528	21.5%-46.5%	0.9%-7.4%	15.1%-33.3%	9.0%-20.8%	13.9%-34.6%	0.0%-4.0%	0.8%-4.8%

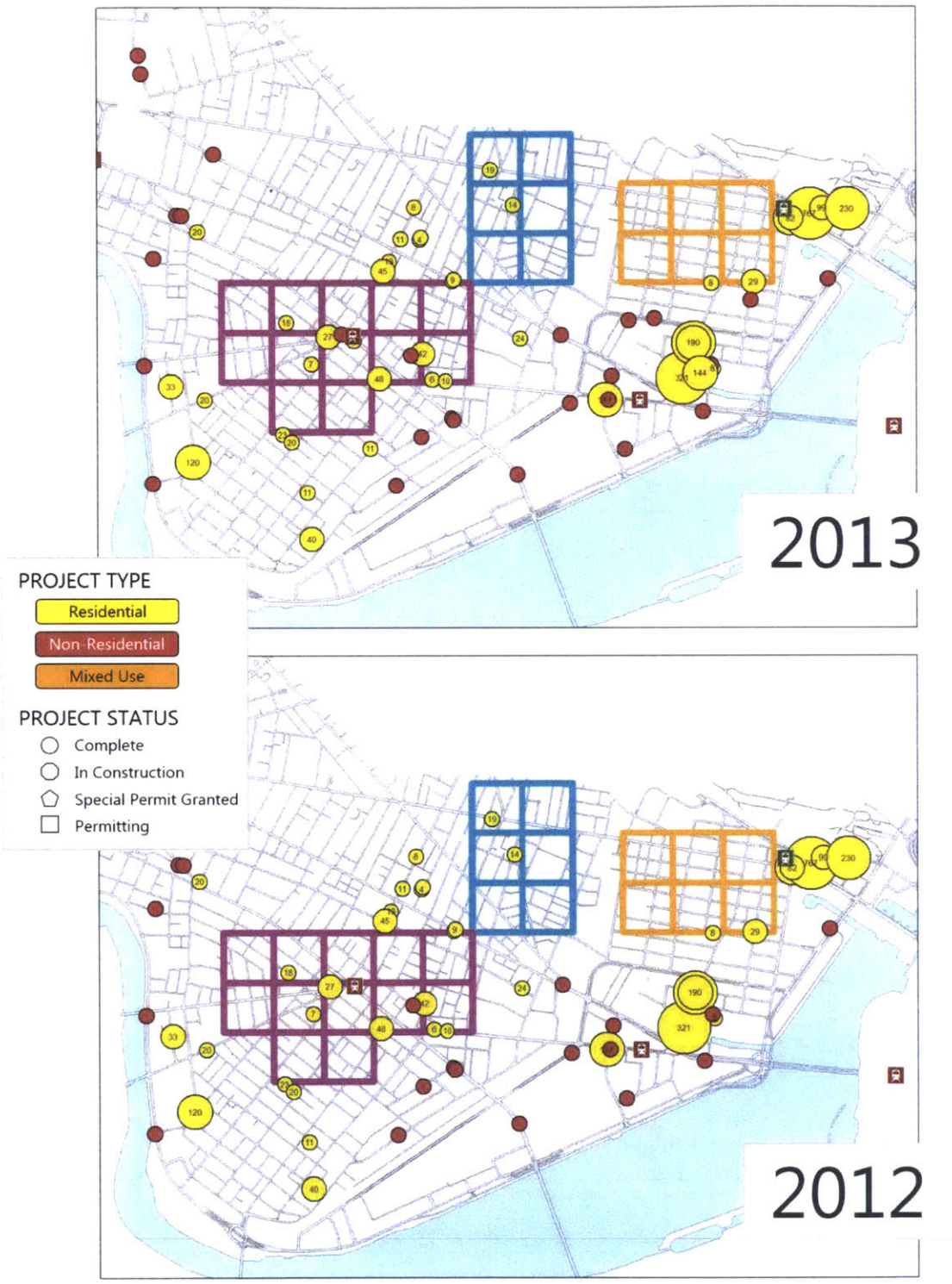
EC

EC – Tracts (1990)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3521	100.0%	59.8%	11.0%	24.2%	0.6%	4.0%	0.2%	0.1%
3522	100.0%	63.8%	12.9%	3.3%	0.0%	13.3%	0.0%	6.6%
3523	100.0%	56.2%	13.7%	23.5%	1.2%	3.6%	1.6%	0.2%

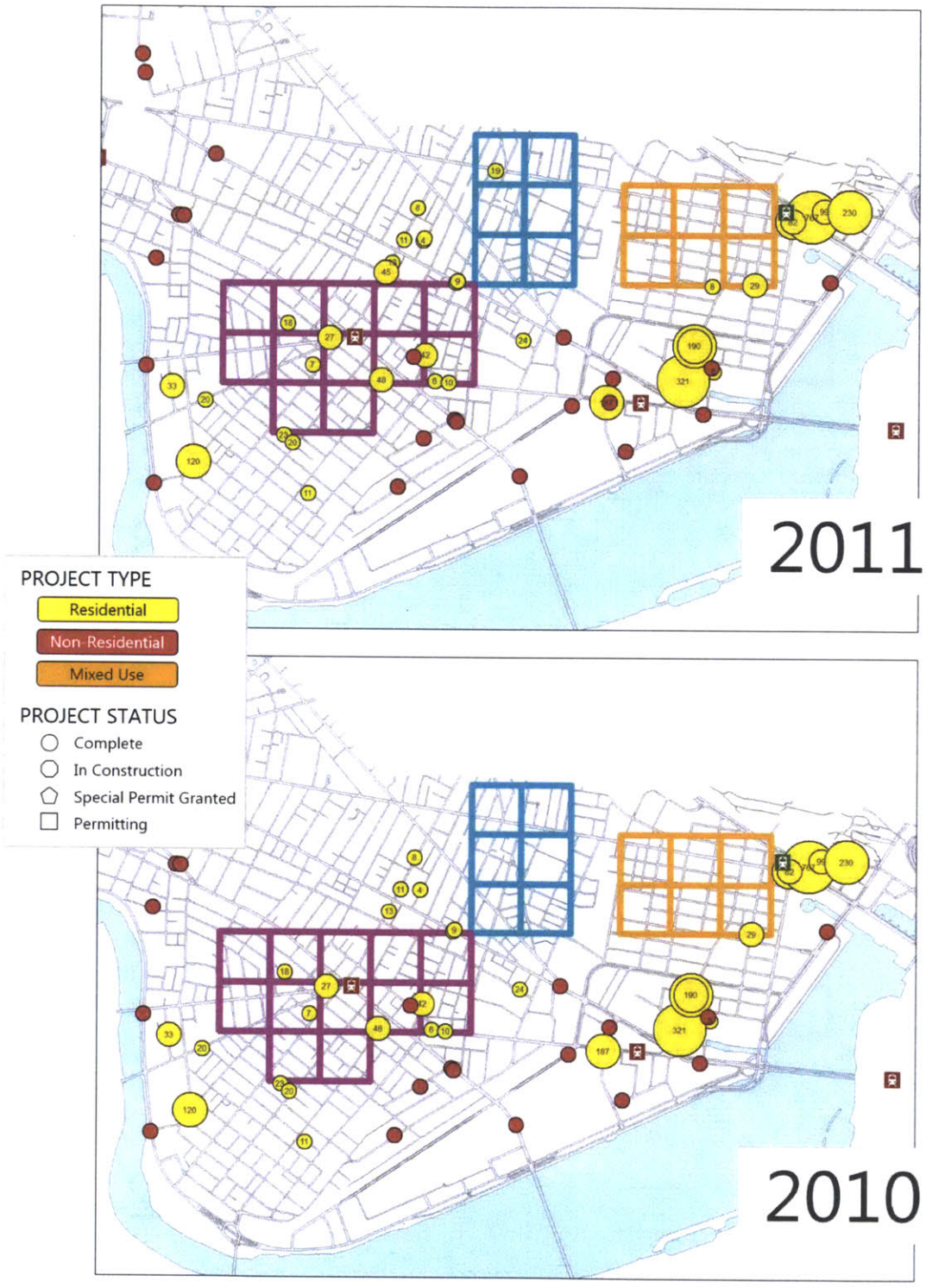
EC – Tracts (2000)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3521	100.0%	52.1%	11.1%	28.0%	1.2%	5.7%	1.3%	0.5%
3522	100.0%	52.7%	15.2%	6.5%	3.8%	18.8%	2.5%	0.5%
3523	100.0%	54.2%	11.1%	26.6%	1.6%	5.3%	0.5%	0.7%

EC – Tracts (2008-2012 5 Yr estimate)								
	Total	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3521.02	100.0%	31.6%	1.5%	29.2%	2.0%	23.3%	1.4%	11.1%
3521.01	100.0%	44.0%	10.2%	23.5%	5.0%	12.6%	0.6%	4.2%
Equivalent of old 3521 (3521.02 + 3521.01)	100.0%	38.8%	6.6%	25.8%	3.7%	17.0%	0.9%	7.1%
3522	100.0%	20.1%	2.6%	27.3%	13.4%	34.4%	0.0%	2.2%
3523	100.0%	26.3%	2.6%	31.7%	7.2%	30.7%	0.0%	1.5%

EC – Tracts (2008-2012 5 Yr estimate) – Margin of Error							
	Drive Alone	RideShare	Public Transit	Bike	Walk	Other Modes	Work at Home
3521.02	16.9%-56.7%	0.0%-4.3%	9.8%-62.5%	0.0%-6.2%	10.7%-44.9%	0.0%-8.2%	0.0%-35.5%
3521.01	27.3%-67.5%	3.6%-19.5%	11.5%-40.3%	1.3%-10.2%	5.3%-22.8%	0.0%-4.1%	1.1%-8.6%
Equivalent of old 3521 (3521.02 + 3521.01)	22.8%-63.4%	2.0%-13.6%	10.8%-48.9%	0.7%-8.6%	7.7%-31.3%	0.0%-5.7%	0.6%-19.0%
3522	11.6%-33.0%	0.3%-6.2%	13.9%-48.0%	1.5%-31.8%	17.9%-59.7%	0.0%-4.1%	0.2%-5.2%
3523	16.2%-39.8%	0.5%-5.4%	20.2%-47.1%	2.1%-14.0%	20.5%-44.3%	0.0%-2.5%	0.2%-3.4%



'Completed Projects 2003-2013' and *'Completed Projects 2003-2012'* (City of Cambridge, 2013b)



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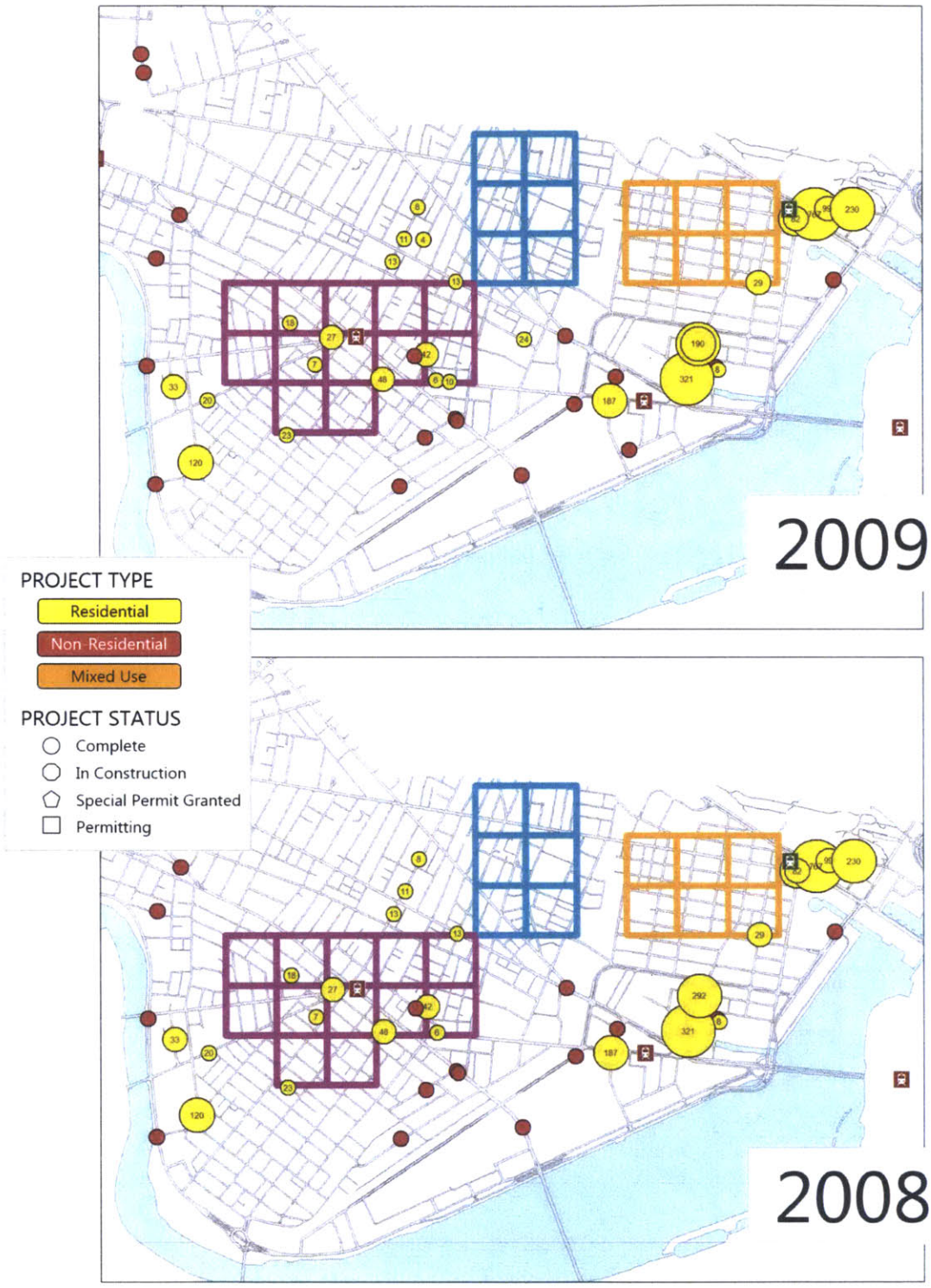

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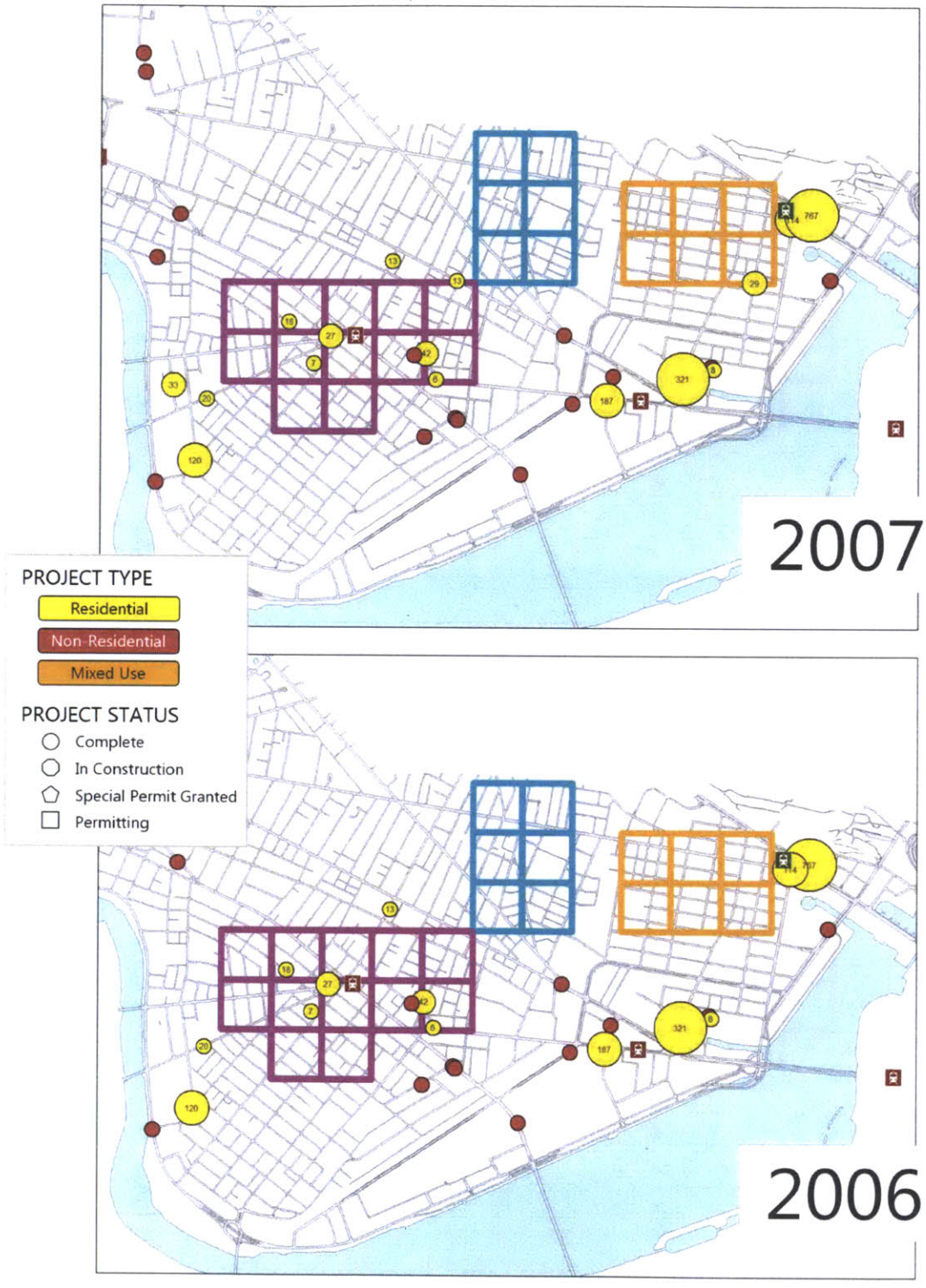

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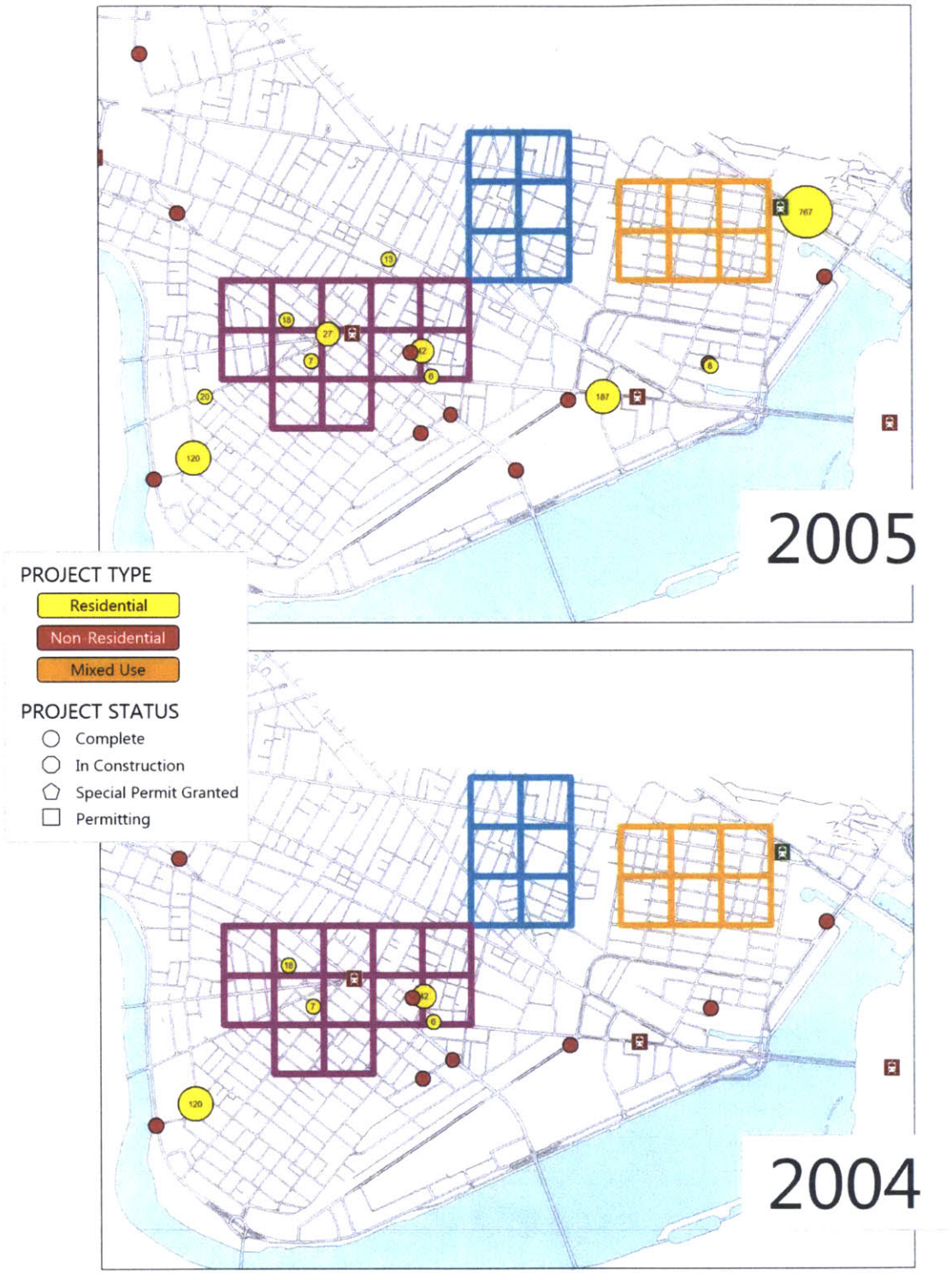
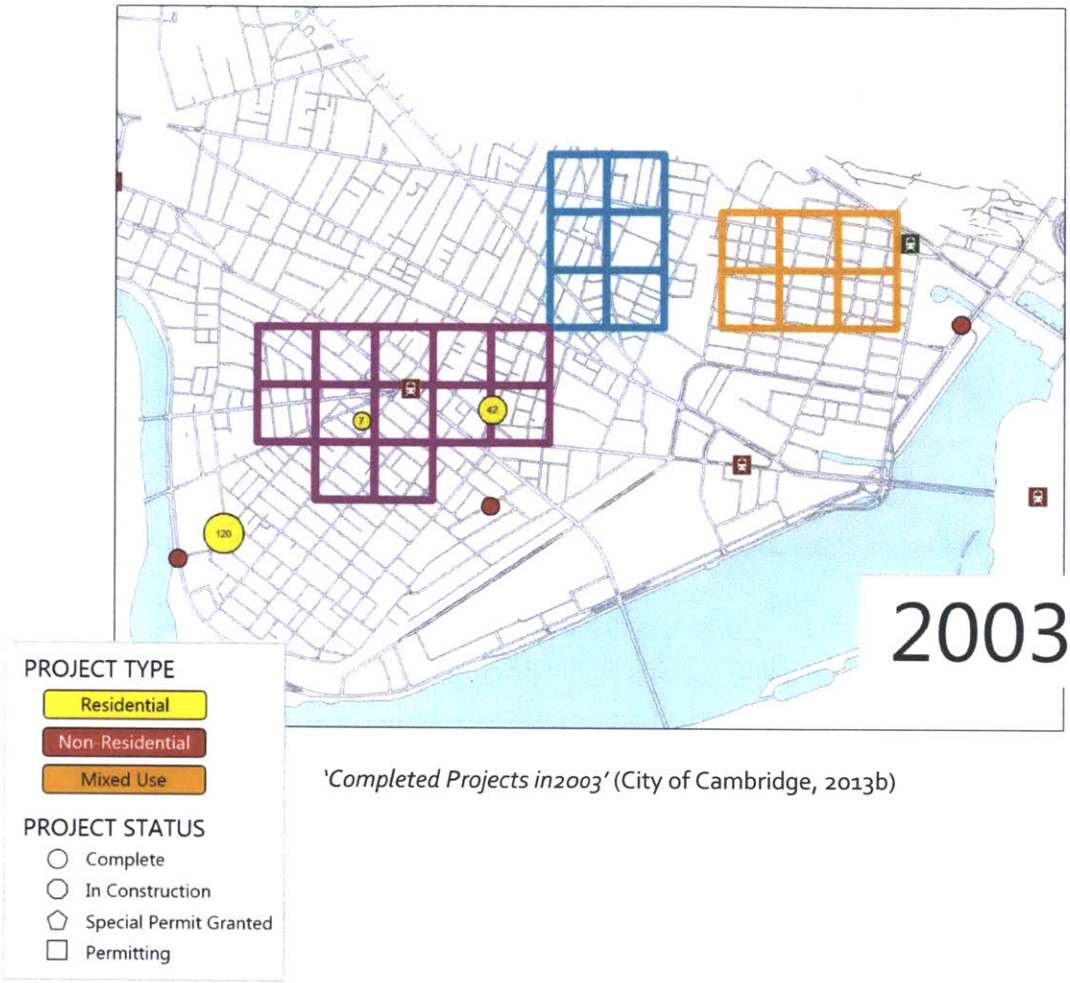


'Completed Projects 2003-2005' and 'Completed Projects 2003-2004' (City of Cambridge, 2013b)



'Completed Projects in2003' (City of Cambridge, 2013b)

New Developments in Cambridge (2003-2013)

Study Area (Within 200 meters of Grid)		Project Use	Completion Year	Street Address	Alternate Name	Developer	Gross Floor Area	Residential Units	STATUS in 2013
	CS	Local Government	--	100 Putnam Avenue	MLK, Jr. School	City of Cambridge	169,000	0	Special Permit Granted
		Office/R&D	--	650 Main Street	MIT	MIT	188,317	0	Special Permit Granted
			--	300 Massachusetts Avenue		Forest City	227,500	0	Special Permit Granted
			2013	5 Western Avenue	Former Police Station	Cambridge Housing Authority	55,553	0	Complete
			2006	250 Massachusetts Avenue	250 Massachusetts Avenue	Novartis Services	65,319	0	Complete
			2004	254 Massachusetts Avenue	Novartis	DSF Real Estate Investors	484,072	0	Complete
		Parking Garage	2004	47 Bishop Allen Drive	Parking Garage	Fennel RE Trust	11,036	0	Complete
		Residential	--	10 Essex Street		3MJ Associates LLC	49,539	46	Permitting
			--	7 Temple Street	YWCA	Cambridge Affordable Housing Corp	96,161	42	Special Permit Granted
			2013	622 Massachusetts Avenue		Hunneman Management	26,650	21	Complete
			2013	100 Pacific Street		100 Pacific Street Trust	19,545	11	Complete

		2011	259 Harvard Street	Jackson Gardens Renovation	Cambridge Housing Authority	55,668	45	Complete
		2010	10 Corporal McTernan Street	Blessed Sacrament Phase 2	Pearl McTernan LLC	37,430	20	Complete
		2010	277 Broadway		277 Broadway LLC	12,831	9	Complete
		2009	823 Main Street		Just A Start	13,356	10	Complete
		2008	21 Brookline Street	21 Brookline Street	1st Cambridge Real Estate	40,755	48	Complete
		2008	20 Cpl. McTernan Street	Blessed Sacrament-Phase I	Pearl St. LLC	42,059	23	Complete
		2007	199-209 Columbia Street	Columbia Court	Just A Start Corp	13,241	13	Complete
		2005	355 Green Street	355 Green Street	Harry Katis	30,400	27	Complete
		2005	146-152 Prospect Street	JAS Scouting Way	Just-A-Start	16,204	13	Complete
		2005	280-290 River Street	280-290 River Street	Mahan	23,700	20	Complete
		2004	369 Franklin Street	Oaktree Housing	Oaktree Green	21,500	18	Complete
		2004	853 Main Street	La Groceria	FMCM, LLC	6,429	6	Complete
		2003	55-99 Columbia Street	CAST Housing	Homeowner's Rehab.	-	42	Complete
		2003	196-198 Auburn Street	CASCAP Housing	CASCAP Inc.	-	7	Complete
					ALL CS PROJECTS*:	**1,706,265**	**421**	
					CS PROJECTS* COMPLETED 2003-2013:	**975,748**	**333**	
					CS PROJECTS IN PROGRESS:	**730,517**	**88**	
A4	Residential	--	34-36 Hampshire Street		CJ Griffen Enterprises	21,300	20	Special Permit Granted
		--	168 Hampshire Street		Agnosis Developmnet LLC	23,543	11	In Construction
		2012	424-430 Windsor Street	Immaculate Conception	Just A Start	24,710	14	Complete
		2011	1066 Cambridge St / 256 Elm St		Just A Start	27,732	19	Complete

		2010	277 Broadway		277 Broadway LLC	12,831	9	Complete
		2007	199-209 Columbia Street	Columbia Court	Just A Start Corp	13,241	13	Complete
					ALL A4 PROJECTS*:	**123,357**	**86**	
					A4 PROJECTS* COMPLETED 2003-2013:	**78,514**	**55**	
					A4 PROJECTS IN PROGRESS:	**44,843**	**31**	
EC	Office/R&D	2013	225 Binney Street	Binney St Development	Alexandria Real Estate (Biogen)	302,680	0	Complete
		2013	17 Cambridge Center	Biogen	Boston Properties	188,000	0	Complete
		2013	150 Second Street	Skanska	Skanska USA	108,600	0	Complete
	Residential	--	20 Charles Street		Jones Lang LaSalle	14,400	8	Special Permit Granted
		--	1-25 East Street	Phase II / Charles E. Smith Housing	C.E. Smith/Archstone Dev	446,005	341	Special Permit Granted
		--	159 First Street		Urban Spaces	126,000	115	In Construction
		--	22 Water Street	North Point	Catamount Holdings LLC	408,225	392	In Construction
		--	262 Msgr. O'Brien Highway	The Ivy Residents	YIHE Group	49,999	56	Permitting
		2011	126 Charles Street		1st Charles LLC/Glanz Properties	7,593	8	Complete
		2008	1 First Street	Phase II	Leggat McCall Properties	136,643	82	Complete
		2007	1-25 East Street	Phase I / Charles E. Smith Housing	C.E. Smith/Archstone Dev	426,000	426	Complete
		2007	110 Second Street	110 Second Street	Charles Passage, LLC	37,729	29	Complete
		2006	1 First Street	Phase I	Leggat McCall Properties	160,363	114	Complete
					ALL EC PROJECTS:	**2,412,237**	**1571**	

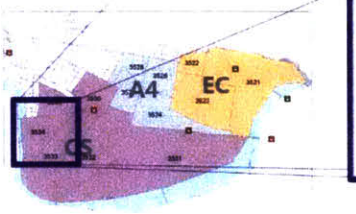
EC PROJECTS COMPLETED 2003-2013:	1,367,608	659
A4 PROJECTS IN PROGRESS:	1,044,629	912

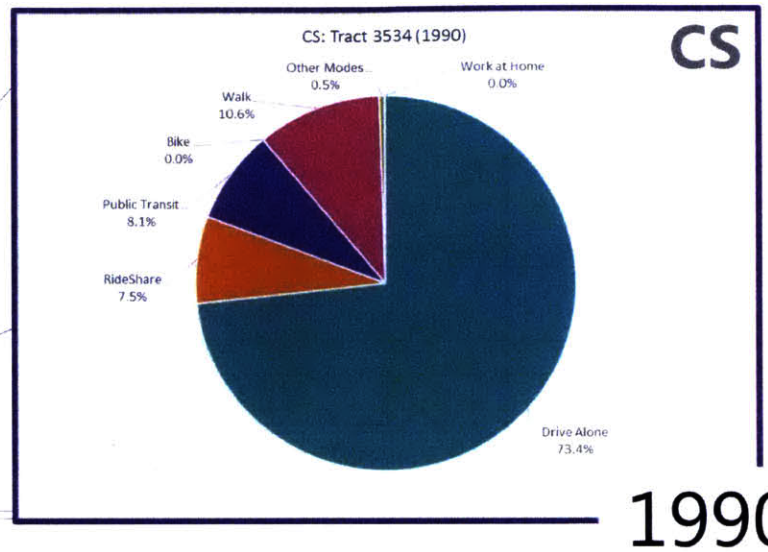
TOTAL CS, A4 and EC PROJECTS**:	4,215,787	2056
TOTAL CS, A4 and EC PROJECTS** COMPLETED 2003-2013:	2,395,798	1025
TOTAL CS, A4 and EC PROJECTS IN PROGRESS 2003-2013:	1,819,989	1031

* CS and A4 subtotals BOTH include 277 Broadway and 199-209 Columbia Street, which are within 200 meters of both study area boundaries.

** Totals include a SINGLE count of 277 Broadway and 199-209 Columbia Street.

(City of Cambridge, 2013b)





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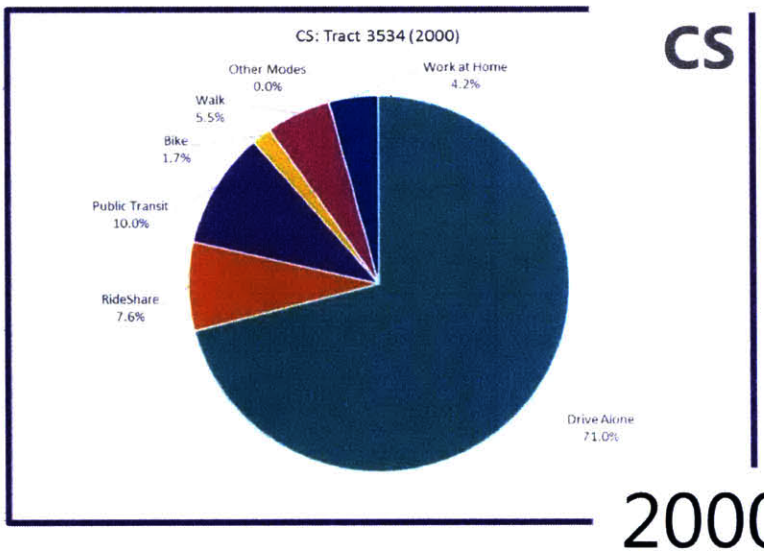

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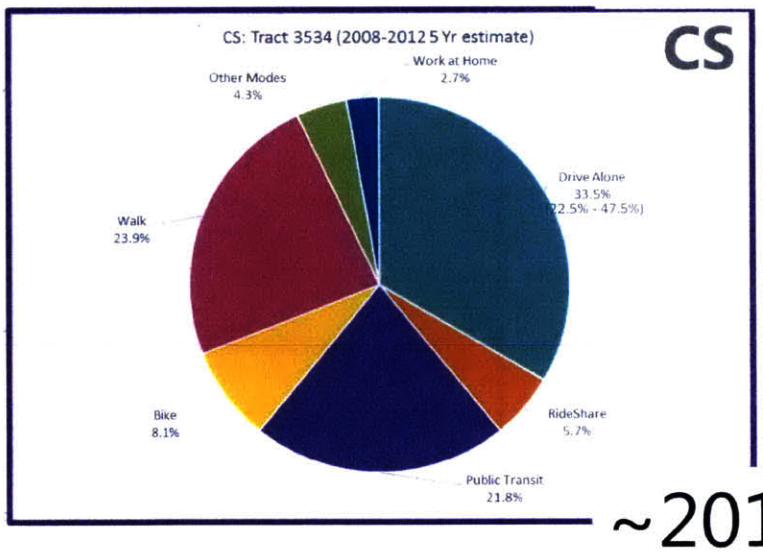

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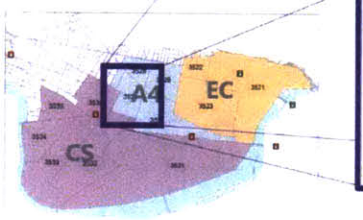

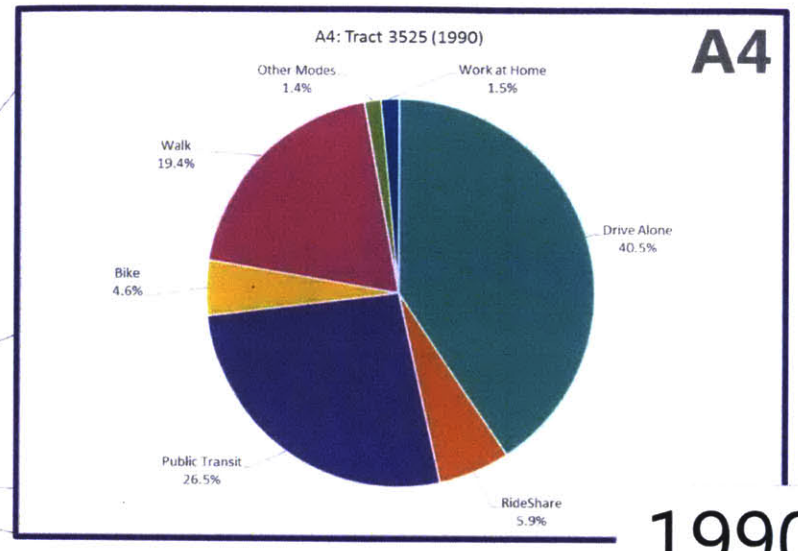

A4

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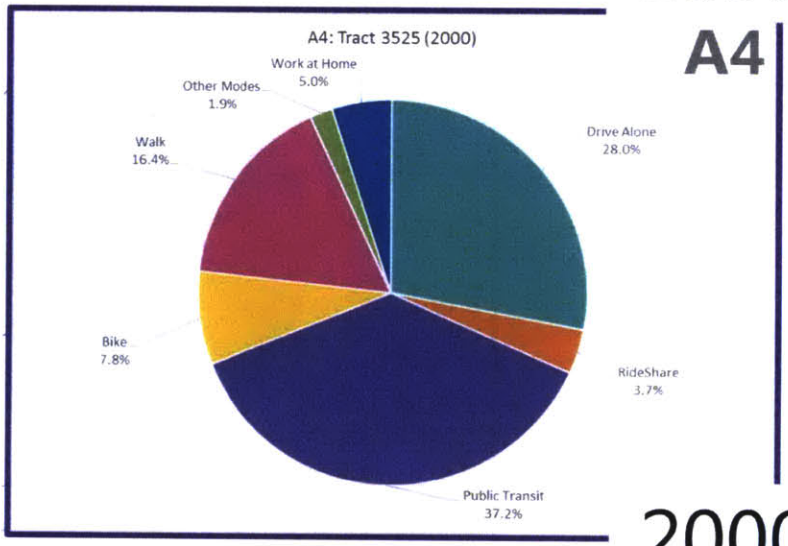
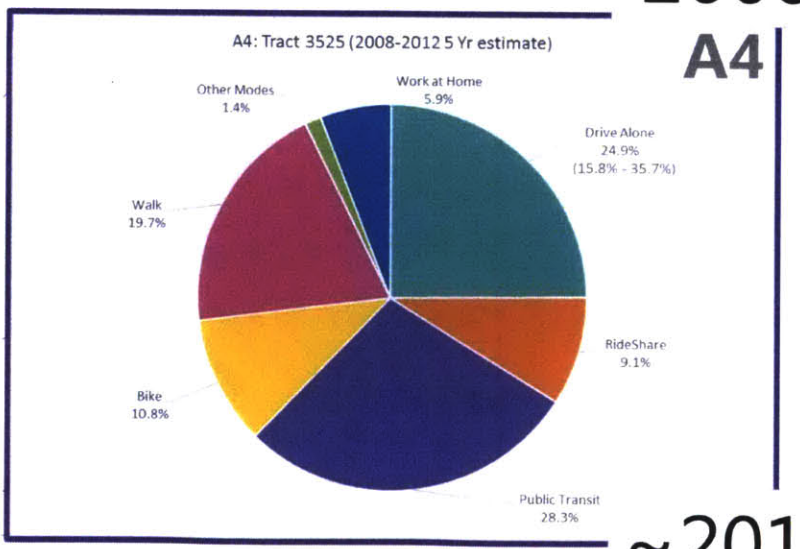


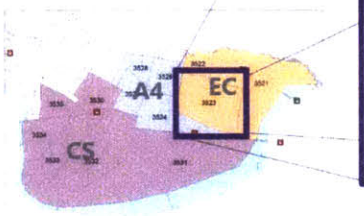
A4

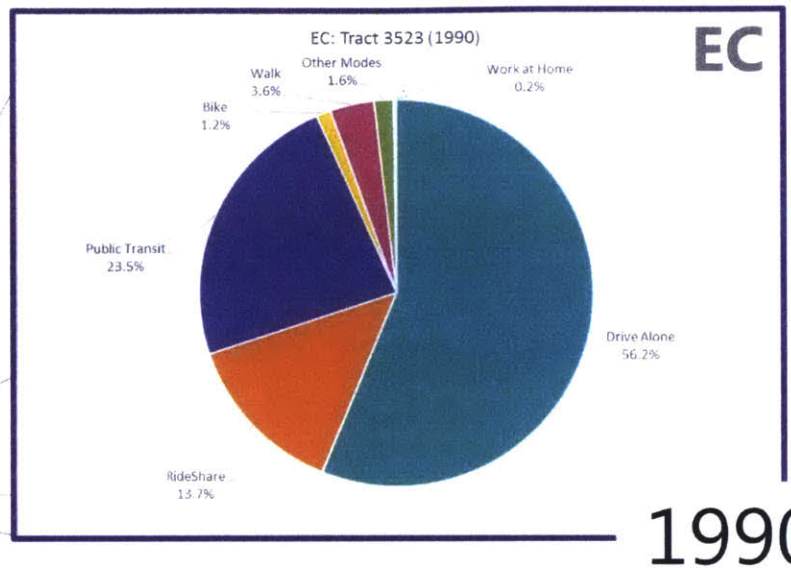
2000



A4

~2012





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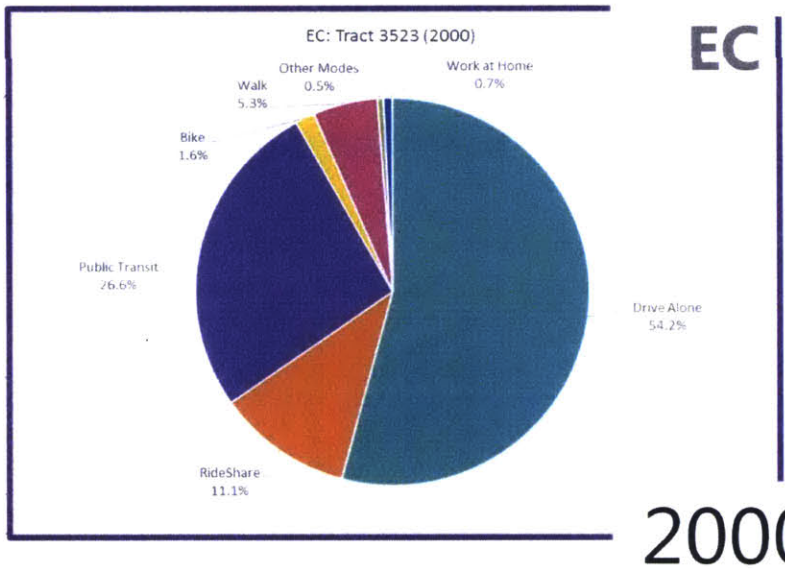

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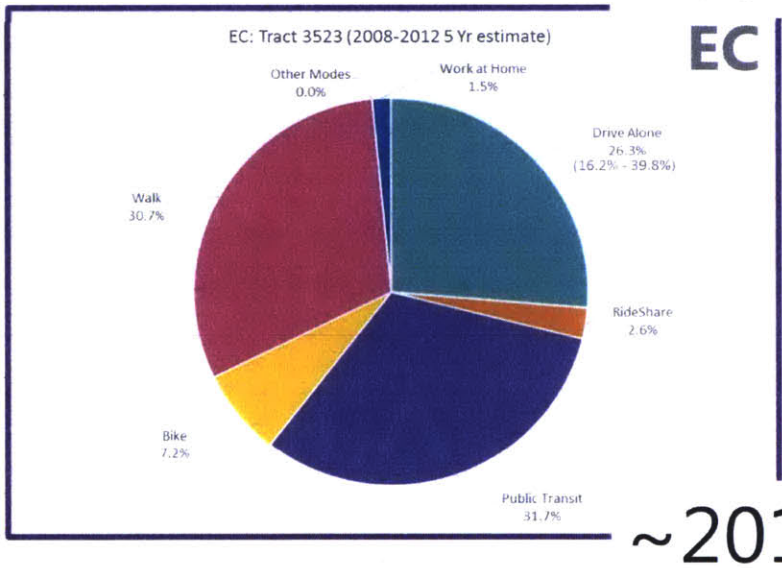

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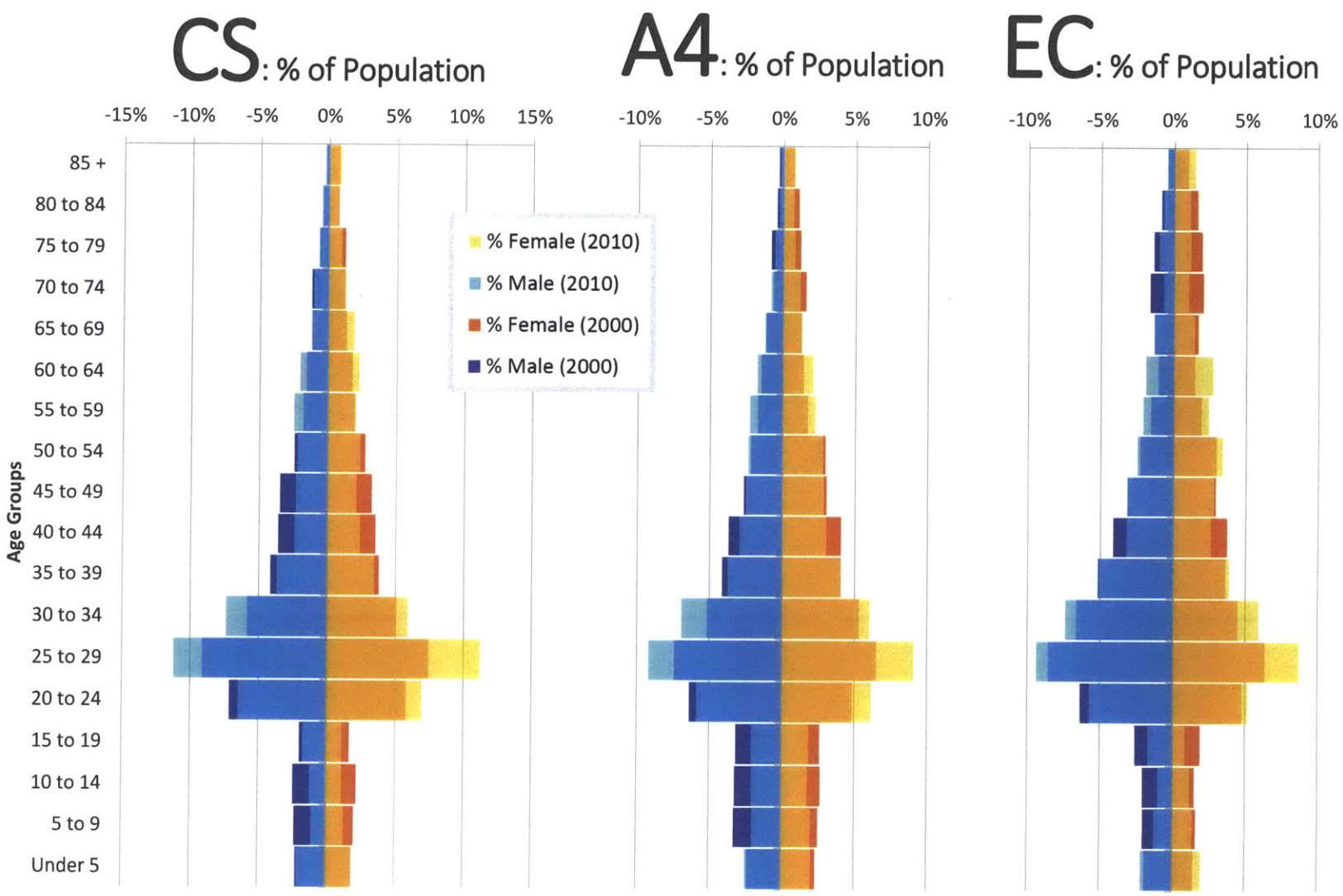
CS: % of Population
A4: % of Population
EC: % of Population
-15% -10% -5% 0% 5% 10% 15%
-10% -5% 0% 5% 10%
-10% -5% 0% 5% 10%
85 +
80 to 84
75 to 79
70 to 74
65 to 69
60 to 64
55 to 59
50 to 54
45 to 49
40 to 44
35 to 39
30 to 34
25 to 29
20 to 24
15 to 19
10 to 14
5 to 9
Under 5
Age Groups
% Female (2010)
% Male (2010)
% Female (2000)
% Male (2000)

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