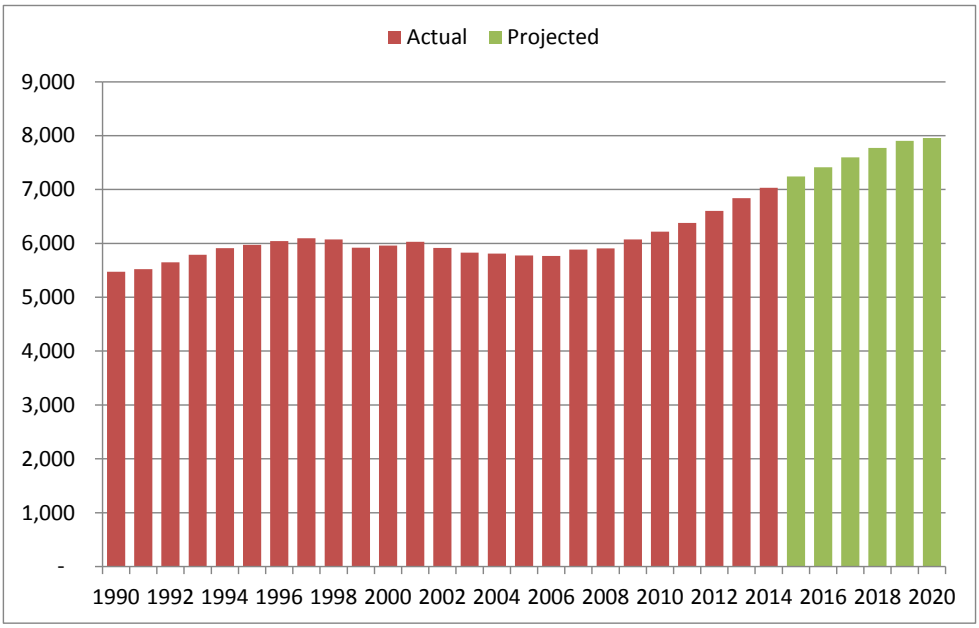
Town of Brookline Override Study Committee – Demographics Subcommittee
Report of Findings and Implications
September 22, 2014

The Demographics Subcommittee respectfully submits the following report. Additional information may be provided as it becomes available.

1. Introduction

Brookline's upcoming override vote will be addressing the current projection that the Town of Brookline ("Town") will need substantially more revenue capacity to provide the buildings and maintain the levels of school and town services that have come to define the quality of life in our community. The major driver of budget distress is the increase in student population in the Public Schools of Brookline ("PSB"). Since 2006, total enrollment has grown 21.9% (or 2.5% per year) and is not sustainable given our current school infrastructure.



The Demographics Subcommittee of the Override Student Committee ("OSC") which is comprised of Ann Connolly Tolkoff (chair), Alberto Chang, Sergio Modigliani, and Lee Selwyn agreed upon the following objectives:

1. Gain a greater understanding of the enrollment growth challenge in the PSB since 2006 through a review of existing reports and Town and PSB data including but not limited to reports from MGT of America, Inc. ("MGT").
2. Review the policy decisions made by the PSB and the Brookline School Committee concerning their response to the enrollment challenge, and
3. Develop tools to help forecast future enrollment trends.

Our approach has been to identify, where possible, the sources of this increased enrollment growth by assessing various assumptions thought to be driving the growth in enrollment and to develop a plan to address the enrollment challenges. We met with members of the various departments from the Town and PSB to obtain as much relevant information as we could get to perform our analyses.

The Demographics Subcommittee is primarily concerned with first identifying trends and then quantifying information, opportunities and impacts that may provide useful concepts for addressing current enrollment pressures. Other Subcommittees of the OSC examined matters concerning the feasibility, desirability and implementation associated with specific changes from the current procedures employed by the School Committee and have provided this information in their Reports. Some of these concepts have been generated by other OSC Subcommittees and some on our own. Selection of which specific concepts, if any, should actually be implemented involves trade-offs and largely remains the purview of the School Committee in association with parents and the Brookline taxpayers.

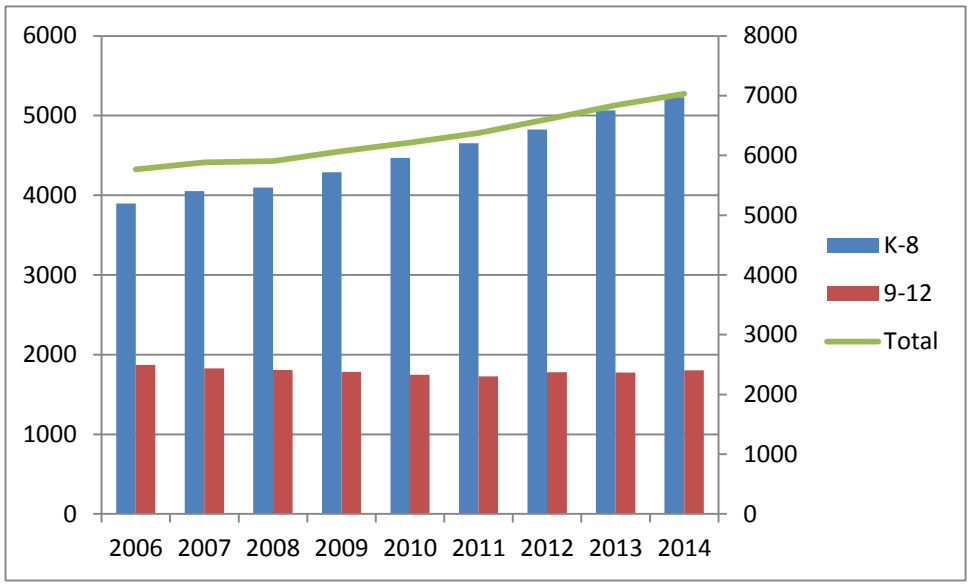
2. Observations

We have made several school enrollment observations listed in greater below:

1. Recent student enrollment growth is concentrated in the K-8 grades (and not the high school)
2. General cohort sizes have grown in comparison to past years

A. Enrollment Growth

The Schools provided the OSC enrollment data by grade for actual enrollment since School Year ("SY") 1990 until SY2014 and projections for SY2015 through SY2020 (see Appendix – table 1). Dividing the enrollment data between K-8 and 9-12, we identified two separate trends. When the above referenced 21.9% growth in overall enrollment since 2006 is bifurcated between elementary and high schools, the growth rates are actually 34.2% and -3.6% for the same eight year period.



As illustrated by the table below, each and every K-8 level has experienced growth regardless of grade level, since FY06, ranging from 15.9% in the third grade class size to 58.3% in the first grade class size.

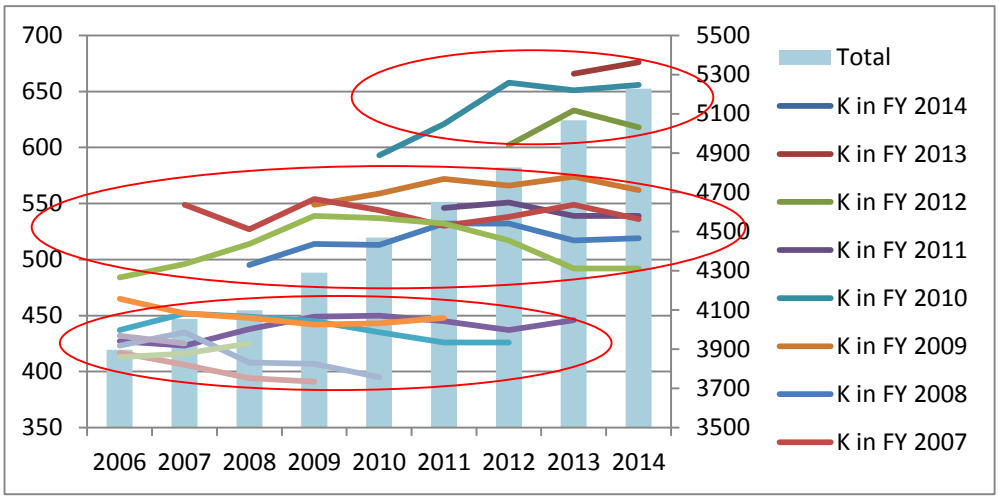
	2006	2007	2008	2009	2010	2011	2012	2013	2014	Growth	CAGR
K	484	549	495	549	593	546	602	666	630	30.2%	3.4%
1	427	496	527	514	559	621	551	633	676	58.3%	5.9%
2	437	423	514	554	513	572	658	539	618	41.4%	4.4%
3	465	452	438	539	544	532	566	651	539	15.9%	1.9%
4	423	452	449	449	537	530	532	574	656	55.1%	5.6%
5	417	435	448	445	450	532	538	517	562	34.8%	3.8%
6	413	406	408	442	435	445	517	549	519	25.7%	2.9%
7	432	416	394	407	443	426	437	492	536	24.1%	2.7%
8	398	425	425	391	395	448	426	446	492	23.6%	2.7%
Total	3,896	4,054	4,098	4,290	4,469	4,652	4,827	5,067	5,228	34.2%	3.7%

B. Cohort size

Using the above data table, we can graph the cohort size over time. Each cohort is illustrated in the graph below by a different color. We can easily notice three separate groupings denoted by the three red circles.

1. The three latest kindergarten classes (K classes that started in FY12, FY13, and FY14) all started with a cohort size over 600.

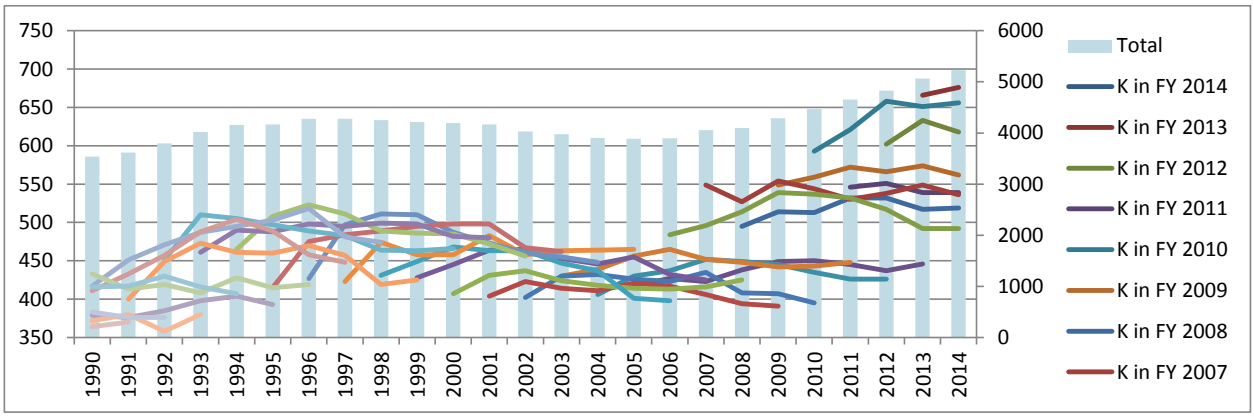
2. The prior five classes (K classes that started in FY07, FY08, FY09, FY10 and FY11) all started with a cohort size of over 500.[1]
3. The kindergarten classes that started prior FY07 all started with a cohort size in the 400s.



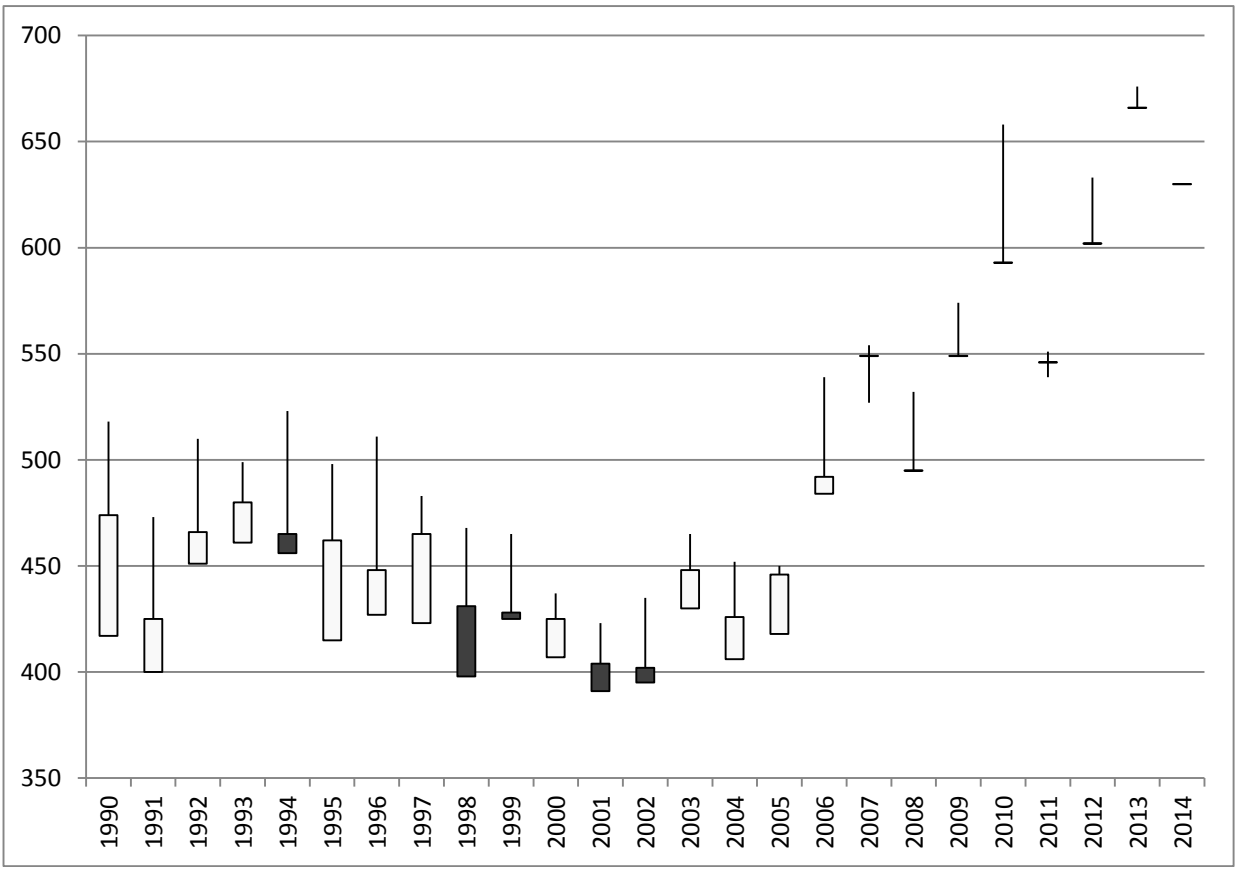
C. Attrition Rate

If we were to follow the class to see how it changes from one year to the next, we could see that class attrition rate. Extending the above graph with additional historical enrollment figures, we have illustrated the class attrition by the changes in each of the graph lines.

[1] FY10 kindergarten class was 593 and FY08 kindergarten class was 495.



Another way to view the attrition is through the graph below.



Each cohort is graphed as follow:

1. Each cohort is graphed in its own column. The year on the x axis represents the year of the kindergarten class.
2. The vertical lines illustrate the spread of the cohort size over time. The top part of the vertical line indicates the size of the cohort when it was at its maximum size.
3. The vertical boxes illustrate the beginning (represented by its kindergarten size) and end (represented by its 8th grade size) of the cohort. White boxes represent a growth between

kindergarten and 8th grade. Solid black boxes represent a drop in size between kindergarten and 8th grade.

4. For the cohorts that started in 2007 or later, we do not yet know their 8th grade enrollment figures yet and thus, are not graphed by white or black boxes but by a horizontal tick mark at the kindergarten class size level.

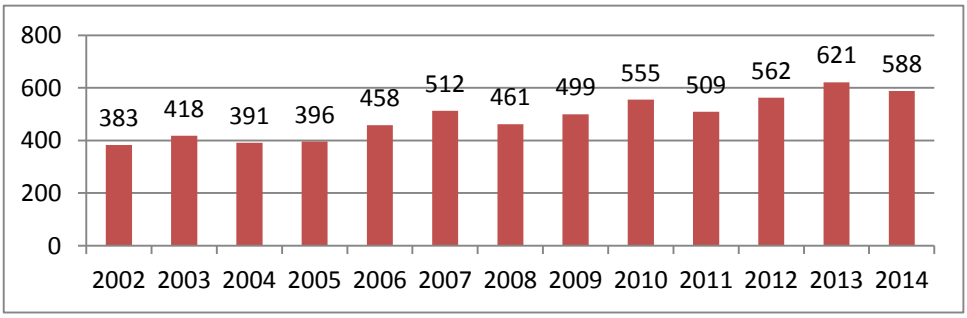
Of the 17 years we have cohort data for all nine years (kindergarten through 8th grade), 12 kindergarten class sizes represented the minimum size over time. Said another way, these 12 cohorts grew over the nine year time frame and never went below their kindergarten levels. In essence, the kindergarten class size served as a floor to the cohort size except for the kindergarten class that started in FY98 .

These historical and projected figures include non-residents (i.e., METCO and material fees students). We requested and obtained historical non-resident enrollment (see Appendix – tables 2 and 3).

From our review of the Town, School, and other governmental data, we have not only confirmed the increasing kindergarten class size but also the increasing K-8 class sizes.

D. Increasing Kindergarten Class Size

One source of the overall increase in enrollment is found in the kindergarten enrollment figures. Resident kindergarten enrollment[2] has continued to increase steadily over time despite periodic dips (refer to graph below of enrollment figures for school year provided by PSB).



While no single reason is causing the greater enrollment figures, one noticeable spike in recent years is the increased enrollment of students classified as immigrants (i.e., foreign-born children who immigrated to the United States). While in the past, the number of students classified as immigrants ranged from the mid-30s to the high-60s, this number has now grown closer to and over 100, in some instances. For example, immigrant kindergarteners total 107 and 120, in October 2012 and 2013, respectively.

Residents	06/02	10/02	06/03	10/03	06/04	10/04	06/05	10/05	06/06	10/06	06/07	10/07	06/08	10/08	06/09	10/09	06/10	10/10	06/11	10/11	06/12	10/12	06/13	10/13
Total Kindergarten	379		407		397	396	396	458	449	513	510	461	466	506	502	561	570	508	517	561	583	623	612	589
Non-Immigrant	309		366		341	362	355	400	393	469	465	419	419	471	468	499	505	447	449	505	514	516	514	469
Immigrant	70		41		56	34	41	58	56	44	45	42	47	35	34	62	65	61	68	56	69	107	98	120
% of Imm.	18%		10%		14%	9%	10%	13%	12%	9%	9%	9%	10%	7%	7%	11%	11%	12%	13%	10%	12%	17%	16%	20%

[2] Figures exclude non-residents (e.g., METCO and material fee students).

E. Increasing Class Sizes and Student Churn

Another source of the increase lies in the growth in non-kindergarten enrollment. This increase is masked by the heavy churning (entering and departing) that occurs routinely each year. Isolating the numbers, kindergarten students represent 50% or less of new annual enrollment. That means that total new arrivals to the school system are more than double the number entering kindergarten.

	Enrollment Increase	New Kindergarten	New (1 to 12)	12th Graders	Non 12th Exits	Kindergarten as % of total Inbound	12th Graders as % of Outbound
2008 to 2009	158	596	587	-451	-574	50.4%	44.0%
2009 to 2010	161	546	616	-438	-563	47.0%	43.8%
2010 to 2011	247	607	675	-429	-606	47.3%	41.4%
2011 to 2012	226	669	656	-462	-637	50.5%	42.0%
2012 to 2013	184	632	672	-432	-688	48.5%	38.6%

The Demographics Subcommittee has identified the following findings that are likely contributors to the increased enrollment:

3. Growing Population

Brookline's overall population has grown by 2.8% from 57,107 to 58,732 for the 10 year period from 2000 to 2010 (Source: US Census). While the overall Brookline population increased by a marginal amount, population growth trends for certain age groups highlight the ongoing school enrollment surge:

1. Brookline is experiencing a faster rate of growth for the school age population.

	2000	2010	% Growth
Under 5 years	2,639	3,209	21.6%
5 to 19 years	7,939	8,454	6.5%
Total (0-19 years)	10,578	11,663	10.3%

2. Brookline's households are also getting denser.

	2000	2010	% Growth
Households with individuals under 18	5,805	6,075	4.7%
Avg. household size	2.18	2.27	4.1%
Avg. family size	2.86	2.91	1.7%

3. Brookline's increased density occurred regardless of housing situation.

	2000	2010	% Growth
Avg. household size of owner-occupied unit	2.39	2.42	1.3%
Avg. household size of renter-occupied unit	2.00	2.12	6.0%

4. Relative to our neighbors, our growth in school-age population far exceeds that in abutting communities during the same time period:

	Brookline Growth %	Newton Growth %	Cambridge Growth %	Boston Growth %
Under 5 years	21.6%	2.2%	9.7%	1.2%
5 to 19 years	6.5%	10.1%	-13.1%	-6.1%
Total (0-19 years)	10.3%	8.5%	-8.1%	-4.5%

	Brookline Growth %	Newton Growth %	Cambridge Growth %	Boston Growth %
Households with individuals under 18	4.7%	2.5%	-7.8%	-4.6%
Avg. household size	4.1%	-0.4%	-1.5%	-2.2%
Avg. family size	1.7%	0.0%	-2.5%	-2.8%
Avg. household size of owner-occupied unit	1.3%	-0.4%	-3.2%	-5.2%
Avg. household size of renter-occupied unit	6.0%	0.5%	-1.0%	-0.9%

It is not a surprise that population in Brookline has grown:

1. The reputation of the Brookline school system in particular attracts households with children or households who are planning to have children.
2. The proximity to Boston as well as other suburbs (e.g., Waltham, Cambridge, etc.) appeals to employees who wish to decrease commuting time or those who prefer using public transportation or other active modes of transportation (e.g., walking, biking, etc.).
3. The societal shift towards wanting to live in a more urban setting given the greater conveniences (e.g., walking to grocery store, etc.) make (North) Brookline an appealing domicile.
4. The existing demographic diversity continues to attract families seeking a diverse population.
5. The improved economy and job growth especially within the fields of biomedical engineering, pharmaceuticals and other health related fields are contributing to an increase in Brookline's population.
6. The increased child support services (e.g., early childhood programs and day care) facilitate households with young children who have dual working parents.

4. Growth in Housing Stock

To accommodate over 7,300 currently enrolled (resident only) children ranging from Pre-K to 13th year, Brookline has approximately 26,000 dwelling units of various types:

	Parcel IDs	Unit/ID	Units
ONE FAMILY HOUSE	4,572	1.0	4,572
CONDOMINIUM UNIT	9,903	1.0	9,903
TWO FAMILY	892	2.0	1,784
THREE FAMLY	459	3.0	1,377
MULT (1-3 FAM.) HOUSES ON 1 LOT	72	2.0	144
4-8 UNIT APARTMENT BUILDING	174	5.6	982
9+ UNIT APARTMENT BUILDING OR COMPLEX	129	35.5	4,582
LODGING/BOARDING HOUSES	24	16.7	400
FRATERNITY HOUSE	2	25.0	50
RESIDENCE HALL OR DORMITORY	-		-
RECTORY	-		-
ASSISTED LIVING	1	115.0	115
RESIDENTIAL W/COMM	75	15.9	1,190
COMMERCIAL W/RESIDENTIAL	29	3.7	108
	16,332		25,207

Over the past 10 years (2003-2013), Brookline has been experiencing a growth in housing stock. Using the Tax Assessor's information, the quantity of tax parcel IDs has grown 10.9%. The primary driver of this growth has been within the condominium type of housing stock (23.3%). While the majority of this growth is due to condo conversions (81.5% of new tax IDs), overall growth in new housing units is still a significant increase. Estimated new dwelling units range from 40 to 70 new units per year, or 400-700 in 10 years.

The increase in the number of condominiums (new or via conversion) has allowed families to trade off living in expensive single family homes for a more affordable housing type in Brookline. Families are willing to live in smaller square footage to take advantage of the numerous conveniences of urban living. Furthermore, more couples who are beginning or planning to begin families can better afford condos rather than a single family home. While in the past these families may have moved to a bigger house, families have adjusted to living in their initial multi-family abodes. On the other hand, if condos are thought of as "starter homes" for young families, when the need ultimately arises for a larger dwelling, the high cost of single family homes (relative to condos) in Brookline could result in more families seeking homes outside of Brookline. In this event, it is possible that the full increases in kindergarten enrollment may not propagate all the way through the 12th grade.

Condo conversions do not typically add square footage, but they do increase the number of units available for affordable home ownership and would attract individuals or couples who are planning or who have planned for medium to long-term time horizons. The Town's Tax Assessor believes that the condo conversion phenomenon will continue as there are still many two and three family houses and large apartment complexes that could convert to condos – albeit in a declining rate in comparison to the past 10 years.

With respect to estimating a limit to new construction/housing, the Demographics Subcommittee has not been able to define a cap; a detailed analysis of the existing parcels available for residential development would have to be undertaken. The Demographics Subcommittee recognizes the trade-off between commercial and residential developments.

5. Addressing the Enrollment Growth

There are several approaches to addressing the impact of enrollment growth on PSB resources. The PSB has expanded the buffer zones around "core" K-8 school districts, thus allowing greater flexibility in assigning students to the K-8 schools.

A. Leveraging Buffer Zones

Since July 2012, when the buffer zones were enlarged, 34% of new arrivals to PSB reside in buffer zones, versus 16% previously.

Each K-8 School neighborhood and buffer zones vary significantly with respect to the type of housing stock and student churn rates. Individual school figures show that those neighborhoods where the majority of students reside in single family or even two and three-family homes have significantly lower churn rates than those where the majority of students reside in multi-unit buildings (e.g., Heath vs. Baker comparison).

B. Leveraging Existing School Capacity

Options to meet increasing classroom demand from rising enrollment include compliance with the 2011 Superintendent's School Committee Budget Directives, which state:

> *"Ensure that current use of space and changes or plans for new or renovated facilities anticipate future (i.e., multi-year) PreK-12 space needs and support, whenever possible, historical class size limits of 22-24 in grades K-3 and no more than 25 in grades 4-12."*

The current K-8 class size average is 21.14, ranging from a low of 15 to a high of 26 in one instance each. However, 83 of the 246 K-8 classrooms – more than one-third of the total - have 20 or fewer students. The approach of adding 1-2 children per classroom that have room under the current policies could eliminate the need for between 10 and 16 new classrooms. This could, for example, remove the need for a Driscoll expansion (slated for 7 net new classrooms) or keep Devotion as a 4 section school (nominally, going to 5 sections adds 10 home rooms, but in fact Devotion has 40 today, so just 5 more are being provided). The capital savings is estimated at $30.0M - $34.0M for Driscoll (a $20M renovation versus a $50M - $54.0M expansion) and at $25M for Devotion. The operating savings are an additional $100,000 for grades 3 through 8 and $138,000 for grades K through 2, or $700K to $1.7M annually.

There may be collateral capital needs resulting from adding 1-2 children per classroom. The concern is that just adding children to a school, as opposed to the Expand in Place approach, would increase the need for common spaces, particularly for seats in cafeteria, library, gymnasium space, art/music, sciences, and potentially for additional offices needed for support staff. This document also examines this question and currently concludes that such common space impacts are small in scale, and typically manageable through small capital expenditures. Where some impacts may need

to be addressed, the corrective capital requirements are significantly less costly than the operating and capital funds required for constructing and populating an additional classroom.

There are about 238 available seats when adding 1 student, and 398 when adding 2 students per classroom. We note that if all K-8 classrooms were at their upper limit (24 in K-3 and up to 25 in 4-8), twice this number, or over 800 additional students could be accommodated. This is equivalent to an entire new 4 section school. Assignment procedures, including accommodating siblings and buffer zone sizes will determine how the more modest 1-2 added students per classroom potential savings could be reached and over what time frame such savings may be gained. We note that the Schools added 0.167 students per section per year over the last 10 years, moving the class size average from 19.47 to 21.14. This occurred even though the Schools actively resisted increasing class size. If instead small increases were viewed as acceptable, continuing *at this same rate* would add about 200 children in 5 years, saving about 9 classrooms, while respecting the existing buffers. In any event, it is appropriate for the PSB and the Town to evaluate the relative costs and benefits of these small increases in average class size, including any resulting collateral impacts, against a capital expenditure of between $55M and $59M.

The largest impacts on common space are in the cafeterias. This analysis assumes 3 lunch periods, with class groupings of K-2, 3-5 and 6-8 eating together. The actual number of lunch periods varies in each school, to as many as 5 at Driscoll and 6 at Devotion. (We note Devotion is scheduled to expand its cafeteria to meet the MSBA 3 lunch period maximum as part of its expansion and renovation.) We use 3 as a conservative number because that is the MSBA's highest allowable on their projects. With this assumption, the addition of 1 student per available classroom generally requires the addition of 1-2 tables for 9-16 children, or 18-43 seats with the addition of 2 children. Auditorium impacts may be similar, depending on each school's requirements for the percentage of the students to be seated at any one session. (We note that MSBA policies do not allow reimbursement for sloped floor/fixed seat auditorium spaces.)

Additional specialists on staff may require office space. Other common spaces include Music, Art, and Science rooms, each of which may have more than one homeroom using the spaces at a time. These impacts would range from 1-4 students, if 2 homerooms shared the space.

6. Predicting the Enrollment Growth

A. Models:

Two predictive models were reviewed by the Demographics Subcommittee: MGT and the MIT Operations Lab Team. The revised 2012 MGT population projections have been accurate insofar as FY13 and FY14 (i.e., two years), but appear to be based on an unreliable model. The new MIT model may provide a better predictive tool if accurate data for net new housing units can be found.

1. MGT Report and Analysis:

In 2008, PSB contracted with MGT to undertake a broad study of the District's enrollment trends and facilities requirements, and to develop forecasts of enrollment over a period of 10 years. In 2011, MGT was asked to return to provide an update to their enrollment projections and utilized

the newly released 2010 census data in doing so. The MGT reports issued in 2009 and 2012 respectively, currently being relied upon by the PSB, the School Committee, and used as a base by the B-Space Committee, were a useful tool insofar as they made valid predictions about the 'new normal' for kindergarten enrollment and the trend toward a yearly increase in the number of students.

The Subcommittee focused specifically upon MGT's enrollment projections and the methodology that the firm had utilized in developing them. We developed and provided a detailed data request that was transmitted to MGT seeking the source data and underlying analysis supporting its projections. However, MGT declined to provide any written responses and, during a conference call that was set up by the School Department on January 29, 2014, offered only vague and superficial oral responses to some of the requests. In large part due to MGT's refusal to provide the source data and methodological details underlying its forecasts, the Subcommittee was not able either to verify, reproduce, or validate any of MGT's forecasts. Moreover, from the limited details that were offered during the conference call, the Subcommittee does not believe that MGT followed any generally accepted analysis or forecasting practices. Accordingly, the Subcommittee has no confidence in the specific forecasts set out in the MGT reports. Indeed, when the ex ante forecasts that were made in 2009 are compared with the actual enrollment data as provided in the 2012 revision, it is clear that the 2009 numbers were well below the ex post reality.

During the conference call, we learned that MGT typically developed enrollment forecasts covering entire population centers rather than individual municipalities within large metropolitan areas. Where an entire and largely insular population center is being examined, extrapolations from live births to subsequent kindergarten enrollment may be a reasonable approach. In a community such as Brookline, however, with significant inward and outward movement of residents occurring on a regular basis, there is no assurance that a "live birth" in the Town in any given year will still be residing in Brookline five years later or, conversely, that a child entering kindergarten in any given year had been a Brookline resident on the date of his or her birth five years earlier.

MGT's school population forecast places a great deal of weight -- 85% -- upon one critical assumption -- i.e., that the size of each cohort will remain roughly constant over the full 13 years from kindergarten through the 12th grade. Under this assumption, the number of children entering kindergarten in any given year is simply carried forward, unchanged, into all subsequent years for that cohort.

The "cohort stability assumption" does not require or expect that the same pupils will stay in the Brookline school system for the full 13 years. Indeed, and as noted above, experience has demonstrated that there is considerable "churn" over the 13-year period, typically in the range of 10% or 700 students each year, excluding the entering kindergarten class. However, according to data compiled by the School Department, children leaving the Brookline schools are replaced, on average, by a similar number of children entering the system in those same grades.

MGT's forecast is critically dependent upon the validity of the "cohort stability" assumption. Although the School Department has compiled data that appears to support this, for the most part the data was compiled over a period of relative stability in total school system enrollment. It is not at all clear that the stability experience present under such steady-state conditions can be extrapolated over to the high and persistent growth condition that the system is currently experiencing.

For example, it has been suggested that some of the growth in the number of students entering kindergarten in recent years has come from young families of graduate students, post-doctoral fellows, and medical residents that are in the Boston area for several years after which they will relocate elsewhere. If this source of demand persists, these departing families will be replaced by new young families with children in the early grades, rather than by those with children of the same age as the departing family. If this is the case, the influx of entering kindergarten pupils will not persist throughout the life of the cohort. And conversely, should that source of demand decrease due to external factors, e.g. decline in NIH funding, the number of children entering the system could actually decline. Also, and as noted above, the large price gap between condos and single-family houses may force young families to leave Brookline in favor of communities with less-costly single family houses as their housing needs expand.

Unfortunately, there does not appear to be any discussion or information in the MGT report supporting its extrapolation of the prior steady-state cohort stability experience into the current and future high growth condition. If that extrapolation is not valid -- and it may well not be valid -- the basis for the MGT forecast, and thus the forecast itself, cannot properly be relied upon to support major capital decisions.

2. The MIT Operations Lab Model

The Subcommittee worked closely for three month with three MIT Sloan School of Management graduate students -- Scott Bromley, Cameron Hosmer and Karl Kulling -- all members of the MIT Operations Lab. Appendix 1 to this Report contains the final powerpoint presentation that was submitted by the MIT team. The team's stated goal was to build a predictive model that could be used by the PSB on an ongoing basis, using current data on several key variables. The project's goal was to achieve an error margin equivalent to about one kindergarten classroom per year – i.e., +/- 20 entering kindergarten students.

This objective was not realized due to time and data limitations. However, the MIT model did succeed in recreating the historic enrollment information over a 10 year period with an error rate of two classrooms. Additional improvements in data input, especially housing units created, may make this a useful predictive tool going forward if the PSB elects to pursue and expand the model's scope.

The MIT model was focused upon enrollment growth associated with resident students only - those that the PSB are mandated to serve and whose number is exogenously determined rather than falling within the discretion of the PSB itself.[3] For 2014, the MIT model projected a range of new resident student kindergarten enrollment between 584 and 630. The MIT team's intuition was that

[3] Current PSB policy is to maintain total K-12 METCO enrollment at approximately 300 students, and to adjust the number to be offered admission to each kindergarten class so as to roughly maintain that aggregate enrollment level. This policy is, however, entirely discretionary and within the control of the PSB and the Brookline School Committee. METCO admission is to be offered on a space-available basis and, although there is some dispute as to exactly what the term "space-available" means in this context, the PSB has the ability to reduce or suspend further METCO admissions in the event that resident student enrollment exceeds anticipated levels. Similarly, the Material Fee program, which offers heavily-subsidized enrollment to children of non-resident School and Town employees, is similarly within the discretion and control of the PSB and the School Committee. Although participation in the Materials Fee program is an employee benefit, it is not mandated in any existing collective bargaining agreement or contract and, like METCO, may be capped or suspended at the discretion of the PSB and School Committee.

a low/middle prediction was more likely than a high one. Note that the current PSB projection of resident students for the fall of 2014 is 590.

Key questions to be addressed

The MIT model sought to address the following questions:

- What are current demographic trends?
- What are the primary drivers of K-8 enrollment?
  - What are changes/trends in population numbers and birth rates?
  - What are changes trends in housing stock?
  - What non-statistical events could be driving enrollment trends?
- Is growth limited to certain sections of Brookline?
- Are demographic trends sustainable in terms of available finances and capacity?
- How have different drivers of enrollment changed in recent years?
- Will Brookline need to construct additional facilities in the near future?

The MIT team offered a general disclaimer: "Enrollment is highly volatile and thereby limits the efficacy of statistical modeling." The team warned that the inherent volatility of enrollment limits the ability of demographics, which are much more stable, from predicting enrollment with a high degree of certainty; that the model will not account for large scale structural changes in demographics such that using the model in the long-term may therefore be inappropriate; and that the only *real* antidote to high volatility is flexible capacity.

The MIT team examined a large number of potential metrics that could affect resident student enrollment over time:

Housing stock -- Condominium Stock, New parcels, Single-Family Home Stock
Home prices -- Number of Home and Condo Sales and Sale Prices
Migration (state, national, intl.) -- ACS Data on Migration (3yr)
School quality -- Global Report Card, US News and World Report Rankings
Population growth -- US Census Data, Brookline Town Census data
Employment trends -- Job Growth in Boston and MA, Brookline labor force
Birth rates -- Annual resident live births, Fertility rates
Age distribution trends -- US Census Data, Brookline Town Census data
Macroeconomic indicators -- National and state GDP growth, # Jobs in Boston Area
Income -- MA median incomes, Boston Metro Salary

The subjecting all of these metrics to regression analysis, the MIT team identified the two best explanatory variables – i.e., those offering the best statistical fit to the long term enrollment data:

Brookline Live Births
Total number of condominium units

A linear regression model was evaluated using these two explanatory variables. The model provided the following results:

- The two variable model provides a reasonably good fit to enrollment data (R2= 89.5%)
- The model over/under predicts by an average of 6.1% per year
- In four of the years the model makes a prediction that has an error greater than 2 classrooms (i.e., 40 students)

•While the limited visibility on condo construction/conversion limits the model's ability to forecast, it significantly improves accuracy

Because condominium growth was determined to be a key driver of future enrollment trends, the overall reliability of the model's predictive ability is seen to be critically dependent upon the ability to forecast, with reasonable accuracy, future condominium growth (including conversions from rental units). Based upon three alternative condominium growth assumptions (i.e., low, medium and high), the model yielded the following enrollment forecasts:

Scenario	2015	2018
Low condo	574	582
Medium condo	581	609
High condo	588	639
Live Births only	573	583

The models thus predict flat to moderate growth over the next 5 years. Recent, short term trends in condo stocks and births would suggest the "Medium" or "Low" scenarios are more likely. The teach noted, however, that the model has failed to predict enrollment spikes in the past, and that history may well repeat itself.

MIT Model Conclusions:
Overall, the MIT team concluded that demographic trends provide a reasonable approximation of recent enrollment growth, with resident live births and condominium inventories representing the largest contributors to enrollment. They predicted enrollment to increase by approximately 4% in the next 3 to 5 years, noting, however, that the model may not hold if there is another "paradigm shift" such as the one Brookline experienced in the early 2000s. They also noted that the model has failed to predict enrollment spikes in the past. Finally, they found that the lack of consistent, reliable data complicates forecasting.

WIth respect to this last point, the MIT team recommended that the PSB develop a plan for flexible capacity by using the known 'churn rate' advantageously by assigning new buffer zone students to balance class size. They reiterate that more consistent and higher quality data would improve prediction capabilities, and recommend that the PSB undertake to develop and maintain additional data relevant to enrollment forecasting on an ongoing basis. Among other things, the MIT team noted that the same data collection and content format be retained from year to year, possibly expanded through the use of an ongoing Town Census form or other device for collecting school-age population data directly from Town residents, including surveys of parents of incoming kindergarten students. They underscore the importance of creating a standard yearly data analysis process so that enrollment forecasting can be accomplished on a consistent and regular basis.

7. Questions to be Answered:

1. Where is the student growth occurring now?

2. Where will it likely be in the next 10 years?

3. What recommendations can be made concerning the optimal location of future new classrooms?

4. Are current trends in condominium production and international migration likely to continue and what are the consequences to enrollments if they do or don't?

8. Recommendations:

1. Assignments to schools need to occur later in the year when more information is known about new arrivals

2. Buffer zones may need to be modified to respond to variations in the churn factors at each school

3. Due to the current 803 seats theoretically available in K-8 classrooms, greater emphasis needs to be placed (or perhaps we should say could be placed?) on improved assignments to optimize class size.

4. Improve data tracking for:
    - new housing units
    - student family arrival reasons and locations
    - student family registration and number of siblings
    - student family departure reasons and locations
    - pre-school enrollment figures
    - population migration in and out of Brookline

9. Improve Data Collection:

Throughout our Demographic subcommittee work, we found missing or poor quality data. Many of the central questions we asked did not have at hand responses, and the effort to generate the needed data often turned up challenges in both the Town's and the School's ability and methodology to collect and analyze data.

We agreed our work was not simply for the OSC, but also to identify ways the Schools and the Town could improve our ability to track data and trends.

Examples include:

1. that the Schools had a lot of data pre-2008 that was on tape and they indicated they had no tape readers. This relevant data should be retrieved and tabulated into current data bases;
2. that the Town had no way to tell us how many new housing units, or net new units, we added each year; Building and Assessor should address this;
3. schools apparently do not have a clear methodology on initial intakes (which appear to occur at the local K-8 and centrally; the format should be standardized and should seek information pertinent to type of residential unit, siblings, buffers, arrival/departure, etc. as may further be determined;
4. Town census procedures should be evaluated and perhaps questions added to better address capturing demographic changes; statistical reliability needs improvement as well;
5. better coordinate Jed Feherenbach and the Schools data team to ensure file compatibility and tracking/trend capacity;

6. evaluate further use of the GIS system for the benefit of the school administration in planning for capital expenditures, student and faculty assignments; enter/display annual arrival/departure data within the school neighborhood and buffer framework;
7. It appears to take 9 months to have the Assessor/Town record a new property owner – why?

Demographic Subcommittee Acknowledgements:

The Subcommittee would like to thank the various individuals who helped with providing data for our analyses:

1. Rachid Belhocine, Town Assessor's Office
2. Kara Brewton, Planning and Community Development
3. Sean Cronin, Deputy Town Administrator
4. Jed Fehrenbach, GIS
5. Melissa Goff, Assistant Town Administrator
6. Dr. William H. Lupini, Superintendent, Public Schools of Brookline
7. Gary McCabe, Town Assessor
8. Linda Olson Pehlke, Urban Planner
9. Peter C. Rowe, Deputy Superintendent for Administration and Finance, Public Schools of Brookline
10. Cori Scott, Public Schools of Brookline
11. Harrison Scott Bromley, MIT Operations Lab
12. Cameron Edward Hosmer, MIT Operations Lab
13. Karl C Kulling, MIT Operations Lab
14. Patrick Ward, Town Clerk