# Open Space, Housing Construction and Home Prices

## What's the Payoff from Smart Growth?

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Massachusetts Housing Partnership

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# ACKNOWLEDGMENTS


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Edward Moscovitch is President of Cape Ann Economics, in Gloucester, Massachusetts. His recent work in the area of real estate includes a study for the Trust for Public Land of the impact that proximity to open space has on real estate prices in Florida. Other current work includes an analysis for the Massachusetts Council of Community Hospitals of the utilization and profitability of community hospitals in Massachusetts. He also plays an ongoing role as outside evaluator for the Alabama Reading Initiative, a $56 million literacy program encompassing over 700 Alabama schools. He is co-founder and chairman of the Bay State Reading Institute, a new program which works with Massachusetts schools on literacy-centered whole-school turnaround. He is the former vice president of Data Resources, Inc. and former budget director of Massachusetts. He holds a PhD in Economics from MIT.

## THE MASSACHUSETTS HOUSING PARTNERSHIP (MHP)

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# INTRODUCTION

## MEASURING THE POTENTIAL OF SMARTER DEVELOPMENT

Common sense, and basic micro-economics, tells us that the more homes that are built in a geographic area, the lower the price. In the case of Massachusetts, the shortage of new housing is undoubtedly a key factor in explaining our sky-high home prices.

Building additional homes would reduce home prices, but it would also use up more open space. All else equal, the more homes built and open space consumed, the lower housing prices. But all else isn't necessarily equal. The trade-off between open space consumed and home prices depends in a critical way on the average lot size – the amount of land used for each new unit of housing. The smaller the average lot size, and the greater the share of new homes accounted for by land-efficient condos, apartments, and town houses, the lesser the amount of open space required to achieve a given home price result.

While we can understand that home prices and open space consumption are related, the purpose of this paper is to quantify these relationships – to show how different development practices could alter the home price/open space trade-off. In order to quantify this relationship, we will measure the impact of additional construction on housing prices, measure the average lot size in eastern Massachusetts under current development practices, and determine the impact that plausible alternatives to our current development patterns would have on housing prices and land consumption.

### STUDY OUTLINE AND OVERVIEW OF RESULTS

#### PART 1 – Estimating Housing Demand Curve

The demand curve for homes measures the impact of greater (or lower) housing construction on home prices. Looking at all of the northeastern states, this study calculates desired housing construction from state population levels and population growth, and then determines for each state the extent to which its recent housing construction levels have been greater than, equal to, or less than what would be expected from state demographics.

Home prices are adjusted for state-to-state differences in construction cost; the demand curve is constructed by comparing cost-adjusted prices in each state to its construction; the greater home construction falls below expected levels, the higher the observed price.

> **Our research found that construction in Massachusetts in recent years has been 31.5 percent below expected; "normal" construction in the state over this period would have reduced the average home price by $31,000.**

Most of the construction activity in the greater Boston metro area occurs in the towns outside route 128 but inside route 495. As our interest is in greater Boston, and as the cities and towns inside route 128 are largely built out, the construction-price relationships observed in the cross-sectional analysis of northeastern states are applied to the population and construction trends in the route 128/495 corridor to arrive at a demand curve for this particular area.

## Part 2 – Recent Development Trends

We are ultimately interested in the relationship between land use and home prices; we need to convert numbers of homes built to acres consumed by determining average lot size in the 128/495 study area. Average lot sizes are calculated from comprehensive information on residential construction in this area over the five-year period from 1998 through 2002. Lot sizes are reported for all single-family homes. We also know the number of condos and multi-family units; using sample data we have a reasonably good idea of how many of these units are typically built on an acre of land, and we can combine this with the single-family data to calculate the overall amount of new land used in relation to the total number of housing units constructed.

**Our research found that the average lot size for new single-family homes in the Route 128/495 corridor has been 1.3 acres; counting condos and multi-family units, the region has used 1.1 acres of land for every new housing unit built.**

One alternative to current development patterns is the type of construction that prevailed in the first half of the 20th century – reasonably dense development in established town centers. The study concentrates on two desirable towns with relatively dense centers – Ipswich and Andover – and traces average lot sizes for new construction in these towns over the last two hundred years.

**Our research found that average lot sizes have doubled in Andover, from .3 acres in the 1920s and 1930s to .6 acres today. In Ipswich, lot sizes have tripled, from roughly .4 acres at the end of the 19th century to 1.2 acres today.**

"Smart growth" projects represent a second alternative to current development patterns. A review was conducted of smart growth projects across the country, with particular emphasis given to those that included a commercial core as well as housing units.

**Our research showed that smart growth projects across the country are being constructed with a median land use of .25 acres for each additional housing unit.**

The assessor's data used for the Andover and Ipswich analysis includes information on home sales – lot size, size and age of home, home location, and price. This information was used to determine the impact of lot size on home prices.

**Our research found that larger home lots command almost no premium in the market. Home prices in the denser Andover town center are eight percent higher than prices in the less dense, rural parts of town. In Ipswich, a statistical analysis indicates that increasing a lot size by an acre adds only $9,000 to the value of the property.**

## Part 3 – Pulling it All Together

The final section pulls together the demand curve and lot size analysis to map out the land-use/home-price trade-offs under different development patterns.

**Our research showed that if development followed the smart growth pattern of .25 acres per unit instead of the recent pattern of 1.08 acres, it would be possible to roughly double the number of units built. This would result in driving home prices down from $400,000 to $293,000, while cutting vacant land consumption almost in half.**

# PART I

## ESTIMATING THE HOUSING DEMAND CURVE

The demand curve for any good or service maps out the impact that scarcity or abundance has on what customers are willing to pay. In this sense, it is a map of customers' preferences. In the case of home prices, if there is an abundance of available homes, customers will see little need to pay high prices; if homes are scarce, they would be willing to bid the price up to obtain one.

An analogy may help to illustrate this. A sudden frost in the Florida orange groves kills off a substantial portion of the orange crop; with oranges then hard to come by, the demand curve measures the extent to which customers are willing to pay more to obtain suddenly scarce oranges.

Local zoning that requires very large lots and government practices that make it difficult to develop new parcels combine to make housing scarce in Massachusetts relative to other states; the demand curve measures the extent to which a given reduction in housing availability drives up prices.

To construct a demand curve, we need to have several observations of quantities built and of price. The methodology used here is to do this with a cross-sectional analysis – by comparing home construction and prices across the 20 states east of or bordering the Mississippi River and north of the Ohio – from Minnesota to the District of Columbia, and from Missouri to Maine. These states are roughly similar in that they have older housing stocks, slower population growth, and cold winters – as opposed, say, to Arizona, where very rapid population growth, newer housing stock, and warmer winters may lead to a very different pattern of home prices.

Although we're ultimately interested in the Boston metro area, the analysis is done at the state level since it is much easier to get population, construction, and price data at the state than the metro area level. The analysis has two parts – the first estimates "normal" construction in relation to population and population growth; the second looks to see if a shortfall between actual and "normal" construction is predictive of higher home prices.

### STEP 1 – HOW MUCH HOUSING DOES THE MARKET EXPECT?

The first step is to calculate a "normal" relationship between population, population growth, and housing construction. This is done using regression analysis, in which the statistical algorithm calculates the best fit of the variable of interest (in this case, the ratio of housing units built to population) in relation to possible explanatory variables (the growth rate in population). All else equal, the greater a state's population growth, the more new homes we'd expect it to build per capita[1].

The actual data are consistent with this hypothesis; the regression equation is:

Units Built/Population = .026+ .323 * Percentage Increase in Population[2]

Population is the average population over the 10 year period from 1992 to 2001; the number of units built is the 11-year total from 1993 through 2003. Population gain is the increase in population from 1992 to 2002[3].

The regression equation is best understood by example. For a state with no population growth, the predicted construction will be 2.6 percent of population (a state with 2 million people would build 52,000 units over this period, presumably

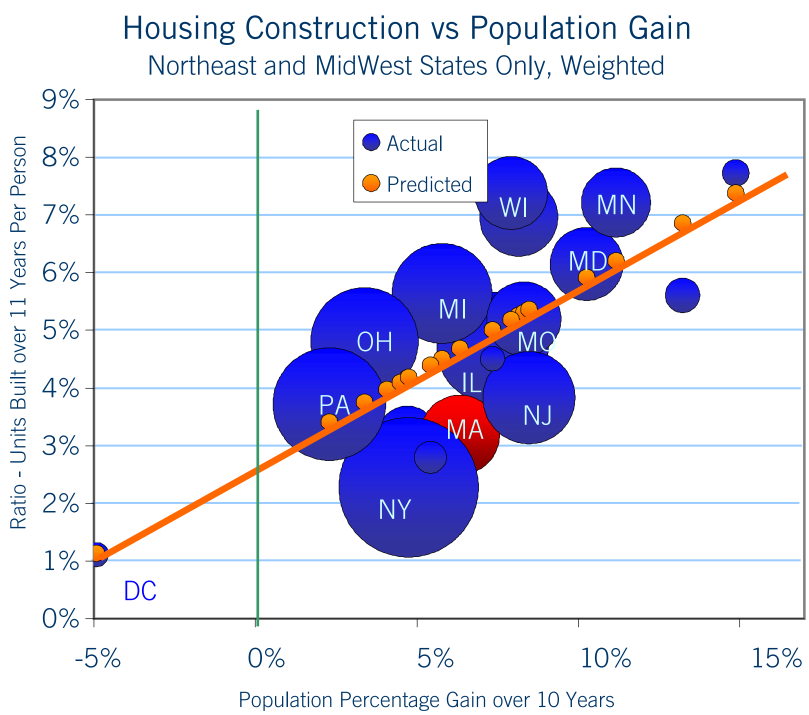
1 Data on number of units built by year and by state are taken from the Census building permit data.

2 The intercept and the coefficient on "Percent Increase in Population" are significant at the 95 percent confidence level.

3 This time span was chosen for two reasons. Both 1993 and 2003 are years just after a recession trough; choosing an interval of this kind minimizes "noise" from the business cycle. As a check, the analysis was also performed over a shorter period (1998 to 2003); the coefficients from this shorter time frame displayed far less statistical significance. To check the impact of the population-construction lag, the analysis was also performed using population from 1990 to 2000 – a three-year lag instead of a one-year lag. The relationships using this longer lag demonstrated less statistical significance, so the shorter lag was used.

for replacement and second homes). A state with a population growth of 2 percent over the decade would have expected housing construction equal to 3.24 percent of population.[4]

The following chart illustrates the relationship between population gain (shown on the horizontal




axis) and housing construction (the ratio of homes built to population is shown on the vertical axis).

Each state is shown as a circle on the chart; the larger the state population, the larger the circle. As we'd expect, the circles lie on a line that slopes upward and to the right – the greater the population gain, the greater the housing construction activity.[5]

The orange line on the chart is the regression fit – the "normal" or predicted ratio of units built to population. Roughly speaking, a state with 10 percent population growth over the decade would normally build twice as many units (almost 6 units for every 100 residents) than a state with no growth (slightly under 3 units per 100).

We don't want to give equal weight to each state; New York has 30 times as many people as the District of Columbia. For this reason, larger states are given greater weight in the regression calculations.[6]

Massachusetts, shown in red in the chart, has construction below what we'd expect. Given our state's population growth of 6.3 percent over the decade, "normal" housing construction would have been 4.7 percent of population, or 291,000 units. In fact, we built only 251,000 units (3.2 percent of our population of 6.2 million). Wisconsin, on the other hand, built more housing units than indicated by its population growth.

We would expect that Massachusetts' low housing construction would lead to higher home prices, while Wisconsin's higher construction activity would lead to lower prices. We explore this relationship in the next section.

## STEP 2 – HOW DOES INCREASED SUPPLY IMPACT PRICE?

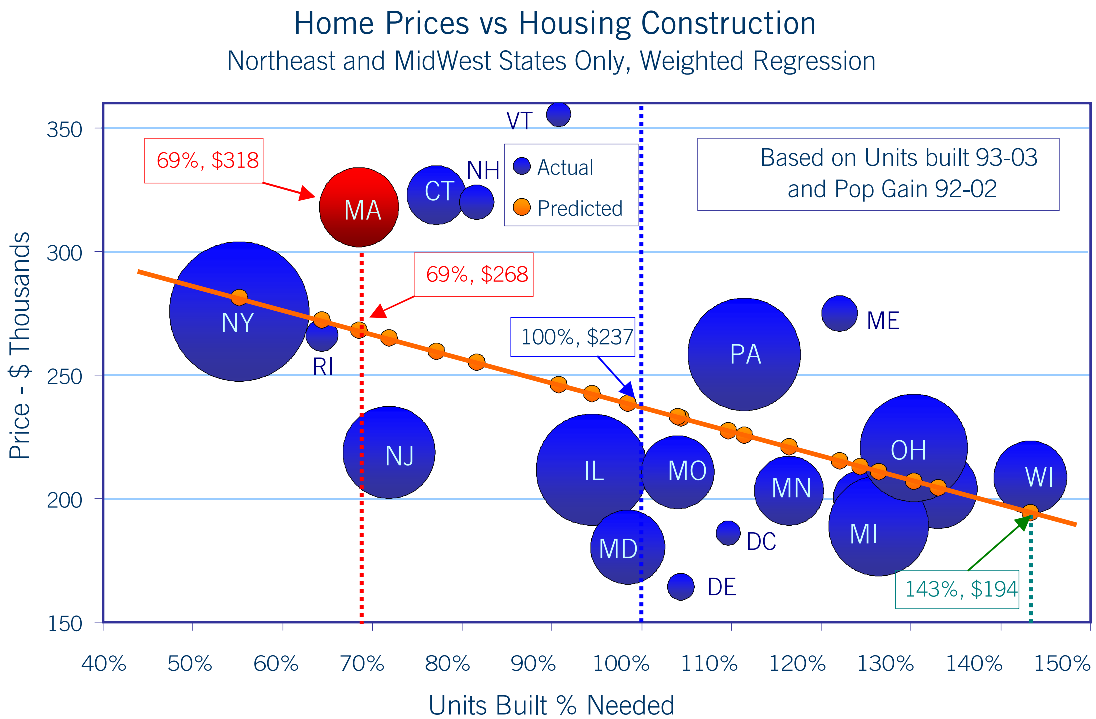
We've seen in step 1 above that by looking at population and housing construction data across states, we can determine "normal" construction volumes. For each state, we can calculate the extent to which its construction volume is high (Wisconsin) or low (Massachusetts) in relation to its population growth. Common sense suggests that states with high construction volumes will have lower home prices, and the data confirm this hypothesis. We use a cross-state regression to quantify the relevant coefficient – how does a given increase in housing construction impact price?

Of course, home prices vary from state to state not only because of differences in the number of units built, but also because of differences in construction cost. These differences may be climate related (homes in cold climates need more insulation and more extensive foundations), but may also relate to materials used, labor rates, or building code requirements. To prevent these cost

4 Calculated by adding the constant .026 to .006, which is the 2 percent gain multiplied by the coefficient .323

5 Population change and housing construction are both measured over a decade, with the housing construction lagged a year behind the housing change.

6 The regression is weighted, with states counted once for the first 5 million of population and counted again for every additional 5 million people. Thus, New York (with 18.7 million people) is actually counted 4 times, Massachusetts, with 6.2 million, is counted twice, and DC, with 600,000, is counted only once.




differences from obscuring our understanding of the construction-price relationship, the regression in step 2 is performed using cost-adjusted home prices.[7] The explanatory variable in our regression is the ratio of actual to expected housing construction, as measured in step 1 above. This regression, run for the 20 Northeast and Midwest states, is:

Cost-Adjusted Price = 335.9 – 98.9 * Ratio of Actual to Expected Housing Units Built

(Note: The intercept and the coefficient are significant at the 95 percent confidence level).

The price is the cost-adjusted new home price in 2002, in thousands of dollars. The negative coefficient (-98.9) on the construction ratio tells us that the more favorable the relationship between actual and expected housing construction, the lower the price of homes.

This relationship is shown in the chart above. As before, each bubble represents a state. The state's horizontal (left to right) position represents the ratio of actual to expected housing construction. In Maryland, Missouri, and Illinois, actual construction was roughly equal to expected construction. In the earlier chart, this meant these states' circles were located on or very close to the orange regression line. In this chart, it means that they are roughly in the middle of the chart, near the vertical dotted blue line indicating a 100 percent ratio of actual to expected construction. Massachusetts built far fewer units than expected, meaning it was below the regression line in the earlier chart and is at the left of this chart – specifically, it built only 69 percent of the units we'd expect from its population growth, as shown by the vertical dotted red line.

The vertical position of each state's bubble represents the cost-adjusted price. At $318,000, the Massachusetts price was one of the highest of any Northeastern state. With the exception of Pennsylvania and Maine, all states with average or above-average housing construction had prices at or under $230,000. With the exception of New Jersey, states with below average construction had average prices of at least $266,000 (New York

7 Home price data is available only by census region (North, Mid-west, etc.) and not by state. But the census permit data contains state-by-state data on the value of new homes constructed. The prices used here are calculated by taking state-specific value data from the permit series and then adjusting this by the appropriate regional ratio of home prices to permit values, giving us a Massachusetts home price of $369,000. To adjust for state-to-state cost differences, these prices are then adjusted by the state specific cost figures reported in the 2005 National Building Cost Manual, published by Craftsman Book Company. Massachusetts costs are 16 percent above the national average; this gives us a cost-adjusted Massachusetts price of $318,000.

and Rhode Island) and, in most cases, more than $300,000 (Connecticut, Massachusetts, New Hampshire, and Vermont).

The regression line – shown in orange – gives us the best fit of price to units built, and represents our estimated demand curve. It slopes downward and to the right – the more units built, the lower the price. The dotted vertical blue line shows construction exactly equal to the predicted normal. All else equal, a state that built 100 percent of the predicted units would have an average price of $237,000 (as shown by the blue arrow, where the 100 percent line crosses the orange regression line). At construction 4 percent above expected and a price of $211,000, Missouri comes closest. With ample housing construction (43 percent above normal), Wisconsin's expected home price is $194,000, as shown by the green arrow. At $206,000, actual Wisconsin prices were slightly above this prediction, but still amongst the lowest of any of the northeastern states.

Construction volume in New York was only 55 percent of normal; it falls ever so slightly below the orange regression line, meaning that its actual cost-adjusted price of $275,000 is almost equal to the $281,000 we'd expect given its restricted housing production.

With construction only 69 percent of normal, the regression predicts a Massachusetts price of $268,000 (where the dotted red vertical line representing construction 69 percent of normal crosses the orange regression line.) In fact, the actual cost-adjusted price in Massachusetts was $318,000, some $50,000 above the best-fit regression line. This extra cost cannot be explained by scarcity alone.

The various factors affecting Massachusetts home prices, as illuminated by this analysis, are laid out in the following table. Starting at the bottom of the table we have the $237,000 cost-adjusted price associated with normal construction volume. Given our low construction volume, the expected (cost-adjusted) price is $268,000, so $31,000 of our high housing costs can be attributed to restricted supply. The actual cost-adjusted price was $318,000, leaving $50,000 that cannot be explained by either construction costs or restricted volume of construction. Finally, the price was $369,000, meaning that construction costs 16 percent above the national average account for $51,000.

### Understanding MA Home Prices

*Thousands in Dollars*

| | |
|---|---|
| **Observed Massachusetts Home Price** | **369** |
| Impact of Construction Cost | 51 |
| **Cost Adjusted Price** | **318** |
| Impact of Other Factors | 50 |
| **Expected Price Given Actual Units Built** | **268** |
| Impact of Construction Shortfall | 31 |
| **Expected Price - Normal Units Built** | **237** |

The construction cost adjustment is taken from a builders' cost manual, and reflects wages, materials, and building codes associated with actually putting up housing units after they're permitted. It does not include the costs associated with obtaining the necessary permits and variances – by all accounts substantially higher here than elsewhere in the country. This undoubtedly accounts for a significant portion of the "unexplained" $50,000. High land prices in Massachusetts are presumably a reflection of the limited availability of buildable lots, and therefore are part of the $31,000 associated with limited construction.

## STEP 3 - CONSTRUCTING THE DEMAND CURVE FOR EASTERN MASSACHUSETTS

Our study concentrates on Eastern Massachusetts – specifically, on the communities between routes 495 and 128, where much of the population growth – and housing construction - in the state has been concentrated. In step 3 we use the supply-price relationships developed in steps 1 and 2 to construct a housing demand curve specific to this 128/495 corridor.

The corridor contains 114 of Massachusetts' 351 cities and towns and just over a quarter of its land acre (2,200 square miles out of 8,100 statewide). The corridor's 2.3 million people (2003 census estimate) accounted for 35 percent of total state population. These are fast-growing communities; the population gain of 156,000 from 1994 to 2003 accounted for just under half the total population growth in the state, and 40 percent of all new homes built in the state from 1995 to 2003 were built in the 128/495 corridor. Homes are expensive here; the average permitted value is some 8 percent above the state average; this implies an average home price in the corridor of $400,000.

The relationship between the $400,000 price in the region and the $237,000 average (cost-adjusted) price in the Northeast is shown in the table above. Actual construction in the region, in relation to population growth, was slightly higher than the state average, so only $25,000 in higher price can be explained by housing scarcity. Higher construction costs in the Northeast account for $55,000 (a slightly higher figure than for the state as a whole since houses are slightly more expensive), leaving $82,000 from other factors. Because the towns in the 128/495 corridor are generally affluent communities with better schools, less crime, and lower tax rates, home prices there command a premium in the market and are higher than we'd find in cities like Boston and Worcester. It is not surprising, then, that the "unexplained" portion of home prices is higher in the corridor than it is statewide.

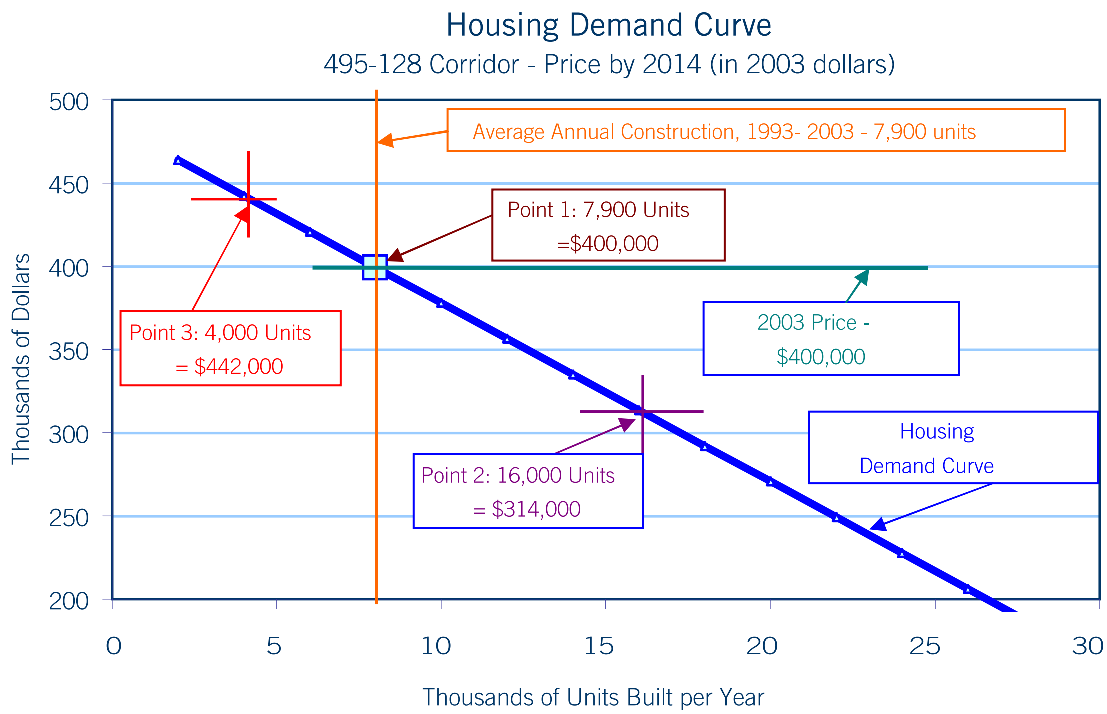
**Understanding MA Home Prices**

*Thousands in Dollars*

| | | |
|---|---|---|
| **Observed Home Price** | **369** | **400** |
| Impact of Construction Cost | 51 | 55 |
| **Cost Adjusted Price** | **318** | **345** |
| Impact of Other Factors | 50 | |
| **Expected Price Given Actual Units Built** | **268** | **262** |
| Impact of Construction Shortfall | 31 | 25 |
| **Expected Price - Normal Units Built** | **237** | **237** |
| Units Constructed % Predicted | 69% | 74% |

In order to build the demand curve for the 128/495 corridor, we need to use the step 2 regression to predict what the housing prices would be at various levels of expected demand (the ratio of actual housing built to the expected amount given population growth). We already know that housing construction in the corridor over the past decade was 7,900 units a year (74 percent of demographically expected demand), and the observed home price is $400,000, so these values become Point 1 on the demand curve in the chart below. If we doubled housing construction to 16,000 (just under 150 percent of expected demand), our regression predicts the price will fall to $314,000, giving us point 2 on the curve. Repeating this procedure with additional levels of expected demand generates point along our demand curve.

One way to interpret this is that if demographic trends are unchanged and construction remains at 7,900 units a year, we can expect the price of homes a decade hence to remain at $400,000 *in 2003 dollars*. (Undoubtedly, prices generally will rise over the decade; if the general price level rises by 50 percent, for example, the nominal price in 2014 would be $600,000).




The chart above shows home prices on the vertical axis, in thousands of dollars, and thousands of units built per year on the horizontal axis. The dark blue line is the demand curve, showing how changes in the volume of construction would affect price. The starting point of our analysis – actual patterns over the past decade with 7,900 units built and price of $400,000 (point 1) – is shown with a large blue square, a brown arrow, and a brown text box.

If construction were reduced to 4,000 units per year – only 37 percent of predicted demand – the regression analysis tells us that price would rise to $442,000 (in 2003 dollars) – point 3 - as shown by the red arrow and red text box. If construction were to increase to 16,000 units (150 percent of predicted demand), prices would fall to $314,000 – point 2 - as shown by the purple arrow and text box.[9]

Construction of this classic demand curve – in which home prices depend on the volume of housing construction – completes Part 1 of our study.

Using data from all of the northeast states, we've confirmed that higher construction means lower home prices, and calculated that for the 128/495 corridor, a doubling of construction rates, to 16,000 units a year, could bring the average price down a decade hence by 21 percent - from $400,000 (in 2003 dollars) to $314,000.

**In the Route 128/495 corridor, a doubling of construction rates to 16,000 units a year could bring the average home price down from $400,000 (in 2003 dollars) to $314,000 by the year 2014.**

Since we are interested in the trade-off between open space and home prices, our next task is to understand more about average lot size – how much land is used to create each new unit of housing. We turn to this in Part II of the study.



9 These calculations assume that the $82,000 in "unexplained" costs remains constant regardless of construction volume. The 16 percent cost premium for construction in the north-east varies slightly as overall home price changes.

# PART II

## RECENT DEVELOPMENT TRENDS: HOW MUCH LAND PER UNIT?

Our interest in this study is to understand how changing land use patterns – changing average lot size – affects the trade-off between the amount of land consumed and home prices. To do this, we need to understand current land use patterns and some plausible possibilities as to how these patterns might change.

We can learn about average lot sizes in recent years by collecting data on new homes built over the last few years in our 128/495 corridor and calculating average lot size. Put another way, how many acres are we using, on average, to build one additional housing unit? Barring any change in land use policy and building patterns, this will tell us how many acres of open space we're likely to consume over the next decade, and how many additional acres we'd need to achieve a given increase in construction (and accompanying decrease in price).

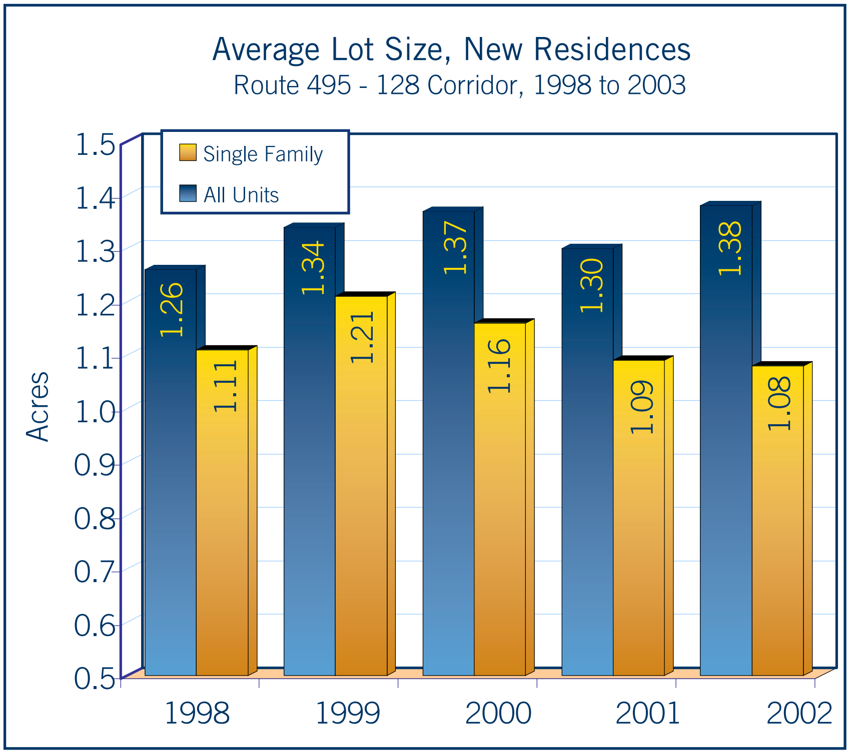
Massachusetts is, of course, very old, at least by American standards, and the 128/495 corridor contains many classic New England towns, with relatively dense town centers, surrounded by woods, fields, or large-lot housing developments. In many cases, these old established town centers are highly desirable areas in which to live, with large and elegant old houses, and plenty of trees, grass, flowers, and greenery – despite the fact that average lot sizes are substantially smaller than those on which newer homes are being built. One obvious alternative to current practice, then, would be to build at densities similar to the established town centers throughout our corridor. In this study, we take a detailed look at two of these towns – Ipswich and Andover – and use assessor's maps and databases to determine how average lot size has changed over time and also to determine whether larger lots actually command a price premium in the marketplace.

In addition to current construction patterns and existing town centers, a third development alternative would be to build along the lines of so-called "smart growth" projects across the country. Typically, these are projects which include town centers and multiple-unit dwellings as well as single-family homes. Smart growth are deliberately built at higher densities to put more homes within walking distance of amenities while preserving some of the land as open space. The study includes a survey of several such developments and calculates average lot sizes in projects of this type.

> **One alternative to current development practice would be to build at densities similar to the established town centers throughout the Route 128/495 corridor.**

In comparison to current land-use patterns, the lower lot sizes represented by the second and third alternatives would allow for the construction of a greater number of units (and thus a substantially greater reduction in home prices) without increasing the amount of open space consumed. Alternatively, these high-density strategies would allow the same number of units to be built while leaving far more acres open or, most likely, some combination of additional units built and less open space consumed.

In this section of the study, we'll quantify each of these three development alternatives. Specifically, we'll calculate what each implies in terms of acres consumed per additional unit of housing created. Then in the third section of the report, we'll take these lot size averages and apply them to the demand curve we calculated in Part I, which will allow us to relate acres consumed to units built to home prices.




## ALTERNATIVE 1 – AVERAGE LOT SIZES IN RECENT CONSTRUCTION

Data made available to the Massachusetts Housing Partnership for this study by the Warren Group contains information on recent construction in Massachusetts. This data is virtually complete; a comparison of Warren Group data for 2001 with the permit data that year for the same towns shows that the Warren Group dataset includes 94 percent of the units reported by census.[10] This data tells us the type of development (single-family homes, apartments, condos, etc.), the lot size, the town, and the year the home was built.

From 1998 to mid 2003 the Warren Group reports on 27,972 residential construction projects built in 108 towns in our 128/495 corridor; altogether, these projects include some 28,541 housing units.[11] Single-family homes account for 83 percent of the units built; the average lot size for these units was 1.32 acres. (This is a very large piece of land; a lot this size would be as long as a football field and almost 200 feet wide!)

Typically, condos are built on .15 acres (7 units to the acre) and town houses on .25 acres;[12] when these are included, the average lot size is 1.13 acres for each housing unit built.

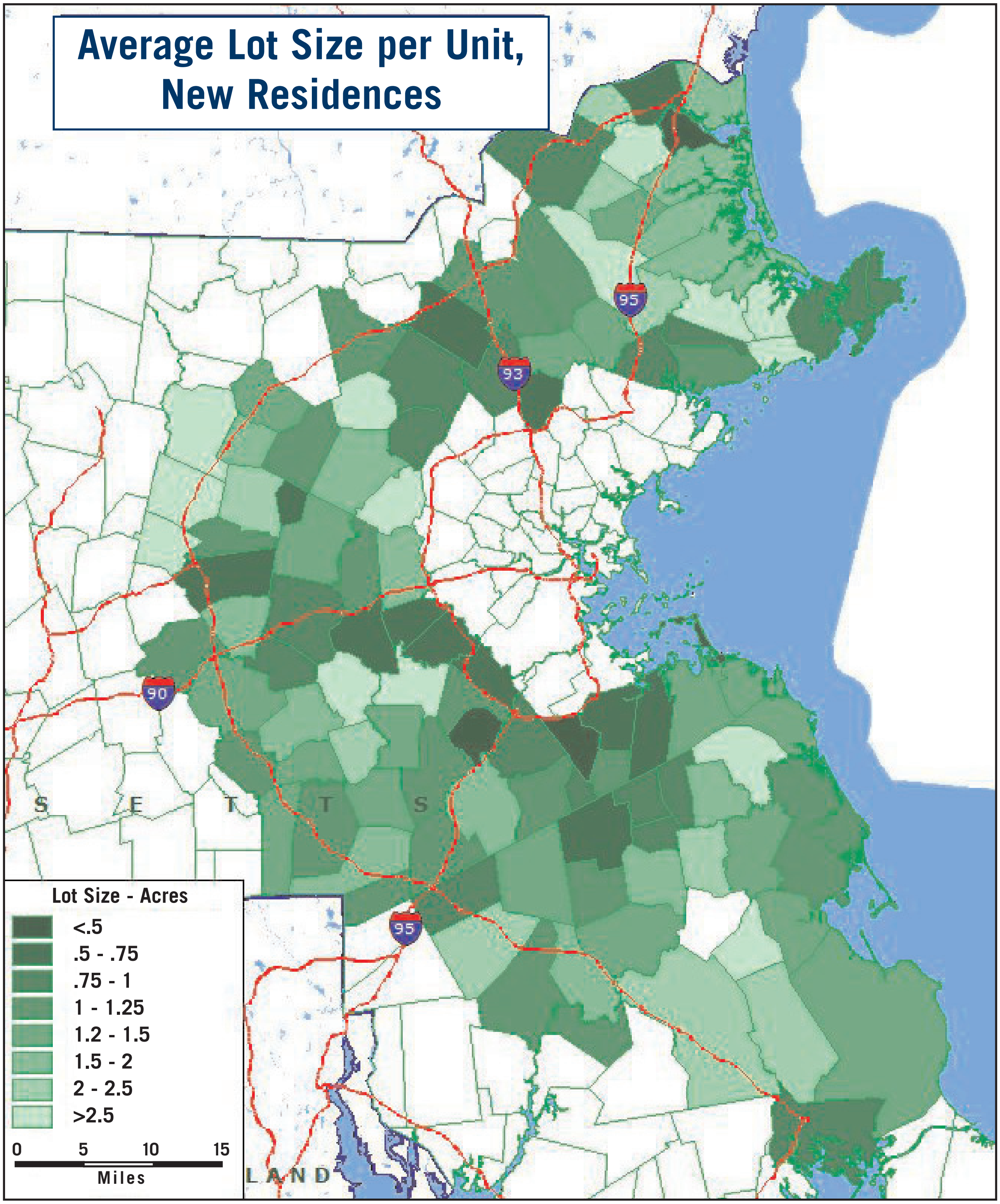
Our Warren Group data run from 1998 through 2002. Over this time period, the average amount of land used per unit of new housing has declined slightly, from 1.11 acres to 1.08 acres, as shown in the chart below. There is virtually no change in the size of new single family homes (1 1/3 acres), but single family homes have fallen from 87 percent of total units in 1998 to 75 percent in 2002.

Average lot sizes vary considerably within the 128/495 corridor, as shown in the map on the following page.

10 The data would not agree completely, since the year a unit is built, as recorded by town assessors, may not be the same year in which the permit was obtained. Still, it's clear from this comparison that the Warren Group data represents a very good sample.

11 There are 114 towns in the corridor; we don't have data on 6 towns. Three of these are cities which fall within the corridor geographically but are not suburban communities, including Lawrence, Methuen, and Lowell.The other 3 are Lakeville, Halifax, and Westford.

12 Data on lot size is available for only a quarter of the multi-family units; the calculations here assume that the units for which size is known are typical of all multi-family units. It's unlikely that a small error here would make much of a difference in the overall result, since multi-family units represent only a small portion of the total and their average land use per unit is certainly far less than the 1.3 acres for single-family homes.



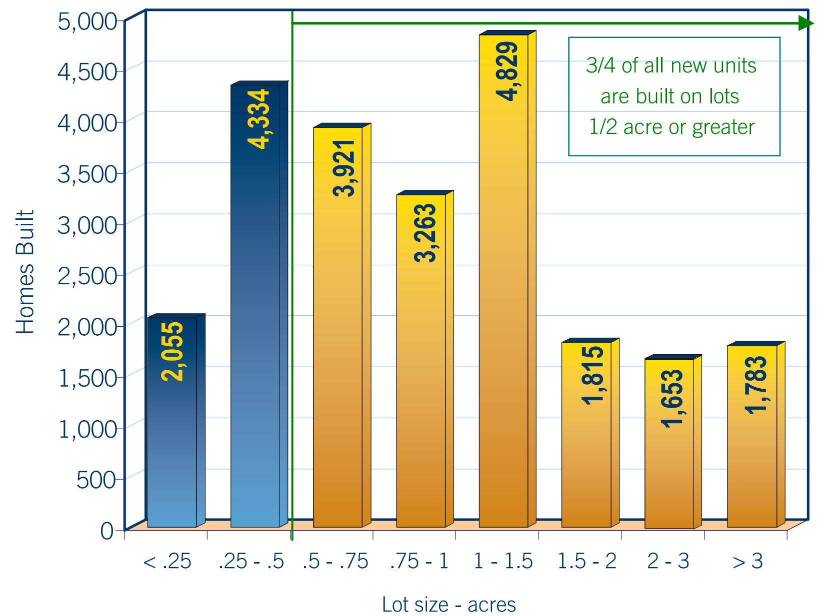

Only four communities have an average single-family lot size under half an acre – Newburyport, Randolph, Norwood, and Hull. At the other end of the scale, 14 towns have an average single-family lot size over 2.5 acres – Plympton, Boxford, Hamilton, Manchester, Dover, Sherborn, Lincoln, Bolton, Upton, West Newbury, Carlisle, Essex, Harvard and Norwell, although Harvard, Manchester, and Norwell have built enough multi-family units to bring the overall lot size under 2.5 acres. In Plympton, Sherborn, and Boxford, average lot size exceeded 4 acres, on a total of almost 300 new homes!

Few homes in the corridor are built on lots smaller than a half acre, as shown in the chart at right. Of the 23,000 single-family homes built in the 128/495 corridor over these years, only, 2,055 – 9 percent - are built on lots of a quarter-acre or less, while 3/4 of all new single-family homes are on lots of at least half an acre. Almost half the homes are built on lots of at least an acre.

This is a stunning reversal of historical growth patterns. As we'll see in the next section, lot sizes were much smaller in past years, and town centers in some highly desirable towns have single-family homes built on lots of 1/3 of an acre or less.

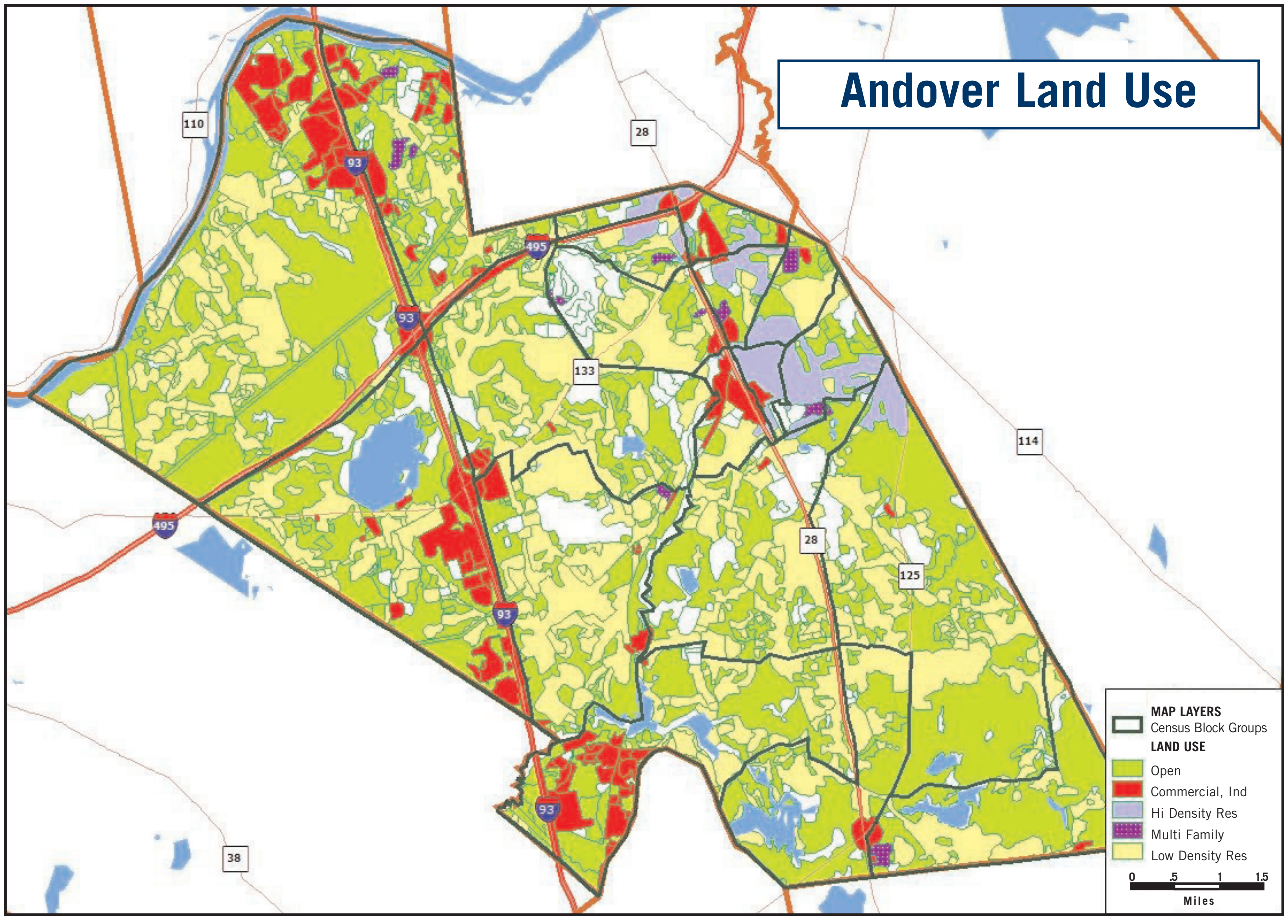
Single-Family Homes Built, by Lot Size

Lot Size in Acres, Route 128-495 Corridor, 1998 to 2002




## ALTERNATIVE 2 – HISTORIC LAND-USE PATTERNS – ESTABLISHED TOWN CENTERS

We've seen above that in recent years, communities in the 128/495 growth corridor have used 1.08 acres for each new unit of housing built. In doing so, these towns are using substantially more undeveloped land than if they were to add new homes at densities similar to their existing town centers. To quantify this, we've taken a detailed look at two prosperous, desirable towns north of Boston – Andover and Ipswich. In both cases, we have complete assessors' parcel databases, with extensive information on all parcels in town, along with maps of parcel boundaries.

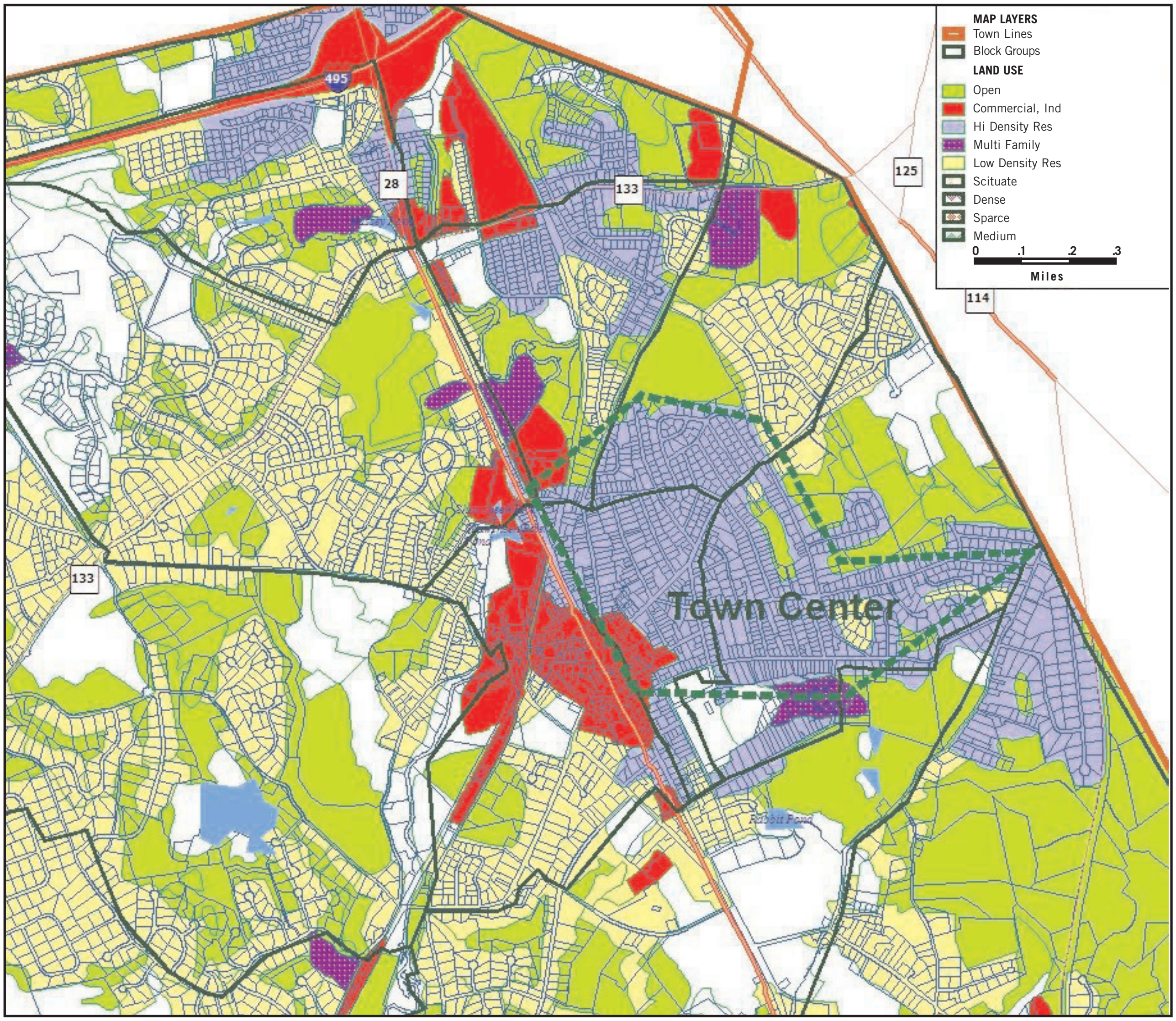



## Andover

The map above shows the town of Andover, with sections of town color-coded accorded to MASS GIS's land-use map of Massachusetts. Land colored green is open; low-density residential parts of town are colored yellow. Commercial and industrial areas are in red, while higher density residential areas are shown in violet.

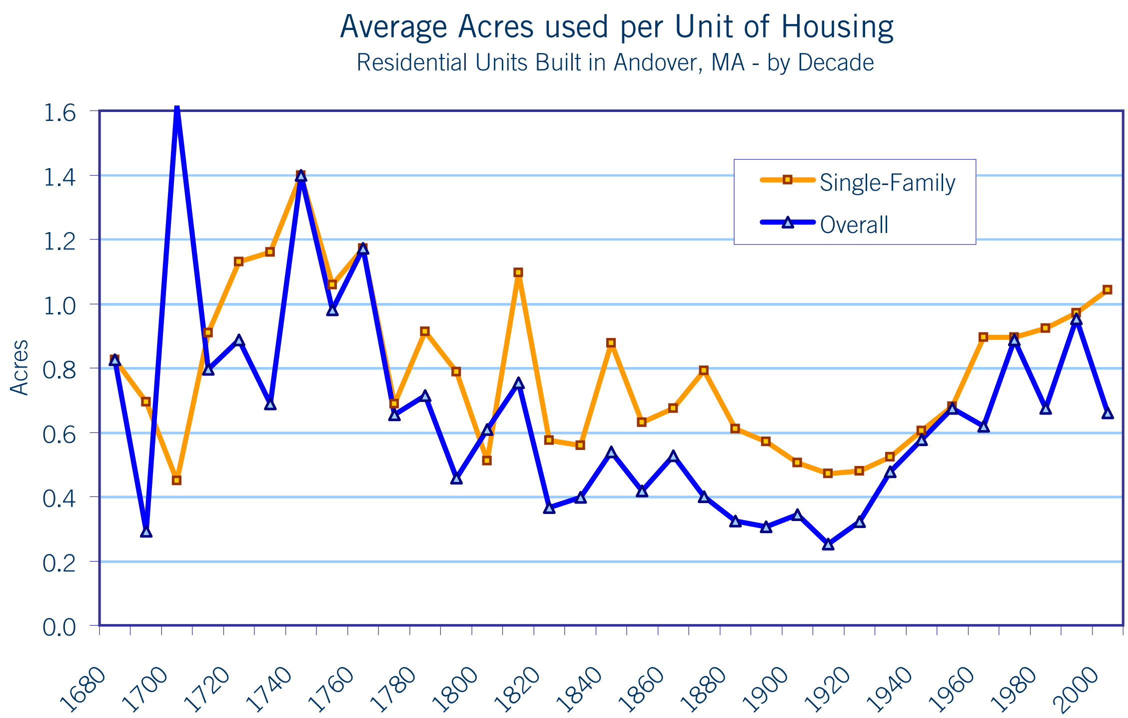
The historic town center is the violet area located just east of Route 28 toward the northeast corner of town. A look at the map shows that low-density housing developments, shown in yellow, have been built extensively in areas well outside the historic town center.

In the analysis that follows, we'll compare lot size and home prices in the historic center with the rest of town. We get a better view of the town center in the map on the next page, which also shows the lot lines. For purposes of this analysis, I've defined the town center as that portion of the three central area census blocks that is also categorized as "high-density residential" in the state land-use maps. This is roughly the area indicated by the dotted green line on the map above.




As we'd expect, homes in the town center are considerably older than those elsewhere in town. The average home in the town center was built in 1921; this compares to 1958 elsewhere in town. In the heart of the town center – the census block right along Route 28 where the "T" in "Town Center" is located in the map above, the average home was built in 1905. In the town center, 65 percent of the residential units are single-family homes, as against 78 percent elsewhere in town.

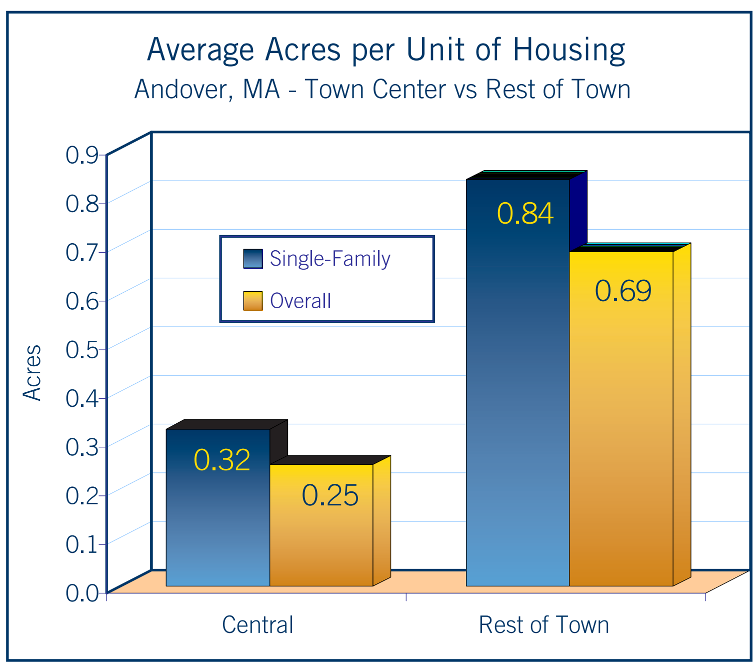
The average lot size of new housing units in Andover has been increasing steadily since the turn of the century, as shown in the following chart.




Back in the 18th century, the average Andover homes was built on lots of 1 acre or larger. This average is misleading, since a few of these homes were undoubtedly part of family farms. By the early 1800's, typical single family homes were built on lots of .6 to .8 acres and the overall ratio of land used to housing units created (counting apartments and town houses as well as single-family homes) was a half-acre or less. In the early years of the 20th century, the typical single-family home was built on a half acre and the overall land use per unit was a third of an acre. From 1930 to 1960, the average amount of land used per unit of housing roughly doubled.

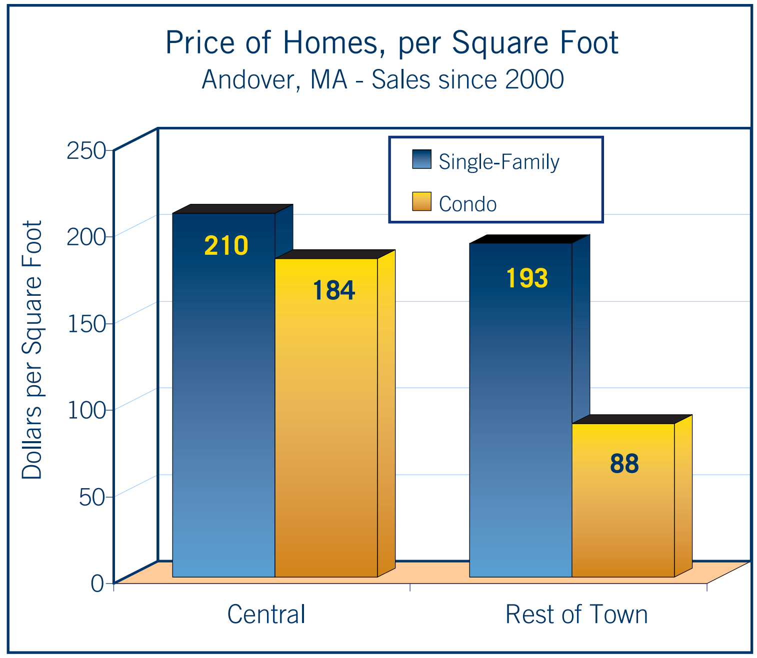
Typical single-family homes in the Andover town center are built on 1/3 of an acre lots; counting condos and apartments, each unit of housing occupies 1/4 of an acre, as shown in the chart at left. On average, housing units outside the center occupy 2 1/2 times as much land as those in the center. And, at 1.1 acres, the average housing unit being built across the entire 128/495 corridor takes up 4 times as much land as units in the center of Andover.

Andover center is not a densely-settled, low-income inner city, like near-by Lawrence. It is not an area of small, crowded homes like the inner ring of blue-collar suburbs just north of Boston. It is, instead, a desirable neighborhood of larger homes on comfortably-sized lots. All the more reason to wonder why we are building new homes on such large lots.

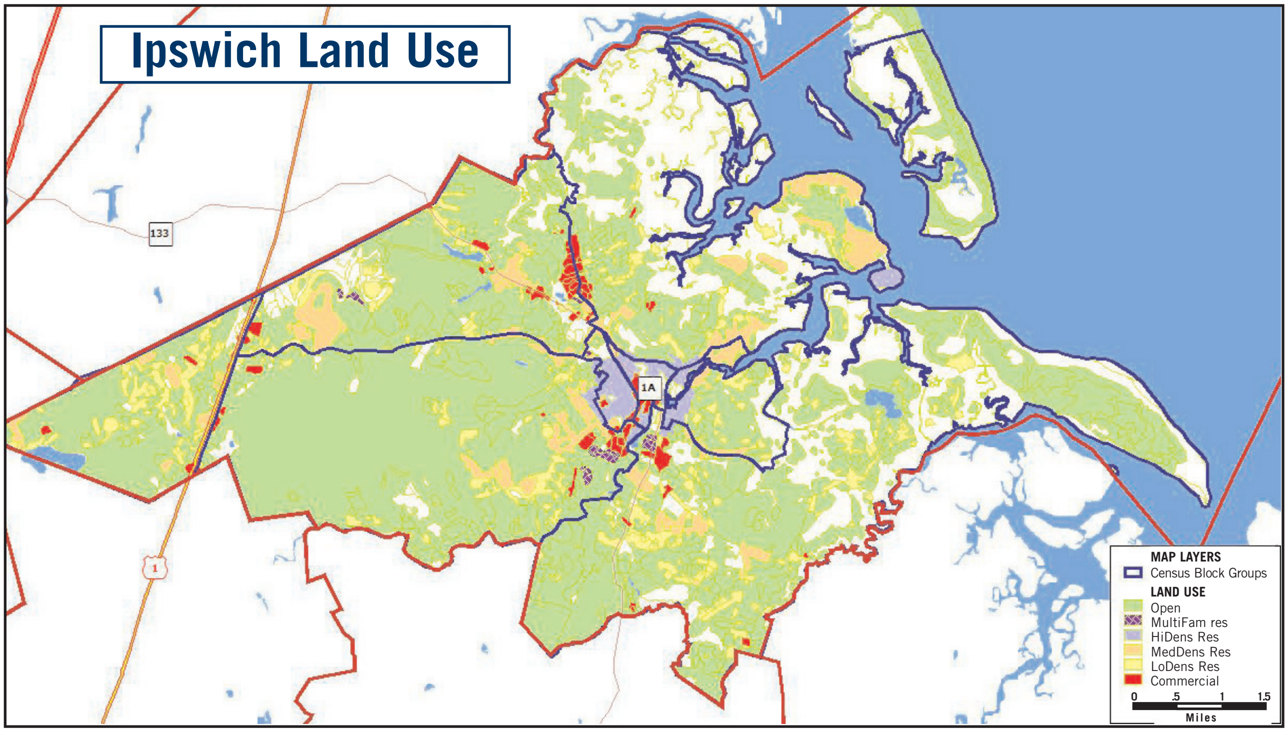


Surprisingly, today's large lot construction is definitely *not* a response to buyer's preferences, as expressed by what they're willing to pay for houses on larger lots. The desirability of the area is indicated by its home prices. Since 2000, the average single-family home in Andover center has sold for $415,000. This is well above the $369,000 average for all of Massachusetts and slightly above the $400,000 average for the 128/495 corridor as a whole.

The price of Andover homes outside the town center is $535,000. Although the total price of homes is higher outside the town center, the price per square foot of living space is not. Homes in the center of Andover are somewhat smaller than those outside the center – 2,115 square feet of finished space vs. 2,768. The price per square foot is actually higher in the town center - $210 per square foot in the center vs. $193 for single-family homes, as shown above.




The higher per-square-foot price of in-town homes indicates that buyers actually pay a premium to live in the town center, and that there is little if any extra economic value created by the new pattern of larger lots far from the town center. At the very least, this indicates that well laid out, denser neighborhoods built at 3 or 4 units to the acre can create just as much value (and generate just as much – if not more - in the way of property tax values) as larger lot developments – and can do so using far less open space.




## Ipswich

Like Andover, Ipswich is a north-of-Boston town with an older, denser, town center and extensive, less dense development outside the center.

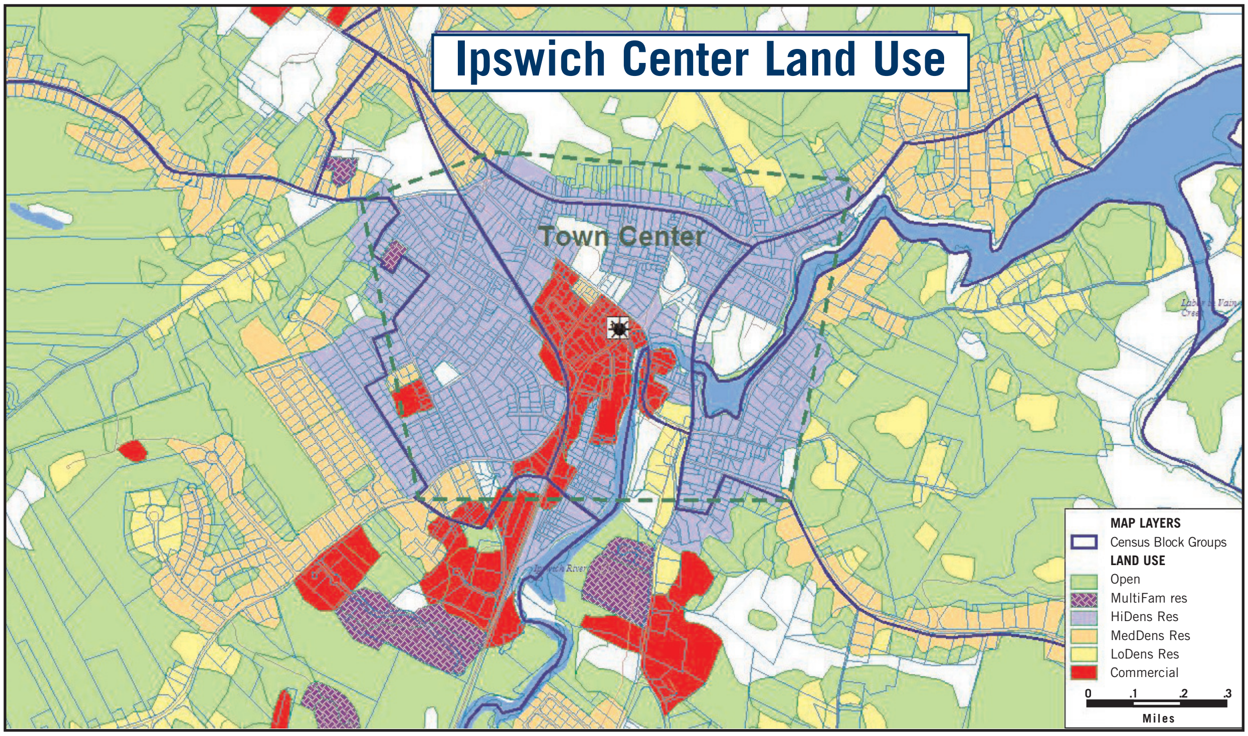
The map above shows land use patterns in Ipswich. The older town core is the violet area in the center of the map. The majority of housing units are outside the center; the map shows that, except for the state forest west of the center and Crane's Beach along the water, there are housing units (shown in yellow) throughout the town.

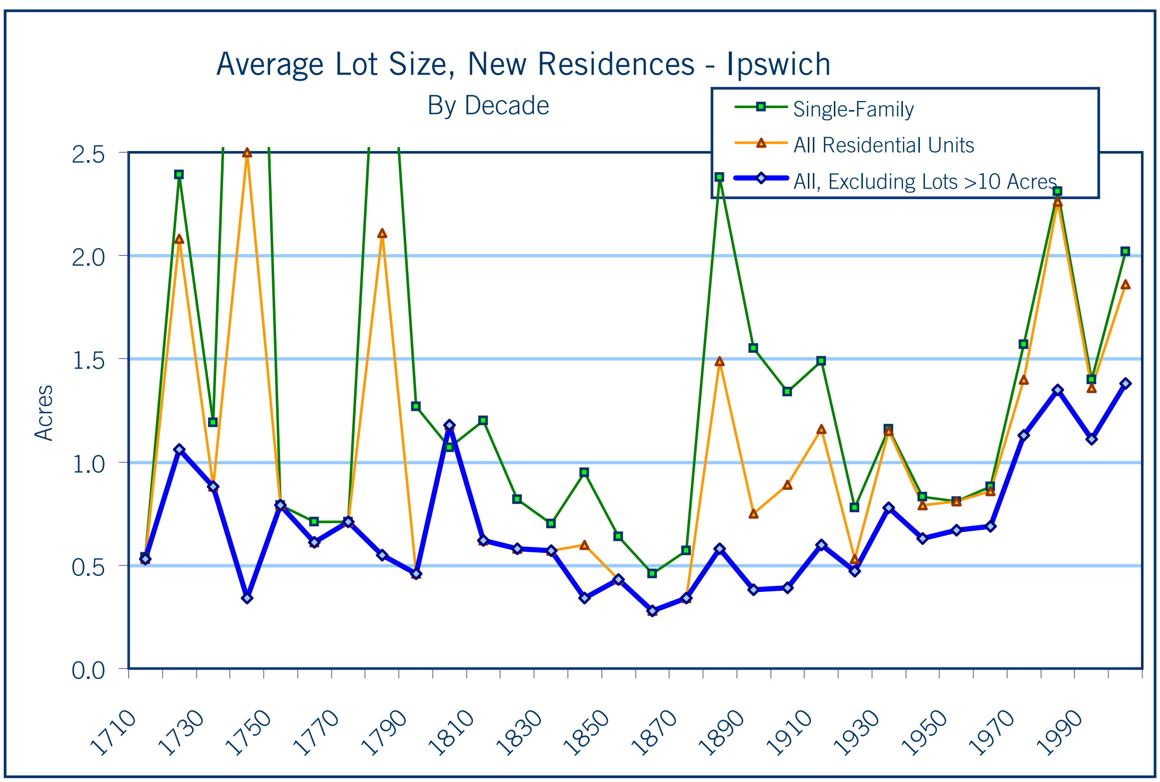
The central area is shown in more detail in the top map above. As in Andover, I've defined the "downtown" area as those portions of the three central census block groups that are also in the state's "dense residential" land-use category (violet on the maps) – roughly the area shown in the dotted green line in the central area map.

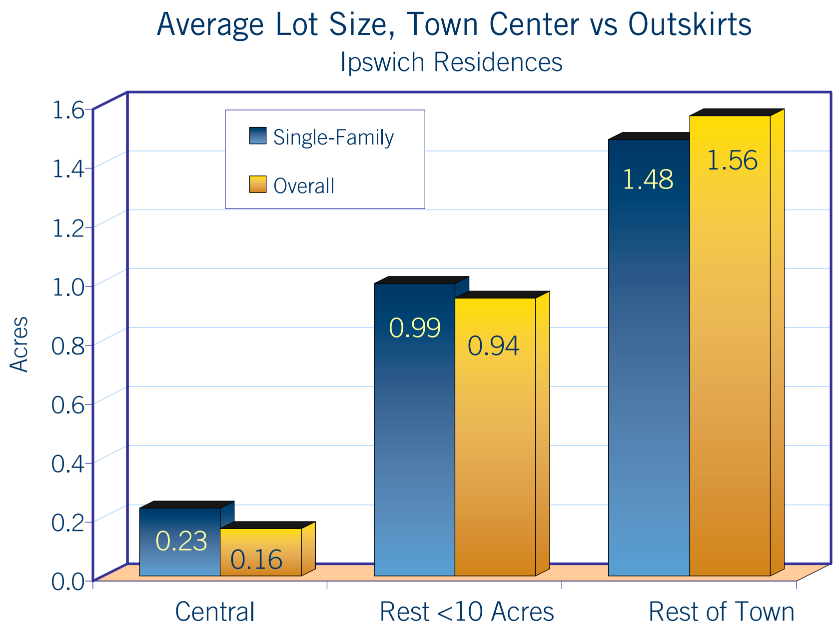
As in Andover, homes in the central area are considerably older than those elsewhere in town. The average town-center home was built in 1893 – some 60 years before the average house elsewhere in town, which was built in 1953. In the center of town, just half the housing units are single-family (49 percent); this compares with 90 percent in the rest of town. I've also calculated the distance of each parcel to the town center (the black star in the red commercial area downtown). On average, homes in the center are a third of a mile from this center; homes elsewhere in town are 2.1 miles away.

As in Andover, the typical size of new residential lots in Ipswich has increased substantially in the last half century, as shown in the lower chart on Page 18[13].

13 The curve goes off the chart in the 1740 – 1750 decade. Only 11 homes built in that decade are in the assessor's database today; one is on 37 acres. Of the remainder, only 2 are on a lot bigger than 1.0 acres.


Ipswich Center Land Use
Town Center
MAP LAYERS
Census Block Groups
LAND USE
Open
MultiFam res
HiDens Res
MedDens Res
LoDens Res
Commercial
0 .1 .2 .3
Miles


Average Lot Size, New Residences - Ipswich
By Decade
Single-Family
All Residential Units
All, Excluding Lots >10 Acres
Acres
2.5
2.0
1.5
1.0
0.5
0.0
1710
1730
1750
1770
1790
1810
1830
1850
1870
1890
1910
1930
1950
1970
1990

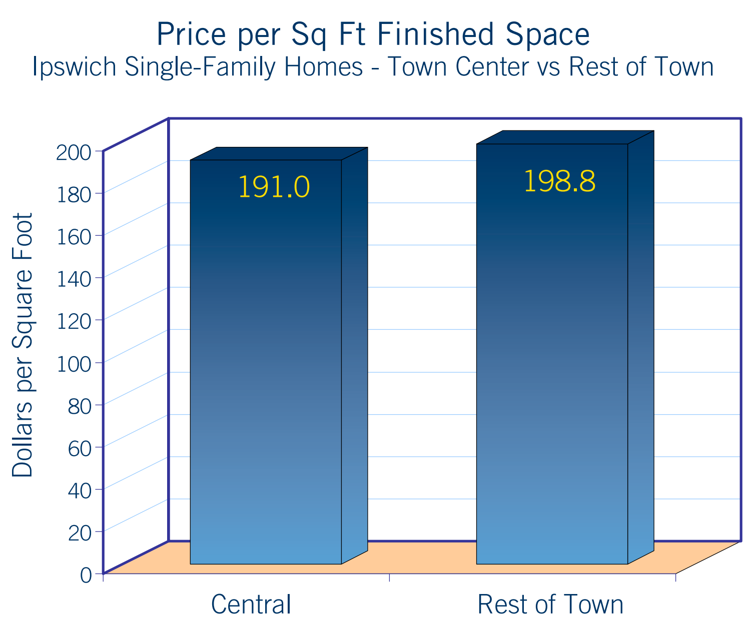



As we'd expect, the trend toward larger lots is correlated with the expansion of settlement outside the town center. In the town center, which accounts for 22 percent of the housing units in town, the typical single-family home is built on just under 1/4 of an acre, as shown at left. Half the units in the town center are multi-family; taking these into account, the overall density is .16 acres – six residential units per acre. Outside the town center, the overall lot size is 1.5 acres; leaving aside the 10-acre estates, the typical lot size is one acre.

As in Andover, the center of Ipswich is a desirable residential area, as indicated by actual sales prices - despite (or perhaps because of) its higher density. On average, single-family homes in the town center sell for $312,000, as against $445,000 elsewhere. But homes in town are smaller (1,711 square feet of finished space vs. 2,316); on a per-square foot basis, the price is virtually identical, as shown in the chart below.

Because Ipswich has some very large farms and estates, the best picture of overall development patterns is obtained by excluding homes built on lots of 10 acres or more, as shown in the blue line in the chart. For a century, from 1810 to 1920, the typical new residence was built at a density of half an acre or less for each residential unit. In the 1950s and 1960s this had increased to about .7 acre; since 1980, the average new home (still excluding those built on 10 acres or more) has occupied 1.3 acres.

The somewhat thinner green and orange lines in the chart show, respectively, average lot size for single-family homes and all residences, including those on 10 acre lots. In the late 1800s and again since 1970, there has been relatively more of such estate homes built. (There were also a significant number of large lot homes built in the 18th century; these were more likely working farms than estates.)



A statistically more elegant procedure for determining the impact of lot size on home values is to use multi-variate regression. The results of such an analysis show the separate impact of each of several possible explanatory factors. Put another way, the coefficient for any particular variable, such as lot size, can be interpreted as the impact of a change in lot size on overall price, holding all else constant.

Just such an analysis was performed for Ipswich home prices, as shown below. The analysis is for all single-family home sales in Ipswich from January 2000 through the end of 2003 – 574 sales. Home prices rise over time; the coefficient of 3.4 on the variable "months" means that, all else equal, prices are rising at $3,400 per month. (This works out to something like 10 percent a year in the red-hot eastern Massachusetts housing market – despite the decline in the state's economy over this period).[14]

**Impact on Home Prices – Ipswich**

*Additional $1,000 per unit factor*

| Variable | Coefficient | T-Stat |
|---|---|---|
| Distance to Center | 17.4 | 3.7 |
| Age of Home | .53 | 4.2 |
| Month | 3.4 | 8.4 |
| Lot Size -Acres | 9.6 | 3.3 |
| Finished Area - Upstairs - Sq Ft | 0.09 | 7.9 |
| Finished Basement - Sq Ft | 0.08 | 3.1 |
| Unfinished Area - Sq Ft | 0.03 | 3.0 |
| Baths | 39.9 | 3.6 |
| Air Conditioned? | 56.7 | 3.4 |
| *Neighborhood Lot Size* | *-4.9* | *-1.4* |

Older homes are worth more – an extra 100 years (all else equal) adds $53,000 to home value. As we'd expect, the amount of living space in the home is a dominant determinant of home prices. All else equal, home buyers pay $90 for each additional square feet of finished space upstairs, $80 for each additional square foot of finished basement, and $30 for each additional square foot of unfinished space. An extra bathroom is worth $40,000 and having the home air conditioned adds $56,700.[15]

Of particular interest to our study, each additional acre of lot size adds $9,600 to the price of a home. This means that if a house on one acre sells for $300,000, then an otherwise identical house next door on a two acre lot will sell for $309,600. Put another way, adding to the size of a lot appears to add almost no value to the sales price of the home – except to the extent it makes possible construction of a home with more finished living space.

The variable "neighborhood lot size" measures the size of residential lots in the immediate vicinity of the house. For this purpose, neighborhood density is measured not at the level of census block groups, which are relatively large, but by the state's land use map (as shown in color shading in the maps on pages 17 and 18). The coefficient on this variable is negative – homes are actually worth slightly less in neighborhoods where average lot sizes are larger, but the coefficient is not statistically significant. This tells us that people are basically neutral about the density of the neighborhood they live in; additional density neither adds nor subtracts from sales prices.

Contrary to what we might expect, the coefficient on distance from the center of town is positive – all else equal, each additional mile from the town center adds $17,400 to home values. Although not shown here, there's no statistical relationship between average income in census block groups and the value of homes.[16]

A closer look at the Ipswich town map suggests that the census block groups are too big to pick up important differences in neighborhood income. Many block groups include some homes at the edge of the town center – often in low-income neighborhoods – as well as more luxurious homes farther out. Although we can't know for sure, it appears probable that the distance to town variable, which is measured for each parcel, is telling us more about overall neighborhood income than about the desirability of being closer to town.

14 The T-statistic is a measure of the statistical reliability of the estimate; a figure of 1.9 or more means that the variable is significant at the 95 percent confidence level.

15 What counts in a house is not the overall square footage enclosed by the walls, but the amount of usable, livable space – bedrooms, living rooms, kitchens, finished basements – as opposed to unfinished basement or attic space used for storage, utilities, or workbenches.

16 The distance to town center variable does more than tell us whether or not a parcel is in the town center. It also distinguishes parcels a half-mile from the center from those located 3 mile out. Hence there is not necessarily a contradiction from our initial finding that, on a square foot basis, homes near the town center are nearly equal in value to homes outside the town center. Parcels in the town center are worth about as much as comparable parcels elsewhere, but parcels far from the center are worth more than those close to it.

### Summary – Existing Town Centers

If future residential development is based on building new town centers, laid out at densities roughly similar to the older town centers in Ipswich and Andover, a conservative guess is that such growth would include four housing units per acre, with single-family homes on lots of a third of an acre and enough condos, townhouses, and apartments mixed in to bring the overall mix down to .25 acres per unit. As normally understood, this would not be particularly dense development; an acre is 43,560 square feet; a third of an acre lot could be 100 feet wide and 150 feet deep.

Such development would include 4.3 times as many homes as recent development patterns in the 128/495 corridor, which come out at 1.08 acres per unit.

## ALTERNATIVE 3 – SMART GROWTH

A third possible growth pattern would follow the lines of "smart growth" projects around the country. Smart growth projects often include apartments and townhouses as well as detached single-family homes, and many use the cluster approach, building on relatively small lots but then leaving a significant percentage of the total acreage in parkland.[17]

The newsletter New Urban News publishes a list of smart growth projects around the country. Of particular interest to our study are those projects that include new town centers, usually with retail and commercial space as well as new residences. Roughly 30 such projects were contacted for this study; we were able to obtain summary data for 20 of these. The New Urban News summary will usually have total project acreage and total residential units, but dividing total project acreage by total housing units overstates the effective lot size for each residential unit, since the acreage figure normally includes open space and commercial areas as well as the land actually devoted to homes, apartments, and condos. Unfortunately, information on how many acres will be used for the residential units (that is, not counting commercial or retail space, or dedicated open space) is not normally published, and, even when contacted directly, many projects are unable to supply the information because they don't keep track of their acreage in this way.

In the absence of specific data on acreage dedicated to open space or commercial use, I assumed that 10 percent of total project acreage was left open and that each 1,000 square feet of residential and/or commercial space required 2,500 square feet of land (allowing for parking, roadways, and landscaping). Both of these estimates are probably too low, meaning that the estimates presented here are likely to understate open and commercial space, overstate the amount of residential land, and therefore overstate the average lot size.

In all, our 20 projects will build just over 15,000 residential units on just fewer than 4,000 acres, which yields an average of just over a quarter of an acre per unit. These are generally large developments, averaging almost 800 units and 200 acres.

**20 "Smart Growth" Projects**

| | | Residential | |
|---|---|---|---|
| | Acres/Unit | Units | Acres |
| Total | | 15,127 | 3,982 |
| Average | 0.26 | 756 | 199 |
| Median | 0.27 | 575 | 183 |

It is perhaps not surprising that the density of these new "smart growth" projects is so similar to the density in Andover town center, since older town centers like Andover's undoubtedly serve as a model for many "smart growth" projects.

In the final section of the paper, we return to the demand curve analysis, this time looking at the trade-off between home prices and acres of land consumed, instead of home prices and units built. To do this, we translate units built into acres consumed, using what we've learned from our analysis of current building patterns (average lot size = 1.08 acres), older town centers, and smart growth developments (in the latter two cases, average lot size = .25 acres.)

17 Smart growth encompasses more than just density; smart growth projects are usually located near transit stations, are built near existing town centers or include new town centers, include commercial as well as residential space, include preserved areas of open space, and are designed to make it easier for people to walk to shopping and transit and for children to walk or bike to school.

# PART III

## PULLING IT ALL TOGETHER: OPEN SPACE CONSUMPTION VS. HOME PRICES

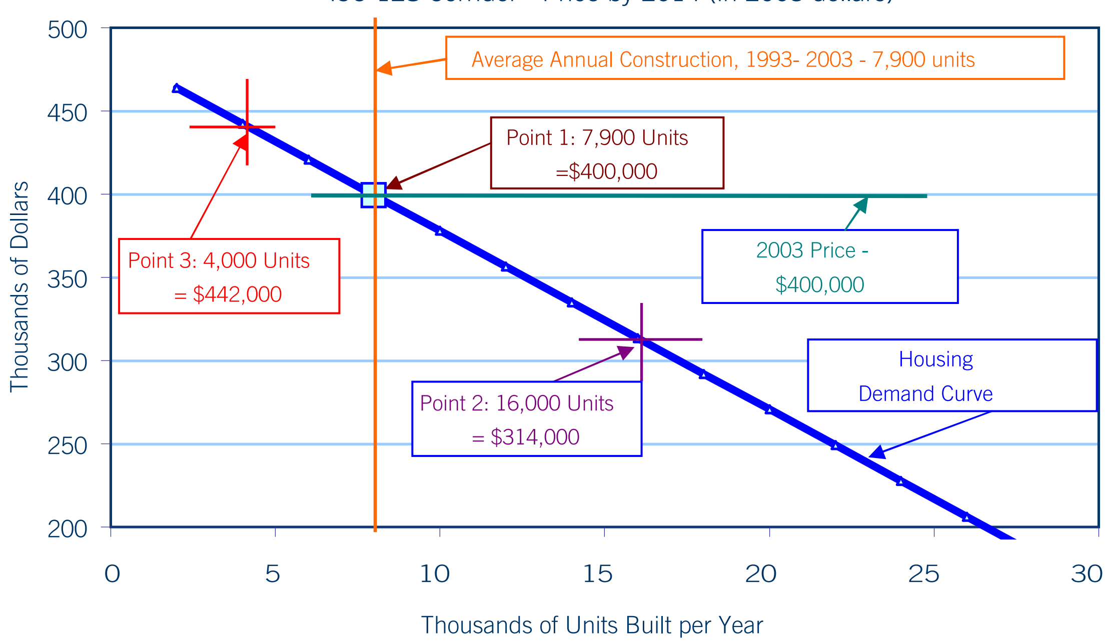
With our study of alternative development patterns complete, we can return to our analysis of the trade-off between open space consumed on the one hand and home construction (and therefore home prices) on the other. In the first section of the paper, we analyzed the demand curve for housing – the impact on home prices of increased housing construction.

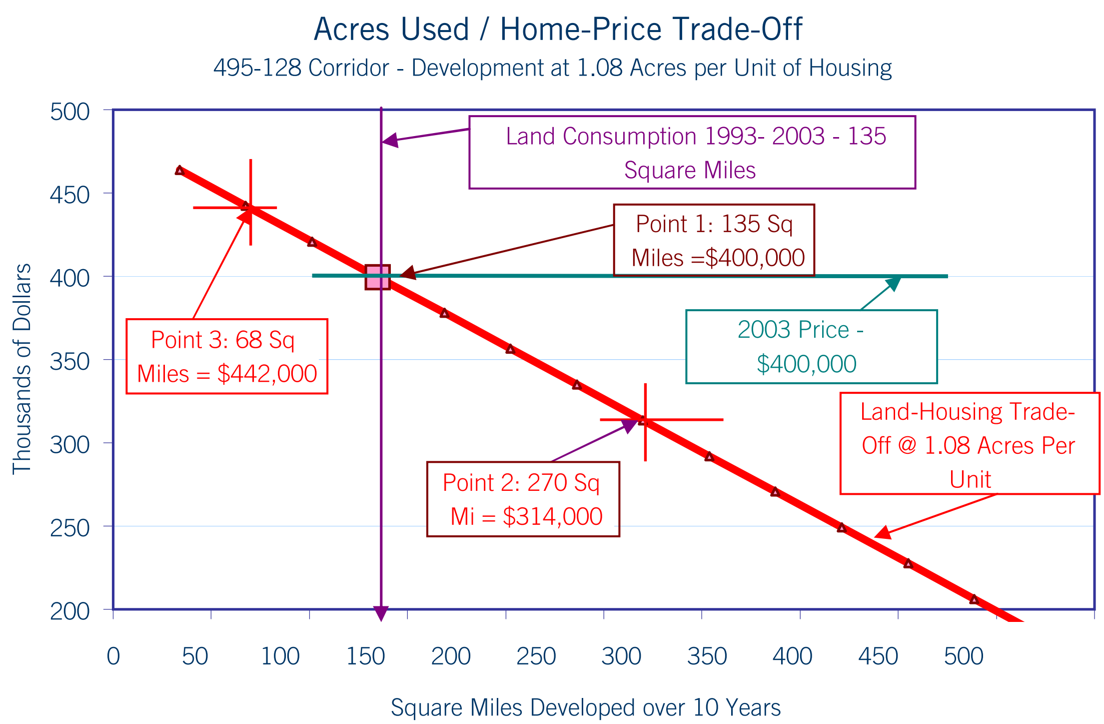
The demand curve calculated in Part I is shown again below. Based on a comparison for the 20 Midwestern and northeastern states of housing units built with "normal" demand, the analysis in part I found that for every additional 1,000 units built per year (10,000 additional units over the decade), the price of a typical home a decade hence will fall by $10,700 below what would otherwise be the case.

With the analysis from Part II, we can now translate homes built into acres of open space consumed.

Housing Demand Curve

495-128 Corridor - Price by 2014 (in 2003 dollars)






The chart above shows the trade-off between home prices in 2014 (expressed in 2003 dollars) and open space consumed – assuming development continues at the recent density of 1.08 acres consumed for each additional unit of housing created. This chart is identical to the one above, except that the horizontal axis now measures square miles of open space consumed instead of number of homes built.

Point 1 on this chart represents the same transactions as point 1 in the earlier chart. The price remains at $400,000 (in 2003 dollars), 7,900 additional homes are built each year, and 135 square miles of open space are consumed over a 10 year period. As before, Point 2 represents construction of enough new homes (16,000 per year) to drive the price down to $314,000; at 1.08 acres per unit, this uses 270 square miles of open space.

At an average lot size of 1.08 acres, the 79,000 housing units built over the last decade in the 128/495 corridor consumed 85,000 acres, or 135 square miles. The growth corridor towns have a combined area of about 2,200 square miles; housing construction in the last decade alone consumed 6 percent of the total land area. If this rate of development – and therefore this rate of land consumption – continues, we assume that inflation-adjusted prices will not change, giving us the $400,000 price/135 square mile point on the demand curve (point 1), as shown at the large square and labeled by the brown box in the chart above.

If the amount of land developed is doubled – to 270 square miles – the inflation-adjusted price will fall to $314,000 by 2014. (This does not mean that the nominal price will fall. At, for example, 6 percent annual inflation, prices will increase by 80 percent over a decade. The nominal 2014 price would therefore be $715,000 with current construction (135 square miles developed), and $561,500 with 270 square miles developed).[18]

The slope of this demand curve shows us that under the current development pattern (1.08 acres per additional housing unit), each additional 10 square miles converted to housing translates into 5,920 units additional units and a reduction in price of $6,400.

18 Remember that these are inflation-adjusted (year 2003) prices. At 6 percent inflation, a home that sold for $400,000 in 2003 will sell for $715,000 in 2014. Driving down the 2003 price to $314,000 would then mean a price in 2014 dollars of $561,000. In economists' terms (taking inflation into account), the price has fallen as a result of this increased construction. In layman's terms, the price rises – from $400,000 in 2003 dollars to $561,000 in 2014 dollars, but the increase is less than 6 percent a year (which would have brought the price to $715,000 in 2014 dollars).

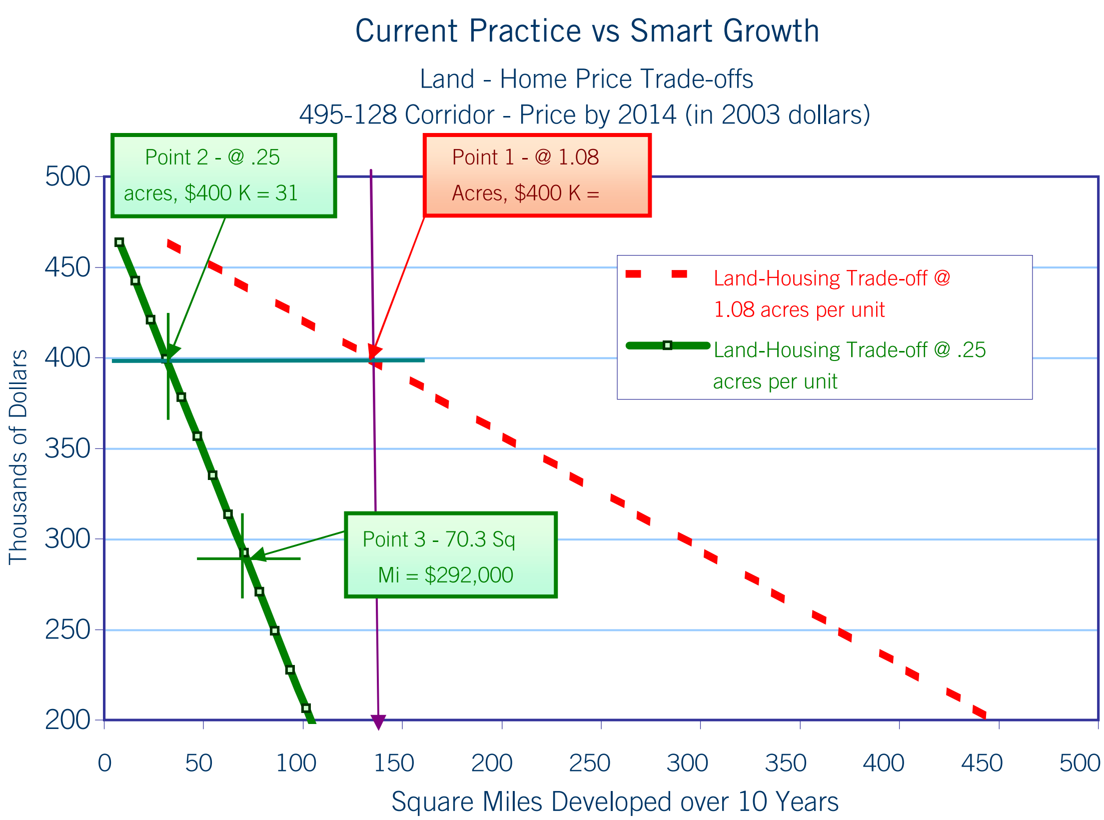
## IMPACT OF "SMART GROWTH" DEVELOPMENT

As we've seen, the current lot size of 1.08 acres per unit is over four times as great as what we find in the centers of older towns like Andover and Ipswich. If we reverted to an average of only _ acre consumed for each additional unit of housing created - the pattern typical of the 1920s, of Andover town center, and of current smart growth developments – the trade-off between land consumed and home prices would be far more favorable, as shown in the chart below.

The chart shows two demand-curves – one at .25 acres per new home unit (shown in green) and the 1.08 acre curve from the chart on page 23, shown as a dotted red line. The difference between the two is dramatic. To build enough homes to keep prices constant in real terms over the next decade would require only 31 square miles under smart growth (point 2 on the chart) instead of 135 under current development patterns (point 1). These two points are shown where the horizontal line that represents a 2003 price of $400,000 crosses each of the two demand curves.

Alternatively, we could develop 70 square miles – just a bit over half what will be required at current lot sizes – and reduce the inflation-adjusted home price to $293,000 (Point 3 on the chart, down and to the right along the 1/4 acre demand curve.

A change in zoning (and regulatory) practices across the region that encouraged denser developments averaging four new units for each acre of open space – a pattern similar to the Andover town center – could cut home prices by just over 25 percent while simultaneously reducing by almost 50 percent the amount of open space consumed.




Over the long term, there are very dramatic differences in how much open space would be consumed under these two development alternatives. Development at current lot sizes and current construction rates will consume an additional 675 square miles over 50 years – just about 1/3 of the total area of the 128/495 corridor. If instead, new construction is brought in at four units to the acre, we could build the same number of units – with the same housing price – on only 156 square miles, or we could double the units built, decrease price by 27 percent, and still use only 350 square miles.

For convenience, I've only shown the two demand curves – at 1.08 acres per unit and at .25. In practice, any number of demand curves could be drawn, and any reduction in average lot size would translate into a more favorable set of land-use/home-price choices.

## CONCLUDING COMMENTS

Average lot sizes in the fast-growing 128/495 corridor are large – very large – by historic standards. Average single-family lots are 1.3 acres – about 188 feet wide by 300 feet deep – bigger than a football field. At current construction rates, one third of the total area of the corridor will be needed simply to hold the houses built in the next 50 years – all this without any increase in construction rates and therefore without any relief in the region's high housing costs.

Surprisingly, the available evidence suggests that these large lot sizes are not a response to public demand for more land; in fact, there appears to be virtually no price premium associated with larger lots (although the larger homes often built on larger lots do command higher prices). This suggests that the increase in land use – roughly quadruple the land-per-unit of the first half of the 20th century – is the result primarily of zoning practices. Far from preserving open space, these practices, carried out across the corridor, result in far more open space plowed under and converted to housing.

> **If we keep building at current construction rates, one third of the total area of the Route 128/495 corridor will be needed simply to hold the houses built in the next 50 years. Our demand curve analysis points to a more constructive alternative.**

A prime motivation behind the large lot zoning is the effort to minimize the number of children in each town's school system. What might make sense for individual towns, however, is not working for the region as a whole. Families that can't move to one town move to another – unless the sky-high home prices in Massachusetts drive them out of the state altogether.

The demand curve analysis points to a more constructive alternative. If a way can be found to make sure that no one town gets a disproportionate share of new housing units and new school children, preferably with changes to the state funding formula to hold towns harmless for the fiscal impact of additional school children (at least those living in smart growth developments) the region can slow dramatically the conversion of open space to housing developments while simultaneously easing substantially the pressure on home prices.