Rethinking Traditional Landscape and Open Space: Hanover & Hartford

Environmental Studies 50, Spring 2007

D a r t m o u t h C o l le g e

Rethinking Traditional Landscape and
Open Space

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TABLE OF CONTENTS

MISSION STATEMENT

For this year's Environmental Studies 50: Environmental Problem Analysis and Policy Formation class, our charge was to investigate the issues surrounding exurban sprawl as a result of land-use change and land-use policy in Hanover, New Hampshire and Hartford, Vermont. For the purposes of this class we define exurban sprawl as the process whereby urban dwellers leave the city and choose to settle in areas traditionally defined as rural with concurrent changes in land-use patterns as well as increases in development, infrastructure and population. This topic covers a number of issues such as historical land-use, agricultural change, gentrification, affordable housing, environmental degradation, land-use regulation and local government structures. For this report, we chose to specifically examine the effect that exurban sprawl has on open space and on the "working landscape"—areas dominated by traditional uses such as farming and forestry.

We chose this topic for a number of reasons: first of all, we often noticed in our investigation that most residents of Hanover and Hartford care about the natural amenities and rural character of the area, qualities that are often embodied in the protection of open space and traditional uses. Also, both towns have made statements supporting the protection of these areas. In their Master Plans, both Hanover and Hartford stress the protection of open space and working landscape.

There are a number of different arenas in which we could have explored this topic. In order to give the fullest explanation of the various effects of exurban sprawl on the working landscape and open space, we examined the economic, social and environmental implications of these changes. The topics of our investigation ranged from agricultural cooperatives to affordable housing and fragmentation to land valuation. In this report, we bring together these seemingly disparate impacts of exurban sprawl and illustrate how they interact and how these combinations affect the Hanover and Hartford areas. Finally, we have developed a number of recommendations which should help each town to address the various issues raised within the report.

INTRODUCTION

At this time we find it useful to give background information that could be used for understanding our analysis of the economic, environmental and social aspects of exurban sprawl in the Upper Valley. First, a brief land-use history is presented to explain the context of the forces that have changed the landscape of Vermont and New Hampshire from the time of first settlement. Second, we present demographic information for Hanover and Hartford in order to compare and contrast the two towns. Finally, we introduce Geographic Information Systems (GIS) as a tool for analyzing these issues of development and sprawl.

A Land-Use History of the Upper Valley

To begin, it is important to consider the past land-use history of the area. Land-uses such as agriculture and forestry still figure prominently in today's landscape, whether they continue to be in practice or have given way to current uses such as residential development.

In the northern New England states of Vermont and New Hampshire, settlement and the clearing of forests began in full force at the beginning of the nineteenth century. Early forest clearing occurred primarily to make way for small-scale agriculture. This initial clearing resulted in the typical landscape of cultivated land with pastures and adjoining wood lots defined by stone fences. These family farms commonly clustered around small village centers (Albers, 2000). After the initial clearing of the landscape, open land was maintained by increased grazing brought about by the introduction of Merino sheep, primarily in Vermont. Due to the rocky nature of northern New England soil and increased demand for inputs to textile production in industrialized southern New

England, sheep grazing was more economically attractive than large scale agriculture. This sheep boom, which lasted until the outbreak of the Civil War in 1860, served to maintain a deforested landscape (Albers, 2000).

After the Civil War, many of the small-scale family subsistence farms were abandoned or consolidated into larger operations because these farmers were unable to compete with more productive farmers in the Midwest (Litvaitis 1993, 867). The opening of the Western states by railroad allowed western wool to reach Eastern markets and thus the Vermont sheep industry could not compete. As a result, the natural resource economy of the area changed yet again. In this period just before the turn of the century, more efficient harvest techniques and economic demand for forest products resulted in the first large scale clear-cuts of northeastern forests. This served to further deforest the landscape and marked the formation of the logging industry (Foster 1999, 100). In addition to the clearing of the forest for economic purposes, another agricultural shift occurred in the late 1800s. This period saw the creation of Vermont and New Hampshire's first large scale dairy farms. Increasing improvements in transportation and storage allowed Northern New England farmers to export dairy products to urban centers such as Boston. This dramatic increase in dairy farms is significant because dairy production has remained the dominant form of large scale agricultural production in Vermont and the Upper Valley up to the present (Albers 2000, 210).

Thus at the turn of the twentieth century the landscape was again transformed by large scale dairy farms and large scale timber harvests. It was at this time that the first conservationists and preservationists became concerned with the current use of the landscape and began to designate protected lands and state parks. Nevertheless, dairy operations and logging continued to grow until the depression era. The economic slump that began in the 1930s as a result of the depression and lack of economic development continued into the 1950s and resulted in the abandonment of many farms and the beginning of the transition of previously logged, cultivated and grazed lands back to forests (Albers 2000, 257). Improvements in technology in the 1950s allowed the further consolidation of dairy operations and caused many smaller farms to shut down. Throughout the mid-twentieth century, abandoned agricultural fields and previously clear-cut forested areas continued to revert to secondary succession forests.

In the 1970s, Northern New England saw one of its largest demographic transitions. The forests and rural character of the area appealed to a new generation of well-educated professionals with a strong environmental and conservation ethic (Albers 2000, 300). This initial influx of people, along with increased tourism and mobility, stimulated both residential and commercial development in the traditional villages. The first major exurban centers emerged in Vermont and New Hampshire. Thus it has been in the past thirty years that the problems of exurban sprawl, a pattern of low density residential and commercial development predicated on single family homes with large lot sizes, have reached the area. Since these new immigrants to the area were attracted to the natural landscape and forests, they tended to settle on the fringes of villages on large lots. However, if this current pattern of low density residential development progresses, the natural and agricultural fields and forests that are attractive and desirable to so many residents of and newcomers to the area will continue to be impinged upon by the necessary infrastructure and accompanying environmental degradation of exurban sprawl. Thus our class has undertaken an economic, environmental, and social analysis of

Hanover and Hartford in order to consider policy recommendations that will work to protect the working landscape.

Hanover Demographic Information

Located in New Hampshire's Grafton County, the city of Hanover has a population of 11,156 residents, according to the 2005 United States Census Bureau. Of the 5,470 persons in the labor force, only 2.6% are unemployed as compared to the national unemployment rate of 4.5%. The range of occupations for employed Hanover civilians is vast. In 2000, 64.2% of the employed held management or professional jobs, whereas less than one percent of the working population farmed, forested, or fished for a living. Seventy-seven percent of residents had a bachelor's degree or higher. The income per capita in 1999 was $30,393 annually, and the median household income was $72,470, as most of the homes have the support of dual income. The median household income of the United States is $46,326, little more than half as much as Hanover. These statistics, as well as the fact that only 0.6% of families in Hanover live below the poverty level when the official poverty rate of the United States is 12.6%, shows that most Hanover residents are moderately wealthy.

Hanover has a total area of 49.1 square miles, 1 square mile of which is water. On the remaining 48.1 square miles of land are 3,109 homes in which the 11,156 residents of the town live. This indicates that there are 79.45 houses per square mile of Hanover land, and about eight homes on every acre of land. Of these homes, 2,218 are single-family dwellings, and only 885 are built for the purpose of a multi-family housing unit. Multi-family units (a.k.a. 'condominiums') are generally built to be a more affordable housing option for people in the community, and only make up less than a third of the housing selection in Hanover. This makes sense for the current socioeconomic makeup of the city, since it is mostly families with dual incomes from private businesses. However, if the staff employees of Dartmouth College and the Dartmouth Hitchcock Medical Center with lower wages wish to live closer to their jobs, economically viable housing options are limited. Hanover has an Affordable Housing Commission that works to “promote the provision of affordable housing in Hanover” (Town of Hanover, NH 2007). The Board members of this commission work with groups such as Habitat for Humanity and the Twin Pines Housing Trust to erect affordable housing units, and provide consistent advocacy for more economically feasible housing in Hanover for residents with lower incomes.

Hanover and Hartford Demographic Information

Before we could begin our analyses of the two towns, it was important for our class to understand the specific demographic information and changing population dynamics and their relation to examining sprawl in Hanover and Hartford. The following chart represents this information from the 2005 United States Census Bureau.

Table ii. 1 - Summary of Hanover and Hartford Demographic Information

	Hanover		Hartford		National
POPULATION					
Total Population	11,156		10,367		299,398,484
People in labor force (age 16+)	5,470	54.90%	5,587	67.80%	63.90%
Unemployed		2.60%		2.70%	4.50%
Per Capita Income	$30,393		$22,792		$21,587
Median Household Income	$72,470		$51,286		$46,326
Average Family Size	2.96		2.83		3.14
Families living below the poverty level		0.60%		5.30%	12.60%
People with bachelors degree or higher	77%		32.40%		24.40%
LAND					
County	**Grafton**		**Windsor**		
Total Area (square miles)	49.1		45.15		.
HOUSING					
Total housing units	3,109		5,493		124,521,886
Housing units per sq mile	79.45		121.7		.
Housing units per acre			5.26		.
Occupied housing units		94.70%	4,509	66.60%	91%
Owner-occupied housing units		66%	3,002	33.40%	33.80%
Renter-occupied housing units		34.00%	1,507	17.90%	9%
Single Family Dwellings	2,218				.
Multi Family Dwellings	885				.

The range of occupations for employed Hanover civilians is vast. These statistics above, as well as the fact that only 0.6% of families in Hanover live below the poverty level when the official poverty rate of the United States is 12.6%, shows that most Hanover residents are reasonably well off. The town of Hartford has a slightly higher poverty rate at 5.30%, but this is still well below the national rate. Although Dartmouth is a major employer for both Hanover and Hartford, the annual per capita income of Hartford residents is $22,792, almost $10,000 less than the annual per capita income of Hanover (U.S. Census Bureau 2000).

While Hanover has historically grown slowly relative to the Upper Valley, during the 1990s the resident population of the town increased 23.6% (Hanover Master Plan 2003, 7.3). In the last two out of three decades, in-migration has been a dominating force in accounting for this increase. In 2000, only 38.5% of Hanover population over 5 had lived in the same house in 1995 (Hanover Mast Plan 2003, 7.4). In Hartford, the largest net population increases have occurred over the past three decades, increasing in population by 60.1%, far above the growth experienced by Windsor County, or the state of Vermont (Hartford Master Plan Population 2006, 48). In-migration drove this increase, accounting for 60.3% of the population increase from 1990-1999 (57). However, Hartford's relative growth in the 1990s was below that of Hanover (53). Population increases via in-migration are accommodated by the construction of new homes and roads to service them.

More important towards proving the presents of sprawl by citing a rapid increase in population it is also important to notice that much of the new population is from out of state. According to the 2000 census a significant portion of Hanover and Hartford's population have migrated from other states. Between the years of 1995 and 2000 the percentage of out-of-states citizens grew from 17% to 75% in Hartford and from 48% to 73% in Hanover. Both towns exhibit the symptoms of exurban sprawl. They are both experiencing accelerated growth from beyond their borders. The information is summarized in tables ii.2 and ii.3.

Table ii.2- Residence in 1995

	Hartford		Hanover	
Population 5 years and over	9,839	100%	9,776	100%
Same house in 1995	5,575	57%	3,607	37%
Different house in the U.S. in 1995	4,199	43%	5,840	60%
Different county	2,125	22%	4,886	50%
Same state	**421**	**4%**	**236**	**2%**
Different state	**1,704**	**17%**	**4,650**	**48%**
Elsewhere in 1995	65	1%	329	3%

Origin (fact finder 2000 Census info)

Table ii.3- Nativity and Place of Birth (2000)

	Hartford		Hanover	
Total population	10,367	100%	10,062	100%
Native	10,087	97%	9,074	90%
Born in United States	10,006	97%	8,903	89%
State of residence	**2,251**	**22%**	**1,548**	**15%**
Different state	**7,755**	**75%**	**7,355**	**73%**
Born outside United States	81	1%	171	2%
Foreign born	280	3%	988	10%
Entered 1990 to March 2000	108	1%	451	5%
Naturalized citizen	178	2%	441	4%
Not a citizen	102	1%	547	5%

Origin (fact finder 2000 Census info)

GIS Technology and Exurban Sprawl

Several of the sections of this report utilize an analysis known as Geographic Information Systems (GIS). GIS allows us to reference various data to specific geographical locations. The use can then analyze and manipulate that data while maintaining that spatial link. The U.S. Geological Survey (USGS) states, “The power of a GIS comes from the ability to relate different information in a spatial context and to reach a conclusion about this relationship…A GIS, therefore, can reveal important new information that leads to better decision-making" (USGS 2007, 1). Another powerful benefit of GIS is that the element of time can be included in a geographic analysis. Mapping change over time can be used as a chronicle of past occurrences; also, it has great currency as a predictive tool. GIS is a means for the creation of maps and other visual representations of data, but it is also used to collect and disseminate information across political and geographic boundaries. GIS is a powerful decision-making tool and a powerful educational tool as well.

GIS has a long history of use in examining future growth and its effects. For example, Woods Hole Research Center has used GIS technology to predict the increase of road mileage on Cape Cod and to asses the impact of that growth on water quality and habitat degradation (Stone et al. 2005). In fact, this report can be seen as an archetypal application of GIS in relation to sprawl: it takes the predicted growth of a certain characteristic and applies that growth to a number of underlying conditions. In many ways, the work of Woods Hole is similar to our own.

In this report, GIS is used to relate data from such disparate fields as zoning regulations, forest fragmentation, water quality and agriculture use. GIS allowed us not only to model future growth under the continuation of current conditions but also under a set of various hypothetical conditions. Comparison across these hypotheticals allowed us to evaluate the effects of a number of potential planning decisions made by both Hanover and Hartford.

The background presented here about the land-use history, population, and methodology helped to guide our study of land-use in Hanover and Hartford.

EXECUTIVE SUMMARY

Section 1 - The Economic Implications of Sprawl

Chapter 1.2 - *Examining the Costs and Benefits of Open Space and Working Landscapes*

In order to understand the economic impact that sprawl has on Hanover and Hartford, we created a framework for identifying costs and benefits of maintaining open space in each town. This was done using two techniques: land valuation and Cost of Community Services (COCS) studies.

Land valuation attempts to put a value upon open space, first by measuring what people actually pay to use—or protect—that open space and then measuring how people feel about the relative importance of protecting open space. A COCS study, on the other hand, measures how much money each additional acre of residential development costs a municipality in increased infrastructural costs relative to how much property tax revenue each additional acre of residential development may contribute. This measure is repeated for each acre of commercial and industrial development, as well as for open space and farmland, in order to determine which type of land-use is more profitable to the municipality.

The methodology we reviewed for valuing open space in Hanover and Hartford indicated that any comprehensive study should examine three different factors: recreational expenses, survey and focus group data, and finally expenditures toward the purchase of conservation easements. By examining both the objectively verifiable evidence and the emotional values indicated by these three factors, an effective valuation of Hanover and Hartford's open space should be possible.

Though conducting our own COCS study for the area was unfeasible, examinations of the studies that had been conducted for towns in the region—such as Deerfield, MA and Meredith and Lyme, NH—showed that open space/farmland had a favorable balance of income and expense compared to residential development.

Finally we undertook a GIS study of various development scenarios in Hanover and Hartford and examined each scenario's impact on agricultural resources in both towns. GIS allowed us to create accurate models of each town's agricultural resource base, as well as its current growth. This analysis, known as build-out, allowed us to compare low density development and clustered development scenarios to a base scenario using the current zoning ordinances. This comparison illustrated the different impacts of each scenario on agricultural resources and the dramatic increase in protected open space under the cluster development scenario.

Recommendations:

- **Both towns should undertake both comprehensive land valuation and Cost of Community Services studies to determine the relative importance of open space and agricultural lands and their economic viability.**
- **Policies that promote clustered development along existing roads, especially in the rural areas of both towns, should be implemented.**
- **The establishment and the regular upkeep of a comprehensive GIS database are integral to providing concrete data regarding rural growth. Both Hanover and Hartford should use these databases to create build-out analyses at regular intervals in order to evaluate growth management policies.**

Chapter 1.3 - ***Market Solutions for Protecting Farmland and Open Space***

After investigating the value and development prospects for open space areas in Hartford and Hanover, we examined various market-based solutions that would allow for the protection of farmland and open space in both towns.

First, we examined the creation of a market for development rights through the use of a Transfer of Development Rights (TDR) program. TDR programs use government action to create markets for the rights to develop land. These rights, however, are not tied to a specific piece of land, and therefore can be used to transfer development from certain properties to other properties. TDR programs are often used to guide development away from lands that are then protected as open space.

Since TDR programs create an economic market for development rights, they should more efficiently allocate development than other programs for protecting open space. TDR programs, however, require careful set-up in order to produce an efficient market. We examined several model TDR programs—those in Montgomery, MD, South Middleton Township, PA and Williston, VT—in order to better understand the process, goals and methodology of TDR program implementation. We then used the lessons of these programs in the context of Hanover and Hartford to define the parameters of future TDR programs for each town.

Markets for development rights are created through the action of municipalities. Complementary to this, existing agricultural markets can be encouraged to create advantages that protect farmland. One way to do this is through the formation of farming or forestry cooperatives. Cooperatives are mechanisms by which a number of small farmers or foresters join to pool their resources, manage their land and sell their goods cooperatively, thereby creating an economy of scale and leveling the playing field with larger agricultural operations.

The major advantages that an agricultural cooperative brings to its members include decreased infrastructure costs, increased marketing power and the ability to hedge against unforeseen events such as poor harvests. A number of preconditions, however, must be met for viable cooperatives to exist. Forestry cooperatives function best when many small landowners can be brought together, therefore minimizing redundancy in infrastructural investment. Farming cooperatives require both a sufficient amount of land and equity as well as interlocking and complementary array of products produced by the member farms. Using these principles, we examined the state of farming and forestry in Hartford and Hanover in order to produce a determination of the potential viability of farming and forestry cooperatives.

- **Hanover and Hartford should consider the formation of TDR programs, involving community and developer feedback, land valuation studies, state and regional involvement and community education programs in order to create the most efficient and sustainable market possible.**
- **Hanover and Hartford farmers, especially maple syrup, dairy and meat producers should form a cooperative, both at a local or county-wide level, in order to pool resources, share machinery and make more cost-effective bulk purchasing possible.**
- **Both Hanover and Hartford should strengthen their forestry economies by extending the Current Use tax program to as many lots as possible, and by**

encouraging forestry cooperatives using both public and privately owned parcels.

Section 2 - Environmental Issues of Exurban Sprawl

Chapter 2.1 - *Fragmentation*

One way that exurban development impacts the working landscape of agricultural land and productive forests is by causing fragmentation. We looked at how exurban sprawl fragments forests primarily through low density residential development and the construction of roads. We then looked at the ecological implications of fragmentation which include the decrease of suitable habitat and increase in invasive species. We specifically use the ovenbird as a species to indicate overall habitat quality, using its species-specific characteristics to perform an analysis of core habitat in Hartford. By performing a GIS analysis of Hartford we were able to determine current areas of core habitat and how core habitat may be affected by three different development scenarios: the current zoning regulations, the proposed ten acre zoning, and cluster zoning. In this analysis we used both a 152.4 meter (or 500 foot) buffer around roads and structures to find general core habitat areas according to the master plan as well as an ovenbird species-specific buffer of 100m. Through our analysis we find that clustering housing into higher density development would result in the preservation of the greatest amount of Hartford's core forest whereas the current zoning regulations would result in the least amount of remaining core habitat under full build-out.

- **Our recommendation is that if the towns of Hanover and Hartford wish to conserve the existing areas of core habitat in order to prevent the effects of**

forest fragmentation, then further development should be clustered into higher densities along existing road networks.

Chapter 2.2 - *Water Quality*

Upper Valley residents consistently rank water quality as an environmental issue of high concern. We looked at the impact of exurban development on water quality and related it to Hanover and Hartford through sampling and GIS analysis. Our research shows that surface water quality is affected by development through the use of road salt, agricultural fertilizers, the presence of septic systems and runoff due to the increase of impermeable surfaces such as roads. Ground water quality is affected in a similar way, but the issues of impermeable surfaces and runoff are more prevalent and thus led us to focus on surface water in Hanover and Hartford. The increase in structures and concurrent increase in roads has been shown to negatively impact water quality by increasing the amount of dissolved solids in surface waters. We conducted water sampling on local watersheds to see if this is the case in Hanover and Hartford. By testing the conductivity of the water and using our sampling results in a GIS analysis of Hanover and Hartford watersheds for the structure and road density of each watershed, we determined that watersheds with a greater presence of exurban development have decreased water quality when compared to watersheds with less development. However, the average conductivities of most watersheds are well within the range of acceptable water quality as defined by the EPA, and so continued monitoring should be adequate to maintain the high level of water quality in Hanover and Hartford.

- **The towns of Hanover and Hartford should continue to monitor water quality, and focus specifically on the watershed scale in order to prevent exurban development from impacting local watersheds.**
- **Watersheds with extremely high water quality should be protected from further development if at all possible. Such watersheds include Tigertown stream and Jericho Brook in Hartford. Ways to protect these watersheds include changing zoning regulations to favor clustered development in watersheds that already feel the presence of development. As well, land-use decisions should be made that take into account entire watersheds regardless of the presence of political boundaries.**

Section 3 - The Social Impacts of Land-use

Chapter 3.1 – *Socioeconomic Diversity*

While the social implications resulting from land-use decisions are vast, we focused on a few relevant issues regarding land-use in Hanover and Hartford. First, we examined how land-use affects socioeconomic diversity and how that relates to rural culture in the Upper Valley. We found that residents of Hanover and Hartford are concerned with increasingly high renting and purchasing costs associated with land. The high costs will eventually lead to less socioeconomic diversity, creating an area where only the wealthy may afford land ownership. Middle and lower income residents will be pushed farther away and as a result, must commute greater distances. Maintaining socioeconomic diversity is important to Hanover and Hartford because diversity is directly tied to rural culture. The aforementioned middle and lower income residents tend to be the farmers and small business owners, people that provide services essential to the region's culture.

Chapter 3.2 - *Land-use Survey of Hanover, NH and Hartford, VT*

Second, we conducted a survey of Hanover and Hartford residents to further our understanding of relationships between land-use and society. We had participants complete a short questionnaire. We gained insight into the social dynamics surrounding land-use, conservation of the working landscape and the rural culture in Hanover and Hartford.

Chapter 3.3 – *Analysis of Survey Data*

We conclude our sections by examining land-use relationships and presenting our findings. Residents of the towns indicated that the working landscape and its relationship to preserving rural culture were important. Both towns also found the conservation of open space to be important. These two rankings are reflections of how people tend to prefer land-use in the Upper Valley, which is maintaining the current rural state. These views are reflected in the Master Plans of the two towns. Furthermore, residents of both towns ranked social issues of land-use of lesser importance than environmental issues. However, these two towns are inevitably going to continue to grow because of Dartmouth College and DHMC. In order to preserve the environment and the open space, Hanover and Hartford need to address socioeconomic diversity and affordable housing.

Recommendations:

- **Future Master Plans should continue to place high importance on conservation of the rural zones and making the working landscape a priority.**
- **Hanover and Hartford should provide high density affordable housing.**

- **Hanover and Hartford need to do further research on where to place this affordable housing.**
- **We recommend that Hanover and Hartford hold focus groups to brainstorm other ways to conserve the working landscape.**

SECTION 1:

THE ECONOMIC IMPLICATIONS OF SPRAWL

1.1 Introduction

In this chapter, we examined the economic dimensions of exurban sprawl, especially its effects on open space and agricultural landscapes. This section is organized into three chapters. In the first, we examine various frameworks for identifying costs and benefits of maintaining open space in each town. This was done using a number of techniques including land valuation and Cost of Community Services (COCS) studies. These techniques determine the costs and benefits both to citizens and to town governments of maintaining or developing open space. Finally, the use of a build-out study can compare the impacts of various development scenarios on a number of different resources in both Hanover and Hartford. In this report we specifically examine the preservation of working landscapes as well as the areas that could most profitably support the expansion of those landscapes.

After investigating the value and development prospects in Hartford and Hanover, we examined various market-based programs that would allow for the protection of farmland and open space. These approaches are examined closely in the second chapter: *Market-Based Solutions for the Preservation of Open Space*. First, we examined the creation of a market for development rights through the use of a Transfer of Development Rights (TDR) program. TDR programs are often used to guide development away from open space or agricultural lands. Complementary to this, existing agricultural markets can be manipulated in order to create advantages that protect farmland. One of the ways to do this is through the formation of farming or forestry cooperatives. We examined the state of farming and forestry in Both Hartford and

Hanover in order to produce a determination of the viability of farming and forestry cooperatives.

Our section on the economic dimensions of exurban sprawl concludes with our recommendations to facilitate the preservation of open space and agricultural resources in both Hanover and Hartford. Our hope is that these recommendations will guide each town in making decisions that will limit development on, and guide development away from open space, agricultural and forestry lands.

1.2 – Examining the Costs and Benefits of Open Space

1.2.1 – Land Valuation

Introduction

Presumably simple land use decisions often hide a number of complications. Both long term costs and non-traditional sources of value are routinely ignored by municipal planners. For example, many people find intrinsic value in preservation - a fact which is often ignored. Because of the complex nature of preference, evaluating phenomena like sunsets or rustic living is often daunting. An economic evaluation of the value of open space is necessary to identify the most important factors in evaluating open space. By investigating the opportunity costs inherent in supporting open space and the value expressed in surveys and land easements we will see that seemingly complex values can be simplified. It is the goal of this chapter to help make some of those values more concrete and by pointing out a few important values in Hanover and Hartford validate another way at looking at evaluating open space.

Methodology

To aid in the classification and identification of the value of open space within Hanover and Hartford we used the framework from the article *Preservation of Open Space and the Concept of Value* by David Berry. After reading several essays on land valuation we chose Berry's method because it is able to distill a number of variations on value into being simply qualitative or quantitative. Berry writes, "Although it is not possible to prepare an exhaustive list of these values, six seem particularly important: *utility, functional, contemplative, aesthetic, recreational and ecological*" (Berry 1976, 114). These values are defined below:

- *Utility Values* are those in which the value of open space is expressed as a trade-off between acres of open space or visits to the open space on the one hand and other goods or services on the other hand…In short, the utility value of the open space is measured by what is traded off to obtain it or to make visits to it. (Berry 1976, 115)

- *Functional Values* are those in which preservation of open space is an effective means to some end involving natural process such as protection of water quality, minimization of soil erosion, protection of the public health, and aversion of natural hazards, certain or uncertain. (Berry 1976, 116)
- *Contemplative and Aesthetic Values* are those in which protecting a certain landscape as open space (including scenic agricultural land) is important because people appreciate and respond to beautiful scenery… (Berry 1976, 117)
- *Recreational Values* are those in which land preserved as public open space provides places where people can relax, play, engage in physical activities, get away[s] from urban pressures, return to nature, seek solitude, and so on. (Berry 1976, 118)
- *Ecological Values* are those in which locally representative or locally unique plant and animal communities or associations are felt to be valuable in and of themselves and therefore ought to be protected in open space…they are concerned with the well-being of other forms of life. (Berry 1976, 118)

All of these values are deeply interconnected and their importance varies between people. To create a means of quantifying these values, Berry divides them into two interpretations of value: "objectively verifiable" evidence of value and culturally shaped "emotions and feelings" (Berry 1976, 115-118). These categories correspond to the usual analysis categories of quantitative and qualitative value. Utility, functional and recreational values can be classified in a quantitative sense while the contemplative, aesthetic and ecological values can only be captured qualitatively. This separation is at the heart of why open space is often undervalued. Many studies simply evaluate the potential monetary—quantitative—value produced by the land and do not consider the opportunity cost of preserving and utilizing the land.

Opportunity Costs

The value we place on open space can be identified as the opportunity cost of using open space. An opportunity cost is the cost of not performing an action. Every time we perform an action we do so because we prefer it to a number of possible alternative actions. The benefits of those forgone actions can be thought of as lost opportunities—opportunity costs. In our case the opportunity costs are the amount of money that someone donates to a land trust or the other resources they allocate to support open space or agricultural areas. This time and money that has been invested in open space could have been utilized elsewhere. The simple fact that someone is willing to forego other amenities to enjoy the landscape indicates that they place a value on open space at least equivalent to those other foregone actions. Opportunity costs are most often captured as a monetary value, as in the example above. They can, however be captured through purely qualitative data as well. It is often difficult, however to fully estimate the many ways in which open space is supported through feelings and actions, and therefore discovering qualitative opportunity costs can be quite difficult as well. Both land donations and surveys are an acceptable way of estimating this value and we explored both of those options.

Objectively Verifiable Evidence and Emotional and Feeling Value

Now that we have classified values of open space into quantitative and qualitative values, it is possible to locate other values that may have been overlooked. These often overlooked sources of value can aid us in drawing some interesting comparisons between Hanover and Hartford. A full comparison would involve the capturing the spending habits in all parallel industries. To demonstrate the methodology we made the comparison with just one industry: New Hampshire and Vermont Fish and Game Departments. Fish and Game Departments are maintained at the state level. To make a Hanover, Hartford comparison we were forced to prorate the department revenues by population. Prorating allows us to determine the proportion of total value that is derived from the two towns. Prorating by population involved calculating the percentage of citizens from each state that lived in either Hanover or Hartford respectively. We then assumed that the ratio of statewide value to town-wide value is the same as the ratio of statewide population to town-wide population. The prorating throughout this chapter is based on the population percentages in Table 1.1 below.

Table 1.1 – Census 2000 Population Data for Hanover and Hartford

	Hanover, New Hampshire	Hartford, Vermont
State Population	1,235,786	608,827
Town Population	10,850	10,367
% of State	0.88%	1.70%

(Census 2000)

Quantitative Value of Recreation in Hanover, New Hampshire. Fish and Game Departments record a quantitative value related to open space because every customer who purchases a permit is paying to enjoy the land. By seeing what people are willing to pay for activities like fishing, hunting and bird watching, we acquired an estimate of how much they value the space in which they perform these activities. An Upper Valley citizen may spend his or her income in many different ways and so this revenue is a direct indication of the value people place on open space. Table 1.2 below contains data collected from the New Hampshire Fish and Game Department showing the revenue paid to New Hampshire Fish and Game by anglers, hunters and wildlife watchers across the state. The interesting part of this figure is that the same people who spend the dollar equivalent of what they value in the land generate further value for others.

Table 1.2 – Economic Impact of Hunting, Fishing and Wildlife Watching

Recreation	Spent
Anglers	$164,643,000
Hunters	$71,386,000
Wildlife Watchers	$342,940,000
NH Fish and Game Budget	$2,900,000

(New Hampshire Fish and Game Department)

It is because of linked values like these that it is important to conduct a more in-depth analysis of land value. When we prorate the sum spent by anglers, hunters, wildlife watchers and lodgers, we can estimate that these people value open space in Hanover at $6.6 million. As described above, this prorating involves summing these amounts spent and then multiplying that sum by the population ratios in Table 1.1. Even that prorated value is many times the budget granted to the entire New Hampshire Fish and Game department. Therefore, the generated value of the land is greater than what the government offers to sustain it. This value is something not often taken into account in land valuation, even though it dwarfs the more easily obtained budget of the Fish and Game department. To ignore these values risks the destruction of value and sources of revenue. Because prorating is not an exact science, our finding is by no means a full evaluation of open space value in Hanover. It does, however, serve as a means for comparing land valuation between prorated values.

Quantitative Value in Recreation Hartford, Vermont. We captured the quantitative value placed on open space in Hartford using the same method used in Hanover. Figure 1.1 contains a breakdown of the revenue streams which support the Vermont Fish and Wildlife Task Force. The revenue streams we investigated were boat registration as well as duck hunting stamps and hunting license fees.

These sources combined total to $5.6 million, and after prorating this value with population we estimate that the people of Hartford value recreation at $96,000. Once again, this value was calculated by summing the contributions from boat registration, duck stamping and license fees and then multiplied by the ratio between the population of Hartford and the population of Vermont. This is far below the value estimated for Hanover. It is hard to believe that Hanover citizens value recreation on open space over fifty times more than the citizens of Hartford. These calculations show that people often value items at the price they are willing to pay for them, but that this value can also be an oversimplification.

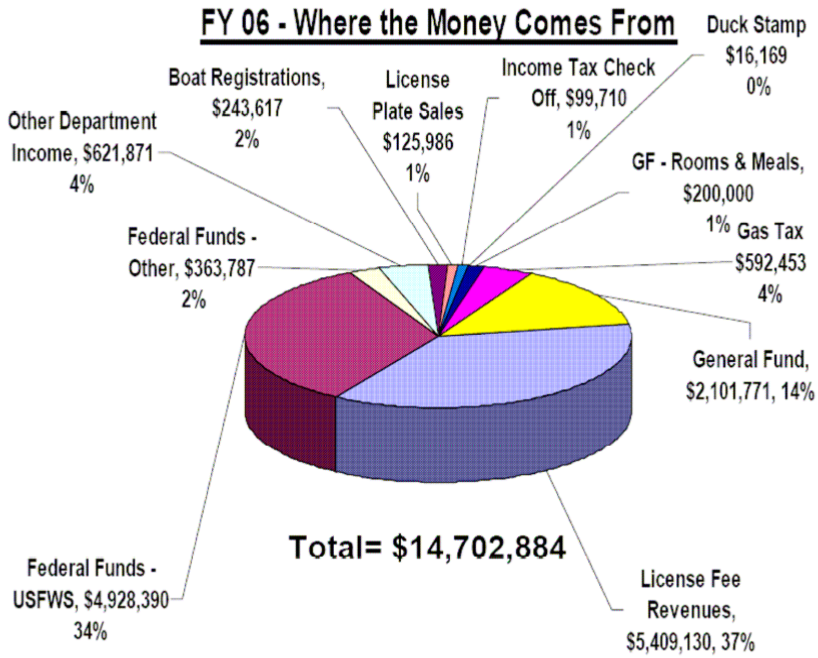


Figure 1.1 – Vermont Fish and Wildlife Task Force Funding
(Fish and Wildlife Funding Task Force 2007, 2)

There are many things that explain why the amount of money spent on fish and game in Vermont differs from what is seen in New Hampshire. Hunting and fishing may be more enjoyable in New Hampshire. The state of Vermont may have stricter licensing laws. Without further itemization of license fee revenues it is not possible to identify which hunting licenses are being purchased and at what cost. The only valid conclusion that can be made is that there is quantitative value placed on utilizing open space. Without considering the qualitative value placed on open space the town risks overlooking further sources of revenue and value.

Qualitative Values through Questionnaires and Easements

The second way we investigated hidden values was by capturing emotional and feeling values. These are the qualitative values placed on the land. These values can be estimated in two ways: monetary support for preservation and through surveys/focus groups.

Land Easements. The ideal way to discern the qualitative value of emotional inclinations toward open space would be to determine what people are willing to pay to satisfy those feelings. This cost, however is very different from the opportunity cost paid to enjoy the open space. In this case, the value was found in what could have been done on the land, whether it was fishing, hiking or hunting. The emotional feelings value is the positive feeling that comes from knowing that the land is conserved. This value is approximated in the amount anyone is willing to pay to support conservation of land to which they are unconnected. This altruistic support for open space is most easily observed in the private support of land easements. (R. Howarth, personal communication, May 7, 2007). Easements are often handled by the principal landowner, there are also land trusts whose mission it is to raise funds towards placing easements on property. It is not often how much land is conserved but only how much private money goes towards supporting land easements.

One organization which accepts private donations is the Upper Valley Land Trust. Many such trusts service several towns, and in turn many towns are serviced by multiple trusts. To make the data comparison the most manageable we exclusively used data from the Upper Valley Land Trust. Table 1.3 contains the land trust's revenue and expense report from January 2005.

Table 1.3 – Upper Valley Land Trust Revenue and Expenses: Fiscal Year Ending June 30, 2005

Revenue		Expenses	
Contributions	$595,703	Program Services	$988,853
Government Grants	$683,682	Administration	$210,792
Program Services	$64,650	Other	$26,876
Investments	$88,185	Total Expenditures	$1,226,521
Special Events	$7,264		
Sales	$0		
Other	$97,990		
Total Revenue	$1,537,474	NET GAIN/LOSS	$310,953

(Upper Valley Land Trust)

To date, the land trust supports over 300 parcels and more than 30,000 acres. In the year 2005, $595,703 was collected to support the conservation of land. It is not important whether or not that money was donated directly to newly acquired lands in 2005. Donations are evidence of support for the activities of the fund. Currently the Upper Valley Land trust has easements on approximately 359 acres in Hanover and 416 acres in Hartford (S. Cavin, personal communication, May 29, 2007).

This means that 1.2% of the protected acreage is located in Hanover and 1.4% in Hartford. After prorating donations ($595,703 in total contributions) based on acreage percentage a value on easements is found to be $7,128.58 and $8,260.41 for Hanover and Hartford respectively. These numbers are just one component of the overall support made through easements. A total representation of the qualitative value of open space could be found by repeating this analysis for all the privately supported funds which support open space preservation. The qualitative value of open space is recognizable in the fact that people are willing to pay for its continued existence.

Questionnaires and Focus Groups. In 1999, a questionnaire called “Guiding Growth in Rural Hanover” was sent out to all rural landowners in Hanover to further understand the public’s impression of current and future growth in the town. A total of 804 properties (roughly 1/3 of Hanover households) were mailed a questionnaire. The questionnaire was written to take 45 minutes to an hour to complete and 523 of the questionnaires were returned. The questions focused on rural character, transportation, commerce and village areas, open space and demographics. After all of the surveys were reviewed, it was determined that the key element to preserve in the face of growth was “Hanover’s Rural Character" (Town of Hanover 1999). In the *Rural Character Descriptors* section of the Survey preferences of various aspects of rural character are weighted against one another (Town of Hanover 1999).

Questionnaires may tell us that a topic is important and tell us the relative importance of items compared to other items within the survey. For example, even if we don’t know how important concepts such as “scenic views” or “dark nights” are, we can tell from the survey that they are more valued than hiking. If we can determine how much the average citizen spends on hiking equipment we could then make an educated guess of how much the average citizen actually enjoys views and the night sky.

After speaking with the Hartford planning office, we discovered that the town preferred to conduct focus groups instead of town wide surveys to gather public opinion for their latest Master Plan revisions (L. Hirshfield, personal communication, April 30, 2007). Even when dealing with qualitative values, like those placed on scenery and rural character, it is possible to make informed estimates of quantitative value based on preferences (R. Howarth, personal communication, May 7, 2007). Focus groups helped Hartford target certain audiences and helped Hartford compile more detailed responses. Although these methods are slightly different, the outcomes are the same. The Hartford Planning Board’s focus groups are concerned with the same issues as those posed in the Guiding Growth survey and no significant difference in preserving rural character has emerged.

This project’s survey is another indication of the qualitative value placed on open space. Numerous respondents were in support of increasing open space and other aspects of rural living. Though this will be discussed in greater depth in section three, we also conducted a survey of both Hanover and Hartford residents. Our survey examined both the qualitative and quantitative value that the citizens of each town placed on open space and working landscapes. For example, we asked residents both to rank the relative importance of various rural qualities (capturing qualitative value) and to say how much extra they would pay for locally produced farm and forestry products (capturing quantitative value). These results further strengthen the perception that qualitative values are of high importance in the towns of Hanover and Hartford.

Conclusion

There is an intrinsic value associated with preserving open space, though it is not often apparent. By breaking those values into quantitative and qualitative categories, we were able to compare and develop a concrete means of valuation. With enough information, it is possible to make informed decisions about preferences and the areas of most value. Using the "Guiding Growth in Rural Hanover" survey as a baseline, many qualitative values may be calculated. By understanding the comparative values expressed in the survey, then by generating information on how much people are willing to pay for the various quantitative items on the survey, a number value could be assigned for the qualitative values. Armed with the knowledge that there may be comparable value between hiking and living in isolation, a planner can more effectively evaluate incentives and understand the drivers behind citizen behavior with regard to land use. In our analysis it appeared that the citizens placed a great deal of value on recreation. The recreation value of open space generated a lot of revenue. Identifying this kind of value presents a strong case for preserving open space for continued outdoor recreation and is a good indicator of where to investigate future sources of revenue and identify sites of preservation. At the same time even if the value placed on fish and game in Hartford seemed artificially low, it was still a good indication that Hartford may not want to invest the same amount of resources in recreation as Hanover for fear of low utilization.

1.2.2 – Cost of Community Services Studies

Once a municipality has used land valuation to come to a determination of how worthwhile its open space lands are, town government must still attempt to decide whether or not those open space lands are more valuable than the property taxes brought in by residential development. This comparative value between different land uses is the main focus of this chapter, which focuses on Cost of Community Services (COCS) studies.

In examining the costs and benefits of open space, people often make the assumption that more development leads to a larger and stronger tax base. They believe that open space is not contributing to the tax base as much as it would if it were at its “best use” (developed commercial or residential holdings). Believing this, many towns have advocated converting open space into more potentially profitable uses. Indeed, according to a Vermont report, *The Tax Base and the Tax Bill*

> most towns, confronted with the rising cost of services, compete for development to increase their tax base. This competition conflicts with the planning process. Towns are forced to waive zoning requirements, make improper siting decisions, and, in general, pursue short-term objectives at the expense of long-term goals. (AFT 1992, 3)

A COCS study may be useful for towns wishing to further investigate this assumption. A COCS study is “a useful way of viewing a town's financial records to find out how much a community is spending to provide services on a land use basis. [The study is] a snapshot of land use relationships based on current costs and revenues” (AFT 1992, 3). Therefore, the COCS study is very helpful—particularly for small towns—in helping determine the economic impacts of land use planning. The studies themselves are cost effective, as they are designed so that the town does not have to bear a large financial responsibility in conducting the study. Often, towns can contract with a third party, Much such as the American Farmland Trust or other agencies which provide support for rural development or farmers, though in some cases a municipality may have to assume the burden of conducting the study itself. According to the American Farmland Trust (AFT), “COCS studies are designed for grassroots use by local officials, community boards and citizens themselves” (AFT 1992, 3). This makes the COCS study very conducive to land use planning for small communities. There are five steps to conducting a COCS study:

> First the scope of the study is determined, land use categories are identified, and [data] is collected regarding local revenues and expenditures. Revenues and expenditures are then divided and allocated to the land use categories that have been identified. Finally, the data is analyzed and revenue-to-expenditure ratios calculated in order to determine which land uses are the most cost efficient. (ENVS 50 Students 2001, 43-44)

COCS studies have helped towns make a comparative determination of the value of various land uses, specifically open space and residential. They have also led these towns to realize a number of surprising conclusions, conclusions which undermine the “best use” assumption.

Cost of Community Services: Case Studies

While COCS studies are affordable at the level of a town or state, they are well outside of our means. Instead, we examined a number of case studies, where COCS studies were conducted on towns in similar situations to Hanover and Hartford. These towns are small northeastern towns located in New York, Massachusetts and New Hampshire. Largely rural municipalities, they form the outermost ring around the major area cities of New York and Boston. One of the towns we use as a case, Lyme, NH, actually borders Hanover to the north. All the towns used in our case study face similar development pressures to Hanover and Hartford, and their experiences can serve as an effective template for the experiences of Hanover and Hartford.

Our first cases come from an AFT COCS study submitted to the Massachusetts Department of Food and Agriculture on three Pioneer Valley towns: Agawam, Deerfield and Gill, MA. These towns, like Hanover and Hartford, have experienced loss of agricultural land caused by high amounts of growth and soaring property values. The COCS studies for these towns clearly demonstrate the misconception that development will strengthen the tax base and economically benefit the towns. These towns all suffered from the pressures of development, and with the use of the COCS study were able to determine that their open space was more valuable to them as open than as developed land. Given their similar nature, it is likely that Hanover and

Hartford would find similar results if a COCS study was conducted. This could help them weigh the cost and benefits of open space and perhaps give planners a solid argument to preserve open space as the pressures of development continue.

As the AFT COCS study stated, “the premise of American planning is the conversion of farm and open lands to developed uses. This has been especially true in the Northeast” (AFT 1992, 2). The residents of Deerfield, Gill and Agawam have found that the AFT finding was certainly true for them: from 1952 - 1972, 80,000 acres were removed from agricultural production. Rapid growth, high property values and limited planning have further threatened the area’s important natural resources (AFT 1992, 4). The construction of Interstate 91 “unified the valley from Vermont to Connecticut and gave commuters easy access to employment centers. Low-density sprawl encroached onto valuable farmland, and property values soared” (AFT 1992, 4).

However, with the help of the COCS study these three towns were able to determine that in their case “[while] residential development increases the local tax base, it does not pay for itself. These towns paid more on residential services than they received from residential revenues” (AFT 1992, ii). When the costs and revenues derived from open space and farmland were determined, however, the AFT found that “while [they] do not raise nearly as much gross income as developed land uses, their need for services is so modest, their net effect on the tax base is a surplus” (AFT 1992, ii). Revenue and expense values were taken from municipal and state documents and “identified as at least one of four types: Property Taxes, State Aid, Local Receipts, and Free Cash. Four broad categories were determined to distribute them by land use: Residential, Commercial, Industrial, and Farm and Open Land” (AFT 1992, 11). The results of the COCS studies analysis of the distribution of taxes is shown in Table 1.4.

Table 1.4 – The AFT COCS Study for Agawam, Deerfield and Gil, MA

Agawam	Revenue	Expenses	Balance	Ratio in Dollars
Residential	27, 437, 004	28, 772, 332	(1, 335, 328)	1: 1.05
Commercial	3, 928, 986	1, 857, 633	2, 071, 353	1: 0.47
Industrial	2, 113, 240	855, 434	1, 257, 806	1: 0.40
Farm/Open	377, 328	118, 583	258, 745	1: 0.31
Deerfield				
Residential	3, 459, 764	4, 025, 367	(566, 603)	1: 1.16
Commercial	549, 074	229, 367	319, 672	1: 0.42
Industrial	630, 099	214, 481	415, 618	1: 0.34
Farm/Open	207, 615	61, 021	146, 594	1: 0.29
Gill				
Residential	659, 681	758, 129	(98,448)	1: 1.15
Commercial/Industrial	169, 089	73, 253	95, 836	1: 0.43
Open/Farm	115, 010	44, 038	70, 972	1: 0.38

(AFT 1992, 19)

As shown on the tables, residential areas cost the municipality, as they cannot pay for themselves. Commercial and industrial areas tend to pay for themselves, costing fewer than fifty cents for every dollar raised in tax revenue. Open or farmed lands, however, are the least expensive land use in terms of ratio of cost to revenue. These results were replicated across New York and Connecticut towns in studies conducted by the AFT, as presented in Table 1.5.

Table 1.5 – The AFT COCS Study for Beekman and North East, NY and Hebron, CT

	Residential	Ind./Commercial	Open/Farm
Beekman, NY	1: 1.12	1: 0.18	1: 0.48
North East, NY	1: 1.36	1: 0.29	1: 0.21
Hebron, CT	1: 1.06	1: 0.42	1: 0.36

(AFT 1992, 20)

In this case, Beekman appears to be the only exception to the trend. Its industrial and commercial lands actually cost less per dollar of revenue generated than its farm and open lands. Regardless, there is an existing trend that can be seen across these six northeast towns: residential areas do not pay for themselves in terms of tax dollars, while open space and industrial and commercial land use do. Often, open space or farmed areas achieve the highest percent return.

Additionally, this trend can also be seen in a study of eleven towns in New Hampshire, presented below in Table 1.6.

Table 1.6 – Cost of Community Services Studies in New Hampshire

Community	Residential Cost per $ Income	Commercial Cost per $ Income	Open Space Cost per $ Income
Grotton	1.01	0.12	0.79
Sutton	1.01	0.40	0.21
Lyme	1.05	0.28	0.23
Freemont	1.04	0.94	0.36
Deerfield	1.15	0.22	0.35
Merideth	1.06	0.48	0.29
Alton	0.92	0.54	0.52
Stratham	1.15	0.19	0.40
Peterborough	1.08	0.31	0.54
Exeter	1.07	0.40	0.82
Dover	1.15	0.63	0.94

(ENVS 50 2001, 44)

Again, we see a general trend where open space pays for itself, whereas in all but one case residential development is unable to do so. Finally, the Environmental Studies 50 report written in the spring of 2001 states that:

> The results of the COCS studies completed in these New Hampshire towns, as well as over sixty similar studies performed in many other parts of the country, all show that open space and commercial / industrial land generate more in local tax revenues than it costs local governments to provide services to them. (ENVS 50 2001, 45)

Though these results are powerful, it is important to acknowledge the limitations of the COCS study. COCS studies do not account for revenue that is generated from non land-use sources. "This becomes problematic when the size of a community may impact future revenue from public and nonpublic sources for specific projects such as parks and recreational activities" (Mackinac Center, 1998). Additionally because COCS studies represent a snapshot of the community at a given point in time they are not dynamic and do not account for future development (Mackinac center, 1998). "As communities grow, certain industries and businesses may be attracted to the community and increase future revenue flows" (Mackinac Center, 1998).

Because a COCS study does not account for such revenue it is somewhat limited in the information it provides about the overall revenues and costs to a town that further development brings.

Nonetheless, from these case studies it must be concluded that open space is certainly a better option on a per dollar basis than residential properties. Also, it competes with commercial properties in terms of what generates the most per dollar income.

Why Is Residential Development So Expensive?

One reason as to why residential development is so expensive—perhaps a suggestion to help combat the common development misconception discussed earlier—is that the infrastructural costs of development are largely born on the town as a provider of services while the developer pays little to none of this cost. As Brueckner points out, “The problem is that local tax systems usually require developers to pay only a fraction of the infrastructure costs associated with their projects, which makes development look artificially cheap and encourages urban expansion” (Brueckner 2003, 6). With new residential development comes the cost of extending services such as water, sewer, roadways, road maintenance and the costs of providing for the larger number of children in the schools. The fact that these costs are born largely by the town makes development artificially cheap for the developer who never sees the bill for these services.

Open or farm lands on the other hand have very minimal demand for these services and many times may often lie in a zone where the town is not responsible for services such as water and sewer. Therefore, although property tax revenues are likely much lower from open space lands, these lands add money to the municipality's coffers because they cost little in infrastructural investment. This means that the open or farmed lands may in fact be of more value to the town than residential development, despite residential development's larger property tax revenues.

Fixing Artificially Cheap Development

There are several ways to combat the drain that residential development puts on a town's revenues. According to Brueckner, “The remedy is to levy “impact fees,” where developers are charged for the full cost of infrastructure” (2003, 6). This would in theory slow development as it would make the cost to the developer much closer to the real cost of development. Developers would have to either absorb these costs themselves or pass them on to the homeowner. Either way, infrastructural cost is not born by the town.

Another economic solution Brueckner suggests to combat sprawl and encourage denser development, is to charge taxes on development and commuting. “Internalizing the open-space externality via a development tax would slow urban growth, and imposing congestion tolls to address the second externality would raise the private cost of commuting, leading to shorter commutes and more-compact cities” (Brueckner 2003, 6). His reasoning is that these taxes and tolls would motivate developers and buyers to avoid sprawl by building in areas with preexisting infrastructure and as a result, limit development from spreading over the surrounding area. The development tax is levied at the developer while the congestion toll is aimed at the buyer so that both parties will have to consider the economics of sprawling development.

COCS and its Implications for Sprawl

Despite these suggestions for combating sprawl and the COCS studies that “demonstrate that open space can be an economic asset that helps to contribute to the financial stability of local communities,” this should not be read to say that development will not take place (ENVS 50 Students 2001, 45). While on the one hand “COCS studies further enhance the findings of fiscal impact analyses by highlighting the fact that open space and agricultural land can also generate a fiscal surplus to help offset the shortfall created by residential demand for public services," these same fiscal impact analyses also "document the high cost of residential development and recommend commercial and industrial development to help balance local budgets" (ENVS 50 Students 2003, 45). Therefore, the COCS analyses should not be seen as a way to stop development, but instead as a way to effectively demonstrate the value of open space to the community. This should serve as a deterrent for sprawl.

For towns like Hartford and Hanover, however, where debates on the nature of development expansion and rural character are of major concern to both townspeople and planning authorities, COSC studies would be a major step towards quantifying the effects of various land uses on each town. By putting hard data to various land use scenarios, the towns could move towards quantifying the costs and benefits of development.

1.2.3 – Build-Out Analysis: Evaluating the Costs and Benefits of Future Development Scenarios

Introduction

Objectives. This study is designed firstly to show the various spatial dynamics of several community planning scenarios in the towns of Hanover, NH and Hartford, VT. These scenarios are: a) current zoning bylaws, b) lower density rural zoning bylaws and c) planned residential development cluster housing. By imagining the theoretical maximum amount of development that each town can accommodate under each scenario, a build-out analysis can illustrate future development and allow for a critical evaluation of future development patterns.

Secondly, in order to fully investigate the economic implications of development in open space or agricultural lands, this report illustrates the effect of each development scenario on the major agricultural resources in each town.

Finally, because a build-out study models future development under a number of conditions, it complements the other means of cost-benefit analysis we have already discussed in this chapter. Build-out analysis allows for the calculation of the costs and benefits of certain development scenarios, not just of certain types of development.

Background to Land Use Regulation in the Upper Valley. Both Hartford and Hanover have laid out specific visions to guide growth in their Master Plans. In fact, the visions of both towns are remarkably similar: in Hanover, the Master Plan lays out "a commitment to preserve over the long term the approximate current population balance between the urban areas (three-fourths) and the rural areas (one-fourth)," (Nancy Collier et al. 2003, 2). Hartford's Master Plan envisions "a population balance between rural Hartford (25%) and the areas served by town water and wastewater service (75%)" (Hartford Planning Commission et al. 2007, 46). In order to accomplish this, both towns have set up rural zoning bylaws which restrict development density to a lower level compared to density in more urban areas. In Hartford, these areas are called Rural Lands (RL) 1, 3, and 5, and restrict subdivision to one, three and five acre plots, respectively (Hartford Zoning Regs. 2007, 24-26). In Hanover, rural development is designated by the Rural Residence (RR) zone, in which subdivision is limited to 3 or 10 acre lots (Hanover Zoning Regs. 2006, 15). Rural character is also maintained through the use of Forestry (F) and Natural Preserve (NP) zones, which severely limit development and road construction (Hanover Zoning Regs. 2006, 16-17).

Scope. In each town, we chose a representative subsection for analysis. Each subsection was chosen because it provided a microcosm for the development issues of the town as a whole, issues such as the preservation of rural character and the protection of agricultural resources and the need to balance these qualities with the maximization of development potential.

Methodology

Introduction to CommunityVIZ and Build-Out Analysis. These build-out analyses were performed using the CommunityVIZ GIS software. This software uses the combination of tax parcels and zoning laws to calculate the total development potential for each parcel. More data may be added to this basic information in order to further restrict or enhance development potential in certain areas. Using this data, the program creates a visual representation of a possible build-out scenario for the targeted area. Finally, CommunityVIZ can look at a number of indicators—data layers affected by each build-out scenario—and can determine the comparative effects each scenario has on those indicator layers.

Agricultural Resources. Beyond merely examining the spatial dynamics of each development scenario, this report investigates the effects that each development scenario has on the agricultural resources of each town. These resources acted as the indicator data for the CommunityVIZ software. These resources were delineated by two factors: soils conducive to agricultural use and tax parcels currently being used for agriculture or forestry. These two factors allow for both an examination of current agricultural use affected by sprawl and an examination of the future potential for agricultural use foreclosed by sprawl.

Determining important agricultural soils required merely contacting the planning departments of each town and collecting the corresponding GIS data layers. We obtained soil quality data for the towns from the Hanover Tax Assessor's office and the Two Rivers-Ottauquechee Regional Planning Commission (M. Ryan and P. Fellows, personal community on May 12, 2007).

Determining current forestry and agricultural land use was more difficult. In Hartford, Pete Fellows once again provided data, this time a listing of all the tax parcels enrolled in Vermont's Current Use program.[1] Data on the New Hampshire current use program in Hanover was not available, so instead we used a general survey of land use by parcel. From this survey, we chose the parcels delineated as "farms" or "managed forests" to represent current land use.

The Study Areas.

Table 1.7 – Hartford and Hanover Study Areas: A Comparison

Hartford		Hanover	
Study Area Size (acres):	5901.84	Study Area Size (acres):	9710.1
Area Zoned Rural:	5582.25	Area Zoned Rural:	Rural Residential Only: 6361.73 All Rural Designations: 8488.86
Area Of Important Ag Soils (acres):	1001.71	Area Of Important Ag Soils (acres):	2064.44
Area of Current Agricultural Use (acres):	1643.14	Area of Current Agricultural Use (acres):	1783.26

Hartford. In Hartford, the study area encompasses the rural north and northwest of the town, approximately 20% of the town's total acreage. The study area stretches north from the White River and west from Dothan Road, and contains the villages of Dothan, Jericho and West Hartford.

The study area is zoned primarily in a rural pattern; approximately 95% of its area is zoned in the three rural designations: RL-1, RL-2 and RL-5 (See Figure 1.3). There are areas of higher density zoning, especially the Residential and Commercial (RC-2) district that parallels the north bank of the Connecticut River.

[1] According to the Vermont Department of Taxes' website, the Current Use Program "taxes farm and forest property according to its use value. The purpose of the [program] is to keep agricultural and forest land in production, and to slow development of those lands." Because lands must be actively farmed or logged to qualify for the program, its logs provide an accurate list of agricultural land use (Vermont Dept. of Taxes 2002, 1).

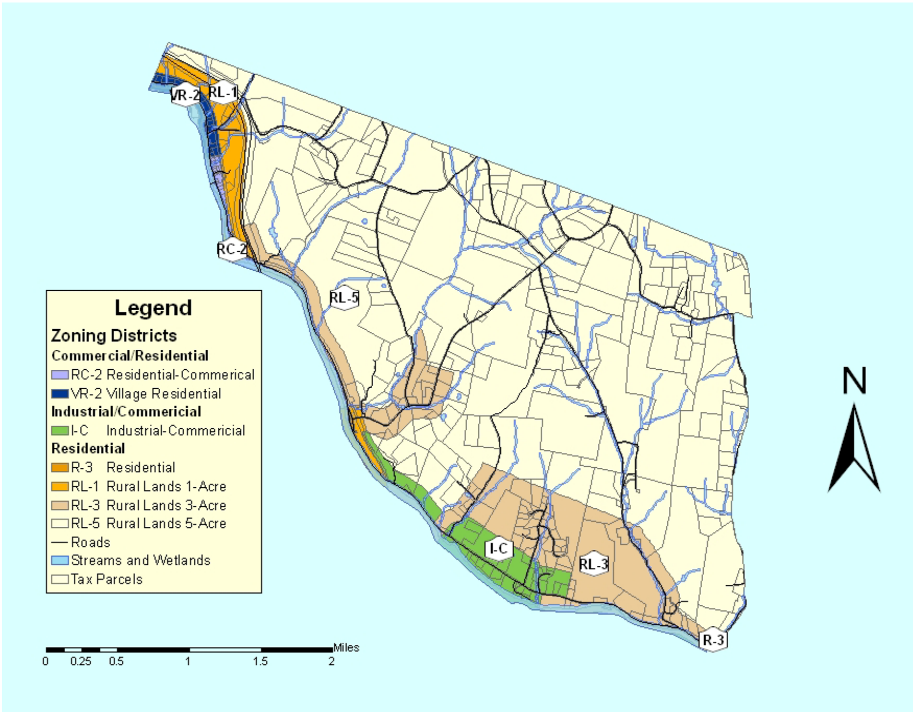


Figure 1.3 – Zoning Districts in the Hartford Study Area

As for agricultural resources, the study area contains 24 tax parcels enrolled in current use taxation, covering 28% of the total land area. Soils with agricultural importance cover almost 17% of the area (See Figure 1.4).

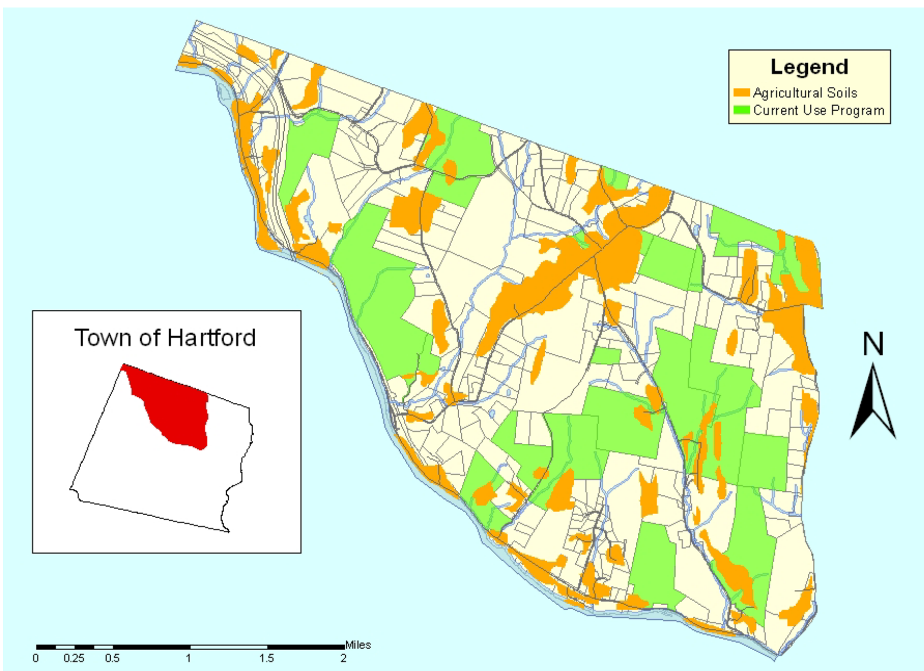


Figure 1.4 – Agricultural Resources in the Hartford Study Area

Hanover. The study area chosen for Hanover begins at the intersection of Greensboro Road and Highway 120, and follows Greensboro road northeast until it reaches Hanover Center. The study area includes the entire valley between Velvet Rocks and Balch and Oak Hills to the west and Moose Mountain to the east, as well as most of the Mink Brook drainage, the main drainage examined in our Hanover water quality study. It comprises approximately 30% of Hanover's total acreage and includes the villages of Etna and Hanover Center, as well as the south eastern edge of urban Hanover (See Figure 1.5).

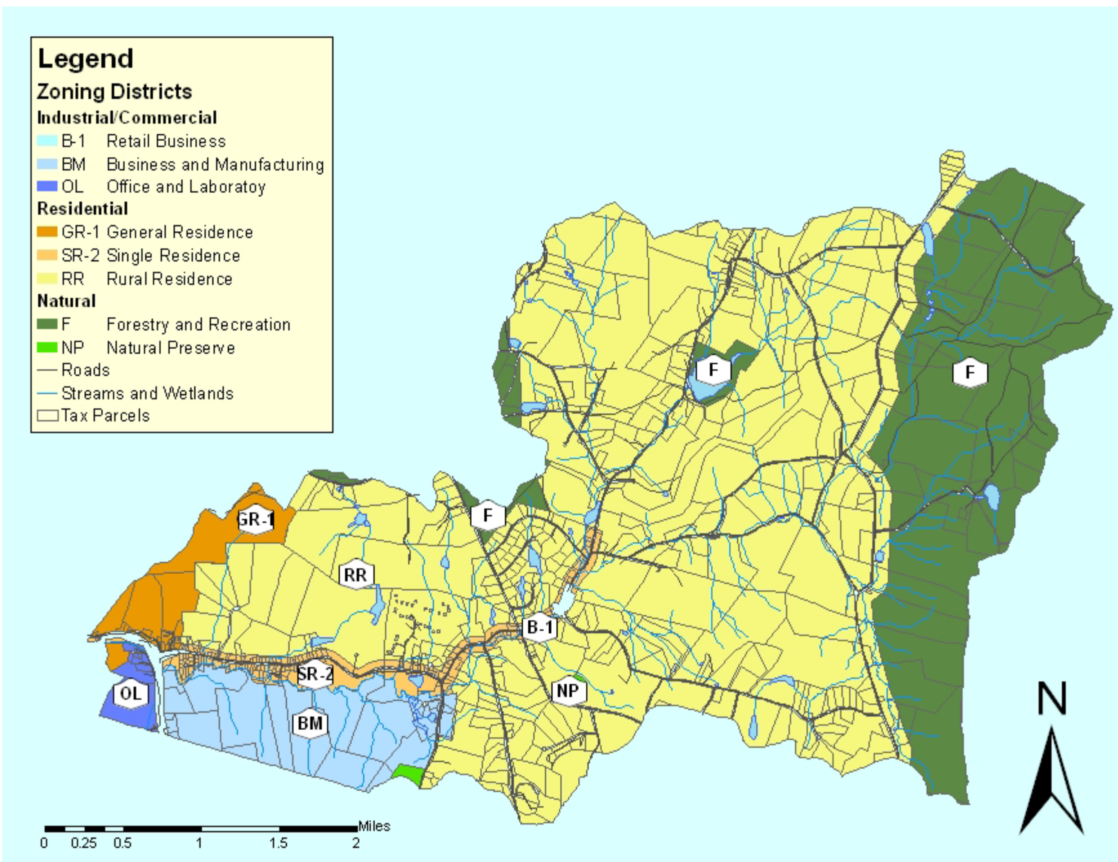


Figure 1.5 – Zoning Districts in the Hanover Study Area

Like the Hartford study area, the Hanover area is primarily zoned for rural development. 66% of the total area is zoned in the rural designation RR, and another 22% is designated either NP or F, which severely restrict development by preventing road construction and by limiting the range of acceptable construction, including the preclusion of residential or commercial development

(Hanover Zoning Regs. 2006, 116-17). The area, however, also contains significant amounts of higher density residential and commercial zoning, as embodied in the in General Residence (GR-1), Single Residence (SR-2) and Business and Manufacturing (BM) districts found in the south west of the area.

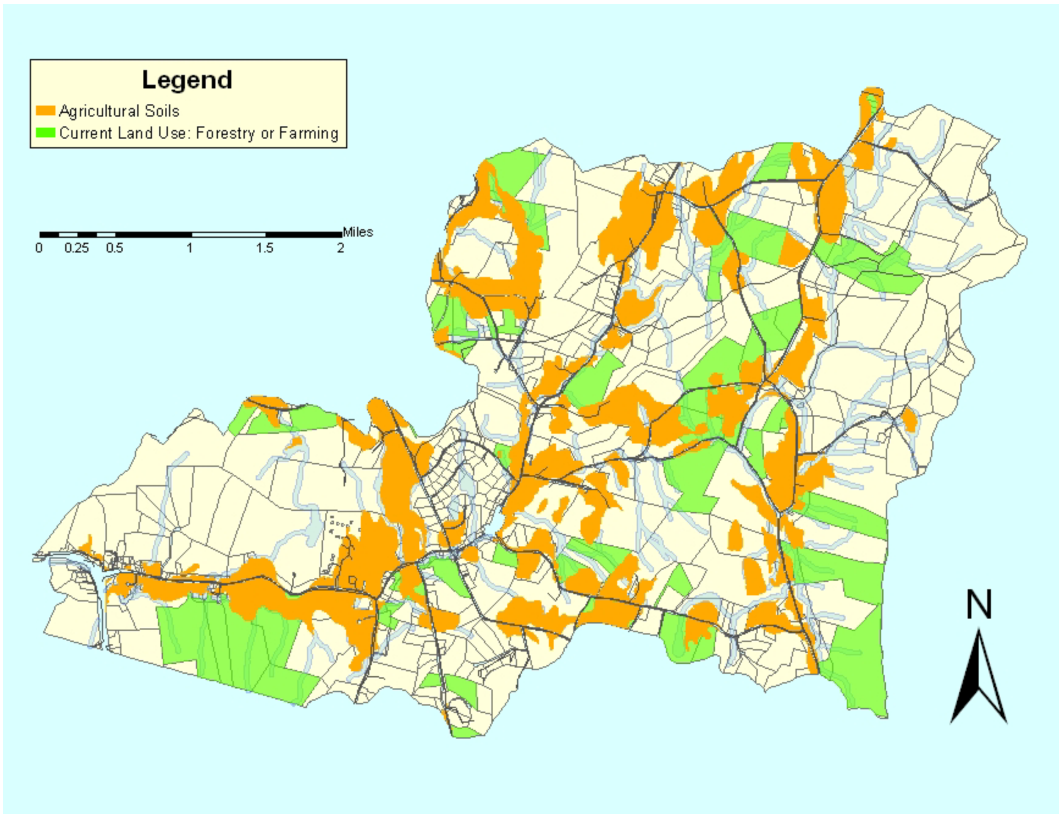


Figure 1.6 – Agricultural Resources in the Hanover Study Area

Seventy-one tax parcels are marked as either managed forests or farms, comprising just over 18% of the study area. While active agricultural land covers somewhat less of the Hanover study area than in Hartford, agricultural soils cover more: over 21% (See Figure 1.6).

Constraints to Development. In addition to the data discussed above, CommunityVIZ allows for the exclusion of development from certain areas due to certain qualities. Both towns exclude development on the basis of a number of factors, but for this study we examined three: slope, proximity to streams and wetlands and the existence of publicly owned land. For the zoning regulations of both towns relating to the protection of streams and wetlands, see Hartford Zoning Regs. §3.4 and Hanover §702. For steep slopes, see Hanover §207.2. We collected data on steep slopes, wetlands and publicly owned lands from the sources mentioned above. Figures 1.7 and 1.8 show each study area's development constraints.

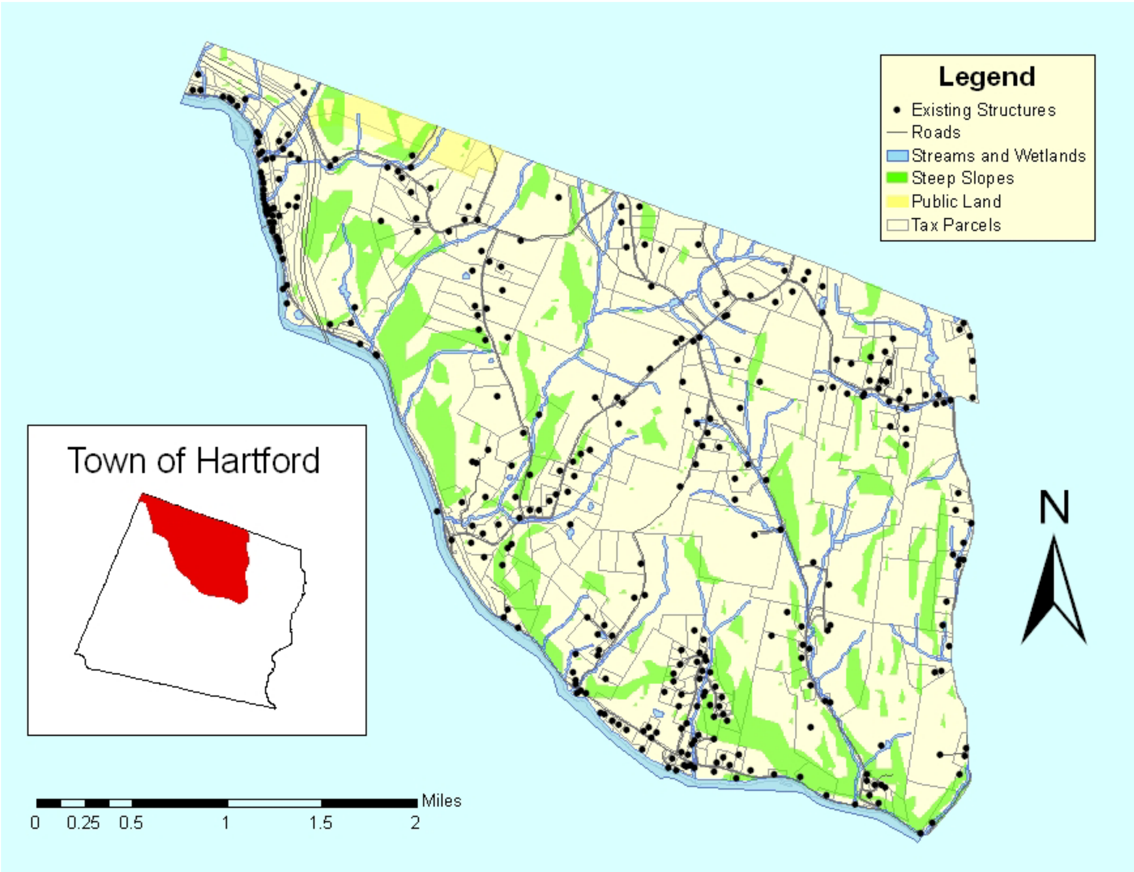


Figure 1.7 – Constraints to Development in the Hartford Study Area

Finally, CommunityVIZ allows for the addition of existing dwelling units and commercial structures to any analysis; development is then excluded from any parcels already filled by existing structures. While this data existed for Hartford, it did not exist for Hanover. As described in Table 1.9, we assumed that no structures preexisted in the Hanover study area, and so no structures are shown on Figure 1.8.

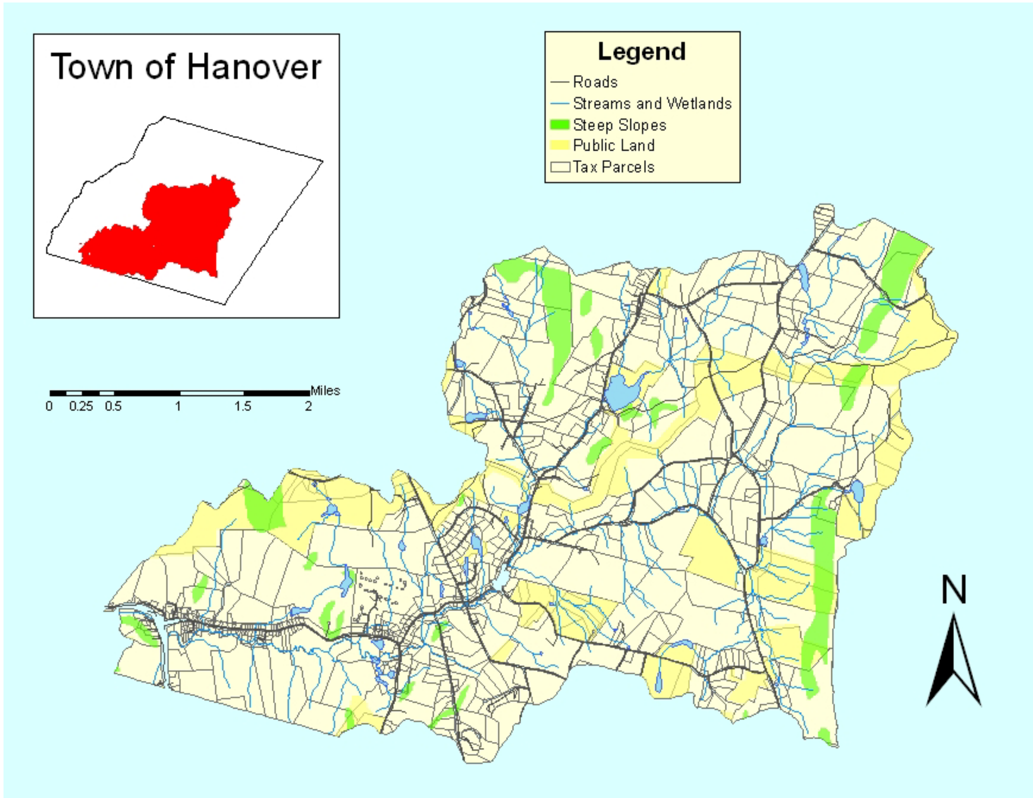


Figure 1.8 – Constraints to Development in the Hanover Study Area

Table 1.8 – Data Collection Assumptions

1. Although Hartford has no zoning laws preventing construction on steep slopes, we assumed a similar restriction as in Hanover. This allows for some uniformity across both towns and conforms to the parameters of Hartford's own build-out analysis of 2004 (TRORC 2004 3)
2. GIS data collected for Hanover dates from 2001, and predates the implementation of the current Master Plan. However, we assumed that all available data did not differ from the current situation

Running the Build-Out Analysis. To the data discussed above, we added a general tax parcels layer and a zoning layer for each of the study areas.

Constructing the Data Layers. First, all the data collected above, which came in multiple coordinate systems depending on the source, was projected into a uniform coordinate system: NAD 1983 UTM Zone 18N. Then the data was clipped, so that its spatial extent matched up with the spatial extent of each study area. The base layer showing development potential was created by intersecting the zoning and tax parcel data for each of the study areas.

Developing a single layer with constraints to development required a number of steps. First of all, we combined the data layers showing lakes and those showing streams together for each study area. Then, a buffer area, where development was also prohibited, was constructed around each water body. Following the Hartford regulations, we created a 100 foot buffer around the Connecticut River, and a 30 foot buffer around all other lakes and streams (Hartford Zoning Regs. 2007, 35). In Hanover, we added a 75 foot buffer around all water bodies (Hanover Zoning Regs. 2006, 68). These layers were then merged with layers identifying the publicly owned land for each town. Finally, we created a layer marking steep slopes. The Hanover GIS data we received from Mr. Ryan at the town offices contained a layer for Hanover marking 25% or greater slopes in the town. To create a similar layer for Hartford, we first downloaded slope data for the entire state off of the VCGI website (www.vcgi.org/). We clipped that layer to the size of our study area and then reclassified the data so that it came in only two classes: 0-25% slope and greater than 25% slope. Finally, we exported only those polygons which corresponded to the second class. The final step in creating a constraints layer was merging this slope layer to the others.

Running the Numeric Build-Out Analysis. The first step in running a build-out analysis is to run a numeric analysis of the study area. This analysis simply calculates the maximum possible number of lots based upon given building density and lot efficiency data. Density data is the number of dwelling units or commercial buildings allowable per acre. For residential areas, density is measured in minimum lot size of Dwelling Units per Acre. Commercial density is determined using the Floor Area Ratio (FAR), which calculates the ratio of floor space to the total size of the lot (CommunityVIZ Help 2006). Efficiency is a measure of the difference between how many lots are theoretically possible on a land parcel, and how many lots are actually placed on that parcel. For example, if efficiency in an area is 80% then 20% of each parcel is lost to development. This value can change due to a number of constraints, including the ones discussed above, but also including such factors as soil quality and parcel shape.

Table 1.9 – Numeric Build-Out Parameters: Model-Wide Assumptions

1. Baseline efficiency for all zoning districts was set at 80%. This was designed to accommodate issues of lot shape, surficial geology, hydrography and any other factor not contained within the analysis parameters.
2. When new houses were placed within lots as opposed to along existing streets, efficiency was assumed to drop based upon lot size. This loss of efficiency was due to the extension of rights-of-way within that parcel and was determined according to this table taken from the Hanover Master Plan Appendix 3.5 (Nancy Collier et al. 2003, 4):

Lot Size	Deduction for Rights-of-Way
<3 Acres	20%
3-5 Acres	12.5%
5-<10 Acres	7.5%
10+ Acres	3.7%

3. When a tax parcel extends into multiple different zoning districts, each piece of the lot was assumed to be wholly within its respective district.
4. Certain zoning districts allowed for different lot sizes based upon the existence of sewer and water services as opposed to septic tanks and wells—in general lots served exclusively by septic fields and wells were larger than those served by one and not the other, or by neither. When this occurred, the lot size we chose for the entire district came from the class where each lot had either a septic field or a well, but not both (Hartford Zoning Regs. 2007 9).
5. In order to avoid placing houses on fractional parcels created by the process of combining the tax parcels and zoning layer, development was banned on any lots smaller than the smallest lots preexisting in each area. This corresponded to 8,000 sq. ft. in Hartford and 4,300 sq. ft. in Hanover.
6. New Hampshire has not completed its survey of structures in the state, so data which showed the existing structures in Hanover (known as E991 data) exists. Therefore, the Hanover models were run as though there were no structures on the parcels in the Hanover study area.
7. In the RC-1 district in Hartford, both commercial and residential development is permitted. We set percentage rates of this development at 70% residential, 30% commercial. These percentages were extrapolated from the zone descriptions present in the Hartford Zoning Regs (21-24). See Appendix 1B

The CommunityVIZ program allows for a general efficiency calculation to be input for each zone which approximates this loss of developable area. We assumed for all zones that these factors of soil, shape, topography and hydrology would remain constant (see Table 1.9). Another major loss of efficiency, however, can be variable across different zones. This loss of efficiency comes from the land set aside for right of way for new roads and driveways within a newly developed parcel. In certain zones, more roads and driveways would need to be built than in other zones, making this a variable parameter, which varies based upon lot size. The assumptions for dealing with right-of-way and efficiency are discussed in Table 1.9. The density and efficiency data we input was derived from minimum lot size, frontage and setback data found in the Hanover and Hartford zoning bylaws and is displayed in Tables 1.10-1.13. For a complete list of the data inputs and outputs of the CommunityVIZ program, see Appendix 1A.

The current zoning scenarios (displayed for Hanover in table 1.10 and Hartford in Table 1.12) were constructed by following the exact zoning bylaws as drawn from the current zoning regulations. The efficiency data was calculated using the table under assumption two in Table 1.9. For Hartford, this meant that the bulk of the rural area was allotted a density of one dwelling per five acres (Hartford Zoning Regs. 2007, 26). For Hanover, the rural area was allotted a density of one dwelling per ten acres (Hanover Zoning Regs. 2006, 15).

For the low density zoning scenarios we made changes to the density allowed in the lowest-density rural zone (RL-5 for Hartford and RR for Hanover). For Hartford, we followed the suggestion of the town’s proposed Master Plan: the RL-5 zone was renamed the RL10 zone and we lowered its density to one dwelling per ten acres (Hartford Planning Commission et al. 2007, 44). Hanover’s current zoning regulations already limit rural density to one dwelling per ten acres. Therefore, we used a new measure of decreased density, also suggested by the proposed Hartford Master Plan: the creation of an Agricultural Zoning District, in which minimum lot sizes would be increased to 28 acres (Hartford Planning Commission et al. 2007, 45). For Hanover's low density development scenario, we envisioned that the RR zone was converted to an agricultural district, in which 28-acre minimum lots were required.

The final scenario for the numeric build-outs was the clustered or planned residential development scenario. These two scenarios involved regulations in which overall structure density across the zone was more important than minimum sizes for individual lots, so we made several modifications to the density and efficiency parameters in order to approximate these affects. Hartford's cluster development scenario was derived from the town's proposed Master Plan, which states that:

> In the RL-3, RL-5 and RL-10 zoning districts reduce the minimum lot size to one acre while maintaining the overall density of each zoning district (one lot per three acres in RL-3, one lot per five acres in RL-5, and one lot per ten acres in RL-10). This will allow the opportunity for greater clustering of houses to protect larger amounts of open lands, agricultural land and forest land. For instance, in the RL-10 district, a 30-acre lot could be subdivided into a maximum of three buildable lots. Two one acre building lots and a building lot for the remaining 28 acres could be created. Further subdivision of the 28-acre lot in the future would not be allowed since the maximum density of three lots would have already been achieved. (Hartford Planning Commission et al. 2007, 45)

We replicated this modification in the numeric density calculations by changing the density units from "minimum lot size" to "dwelling units per acre" in the RL-10, RL-5 and RL-3 districts, which we assumed participated uniformly in this program. Effectively replicating the above scenario also required the creation of two extra zoning districts, called the RL11 and RL-4 districts; both were important in the next phase of the build out.

Implementing Hanover's Planned Residential Development (PRD) scenario required extensive changes to both the density and efficiency data. According to the Hanover Zoning Regulations, a PRD is designed:

> to encourage flexibility of design and development…and allow a more useful and flexible pattern of housing types …to allow for the economic advantage of smaller networks of streets and utilities; and to encourage the preservation and recreational use of Open Space in harmony with the natural terrain, scenic qualities and outstanding features of the land. (Hanover Zoning Regs. 2006 52)

In general this means that PRD allows for much higher housing densities than the zones underlying them, but that those higher densities are coupled with a requirement that large amounts of the subdivided parcel be set aside as protected open space; in Hanover, this protection amounts to as much as 65% of the parcel (Hanover Zoning Regs. 2006, 50-55).

Planned development in Hanover is only allowed on four zones: the RR zone dealt with in this paper, as well as the two more densely developed housing zones, the General Residence (GR) zone and the Single Residence (SR) zone and a primarily industrial zone known as the Office and Laboratory (OL) zone (Hanover Zoning Regs. 2006, 50-52). For the purposes of this scenario, we limited PRD to the GR-1, SR-2 and RR zones—excluding the OL zone, where all other development was commercial—within our study area. Because PRD zoning bylaws are defferent from the regular ordinance with a zone, we created three new zones: RR1, GR-1PD and SR-2PD, corresponding to the RR, GR-1 and SR-2 zones.

Once these new zones were created, we created several new assumptions and density parameters to approximate PRD. The first new parameter was based on parcel size; PRD is only permitted on parcels larger than 50 acres in the RR zone, 5 acres in the GR-1 zone and 1 acre in the SR-2 zone. In this scenario, we assumed that every lot in the RR zone that fit the size qualifications created a PRD, while only lots larger than 15 acres in the GR-1 and SR-2 zones followed suit. Secondly, PRD have different densities than their underlying zoning districts permit, which required us to modify the density parameters for the new zones. For PRD in the RR1 zone, density is increased to one lot per three acres, from one lot per 10 acres in the regular RR zone. For the GR-1PD zone, density increases to approximately 7.5 lots per acre from about 3 lots per acre in the GR-1 zone. Finally, for the SR-2PD zone, lot density remains constant, but lot size shrinks from about two lots per acre in SR-2 to four lots per acre in SR-2PD (Hanover Zoning Regs. 2006, 50-55).

The allowable density within a PRD is much higher than the density on the underlying zone. Therefore, we needed to modify the efficiency requirements in order to create developments that allotted the correct amount of open space. The first efficiency reduction was for statutorily required open space. As discussed above, PRD in the RR and GR-1 zones must preserve 65% of their area as open space, while PRD in the SR-2 zone must preserve 35%; these percentages were subtracted from 100%. We ignored the usual baseline of 80% in this case because we assumed that lots inside a PRD are so small that they would be placed only where the inefficiencies of a regular subdivision could be avoided. Finally, we subtracted the right-of-way percentages as listed in Table 1.9.

Table 1.10 – Hanover: Current Zoning Numeric Build-Out Parameters

Land-Use Designation	Dwelling Units	Floor Area (FAR)	Efficiency Factor (%)
B-1	N/A	0.72	80
BM	N/A	0.49	80
F	0	0	100
GR-1	0.344 acre min. lot size	N/A	60
NP	0	0	100
OL	N/A	0.49	60
RR	10 acre min. lot size	N/A	76.3
SR-2	0.459 acre min. lot size	N/A	60

Table 1.11 – Hanover: Changes from Current Zoning Scenario Parameters

<table>
<tr><th rowspan="2">Scenario:</th><th colspan="2">Changes in Dwelling Unit Density:</th><th rowspan="2">New Zones</th><th rowspan="2">New Zone DU Density:</th><th rowspan="2">New Zone Efficiency:</th></tr>
<tr><th>Zone:</th><th>New Value:</th></tr>
<tr><td>Low Density Zoning</td><td>RR</td><td>28 acre min. lot size</td><td>None</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Planned Residential Development</td><td>None</td><td>N/A</td><td>RR1</td><td>0.333 DU/acre</td><td>22.5%</td></tr>
<tr><td></td><td></td><td></td><td>GR-1PD</td><td>7.5 DU/acre</td><td>15%</td></tr>
<tr><td></td><td></td><td></td><td>SR-2PD</td><td>4 DU/acre</td><td>67.5%</td></tr>
</table>

Table 1.12 – Hartford: Current Zoning Numeric Build-Out Parameters

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
I-C	N/A	0.5 FAR	80
R-3	1 acre min. lot size	N/A	80
RC-2	0.344 acre min. lot size	0.45 FAR	80
RL-1	1 acre min. lot size	N/A	60
RL-3	3 acre min. lot size	N/A	65
RL-5	5 acre min. lot size	N/A	67.5
VR-2	0.459 acre min. lot size	N/A	80

Table 1.13 – Hartford: Changes from Current Zoning Scenario Parameters

Scenario:	Changes in Dwelling Unit Density:		New Zones	New Zone DU Density:	New Zone Efficiency:
	Zone:	New Value:			
Proposed Zoning	None	N/A	RL10	10 acre min. lot size	76.3%
Cluster Development	RL-5	0.2 DU/acre	RL10	0.1 DU/acre	80%
	RL-3	0.333 DU/acre	RL11	0.1 DU/acre	76.3%
			RL-4	0.333 DU/acre	67.5%

Running the Spatial Build-Out. Spatial build-out takes into account the things not covered by numeric build-out, including distance between buildings, road frontage and lot shape. The major pieces of data input into a spatial build-out are distance between buildings and layout pattern, which can be seen in tables 1.14-1.17. We used the side setback data from each town's zoning regulations to determine minimum separation between buildings.

CommunityVIZ allows three different layout patterns: random, grid, and following roads. In general, parcels with sufficient road frontage—that is, enough existing roads so that all of the lots within that parcel could abut (or "front") the road without violating any of the density, setback, or minimum separation distance parameters—were set to follow the roads, while parcels without enough road frontage to accommodate all of the modeled subdivision were set for a random layout, where lots were not required to abut existing roads. This is why the Hartford cluster scenario required the introduction of new zones RL11 and RL-4. The parcels contained within RL11 and RL-4 had the same properties as the RL10 and RL-3 parcels respectively, but not enough existing roads to satisfy road frontage requirements. Therefore, they were set to a random layout, and lots were not required to front existing roads (see Table 1.17). In Hanover's PRD development, the GR-1 parcels had insufficient frontage and were set to random layout as well. Road setback for parcels following the roads layout was calculated from setback data in the zoning bylaws.

Table 1.14 – Hanover: Current Zoning Spatial Build-Out Parameters

Land-Use Designation	Minimum Separation Distance (feet)	Follow Roads (Y/N)?	Setback (feet)
B-1	15	N	0
BM	25	N	0
F	0	N	0
GR-1	15	N	0
NP	0	N	0
OL	25	N	0
RR	50	N	0
SR-2	20	N	0

Table 1.15 – Hanover: Changes from Current Zoning Scenario Parameters

Scenario:	Changes in Minimum Separation Distance:	Changes in Layout Pattern:	New Zones:	Minimum Separation Distance (Feet):	Follow Roads (Y/N)?	Setback (Feet):
Low Density Zoning	None	None	None	N/A	N/A	
PRD	None	None	RR1	100	Y	100
			GR-1PD	15	N	
			SR-2PD	10	Y	20

Table 1.16 – Hartford: Current Zoning Spatial Build-Out Parameters

Land-Use Designation	Minimum Separation Distance (feet)	Follow Roads (Y/N)?	Setback (feet)
I-C	20	N	0
R-3	25	N	0
RC-2	15	Y	50
RL-1	25	N	0
RL-3	40	N	0
RL-5	50	N	0
VR-2	15	Y	25

Table 1.17 – Hartford: Changes from Current Zoning Scenario Parameters

Scenario:	Changes in Minimum Separation Distance:		Changes in Layout Pattern: Follow Roads (Y/N)?		New Setback (Feet):	New Zones:	Minimum Separation Distance (Feet):	Follow Roads (Y/N)?	Setback (Feet):
	Zone:	New Value:	Zone:	New Value:					
Proposed Zoning	None	N/A	None	N/A	N/A	RL10	50	N	0
Cluster Development	RL-5	20	RL-5	Y	50	RL10	25	Y	50
	RL-3	20	RL-3	Y	50	RL11	25	N	0
						RL4	20	N	0

Assessing Impacts on Agricultural Resources. Impact on agricultural resources was calculated in two ways: the number of houses built on those resources, as well as the percentage of those resources that are protected from further subdivision, either by the maximum density having already been reached on the parcel or by the open space percentages mandated by PRD. The number of houses situated on agricultural resources was provided by the "Common Impacts" tool of the CommunityVIZ software. Percentages of unsubdivided land were calculated using the total housing numbers and the zoning data. The number of houses on each zone was multiplied by the minimum lot size to give the total subdivided area. The area upon which development was prevented was then subtracted from the total resource area to give the total resource area available for subdivision. The total subdivided area was subtracted from the total subdividable area to get the remaining unsubdivided or protected area.

Results

The tables below (1.18-1.23) lay out the numeric results: houses built on agricultural resources as well as percentages of those resources protected. All of the tables for Hartford include buildings currently situated in the study area. Because of the lack of data on existing structures in Hanover, all the structures shown in the Hanover maps were modeled by the

CommunityVIZ program; analysis of those structures is just a comparison of the total numer of structures modeled by the program.

Table 1.18 – Total Buildings in Hartford: Scenario by Scenario

Scenario:	Number of Buildings	
	New:	Total:
Current Zoning	590	1015
Proposed Zoning	434	749
Cluster Development	445	760

Table 1.19 – Buildings on Agricultural Resources in Hartford

Agricultural Soils:		Current Use Parcels:	
Current Zoning:	263	Current Zoning:	166
Proposed Zoning:	245	Proposed Zoning:	102
Cluster Development:	292	Cluster Development:	108

Table 1.20 – Percentage of Agricultural Resources Protected from Subdivision in Hartford

Agricultural Soils:				
	Total Resource (acres):	Total Subdivided (acres):	Not Subdivided (acres):	Protected Area %:
Current Zoning:	896.75	737.68	159.07	17.7%
Proposed Zoning:	896.75	839.7	57.05	6.4%
Cluster Development:	896.75	527.51	369.24	41.2%
Current Use Parcels:				
	Total Resource (acres):	Total Subdivided (acres):	Not Subdivided (acres):	Protected Area %:
Current Zoning:	1224.69	777	447.69	36.6%
Proposed Zoning:	1224.69	757	467.69	38.2%
Cluster Development:	1224.69	183	1041.69	85.1%

Table 1.21 – Total Buildings in Hanover: Scenario by Scenario

Scenario:	Number of Buildings:
Current Zoning	1148
Proposed Zoning	1052
Cluster Development	1068

Table 1.22 – Buildings on Agricultural Resources in Hanover

Agricultural Soils:		Parcels, Land Use ID as Farm/Forestry:	
Current Zoning:	371	Current Zoning:	95
Low Density Zoning:	371	Low Density Zoning:	80
PRD:	409	PRD:	97

Table 1.23 – Percentage of Agricultural Resources Protected from Subdivision in Hanover

Agricultural Soils:				
	Total Resource (acres):	Total Subdivided (acres):	Not Subdivided (acres):	Protected Area %:
Current Zoning:	1463.65	N/A (Calculations greater than resource area)	N/A	N/A
Low Density Zoning:	1463.65	N/A	N/A	N/A
PRD:	1463.65	N/A	N/A	N/A
Parcels, Land Use ID as Farm/Forestry:				
	Total Resource (acres):	Total Subdivided (acres):	Not Subdivided (acres):	Protected Area %:
Current Zoning:	1193.5	563.98	629.52	52.7%
Low Density Zoning:	1193.5	1061.98	131.52	11.0%
PRD:	1193.5	446.21	747.29	62.6%

The figures that follow show spatial representations of each of the three development scenarios for both towns. On the Hartford maps, buildings are divided into existing and new structures; which are marked by black and red symbols, respectively. Similarly to the maps displayed earlier in this report, agricultural resources are defined in green and orange, marking current use parcels and agricultural soils, respectively. Visual comparisons of the rural area—that is, the areas removed from the more densely settled Connecticut River, show the most dramatic differences between each development scenario.

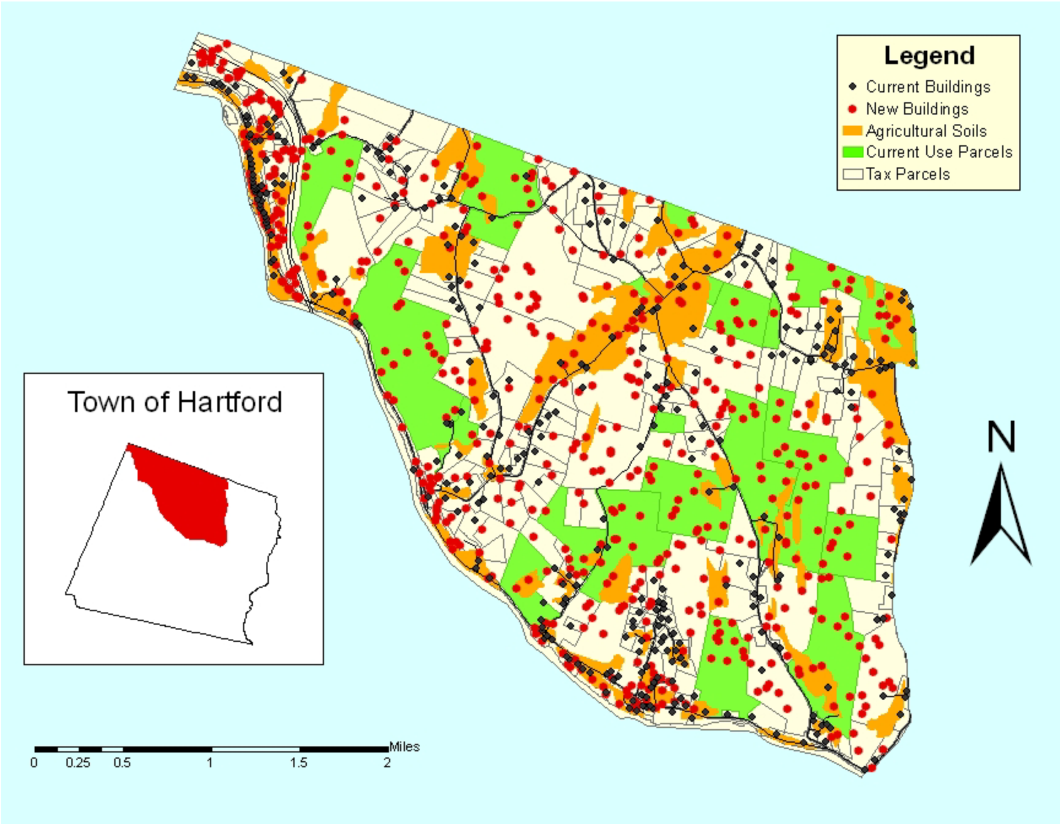


Figure 1.9 – Hartford Build-Out Scenario One: Current (5-Acre) Zoning

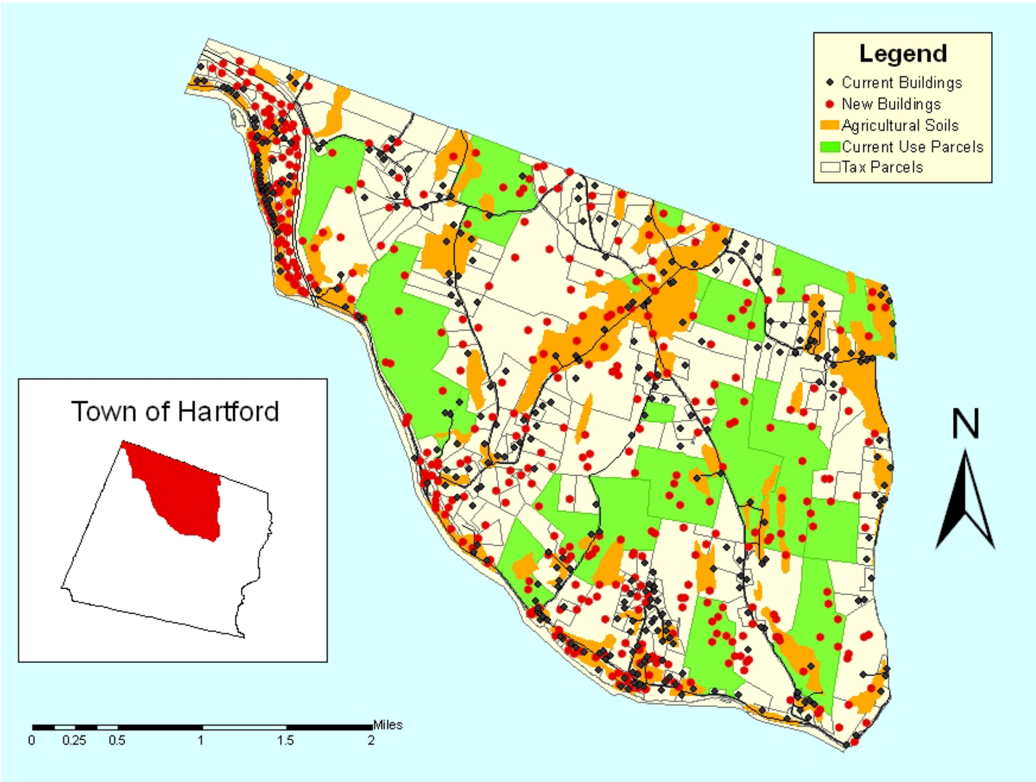


Figure 1.10 – Hartford Build-Out Scenario Two: Proposed (10-Acre) Zoning

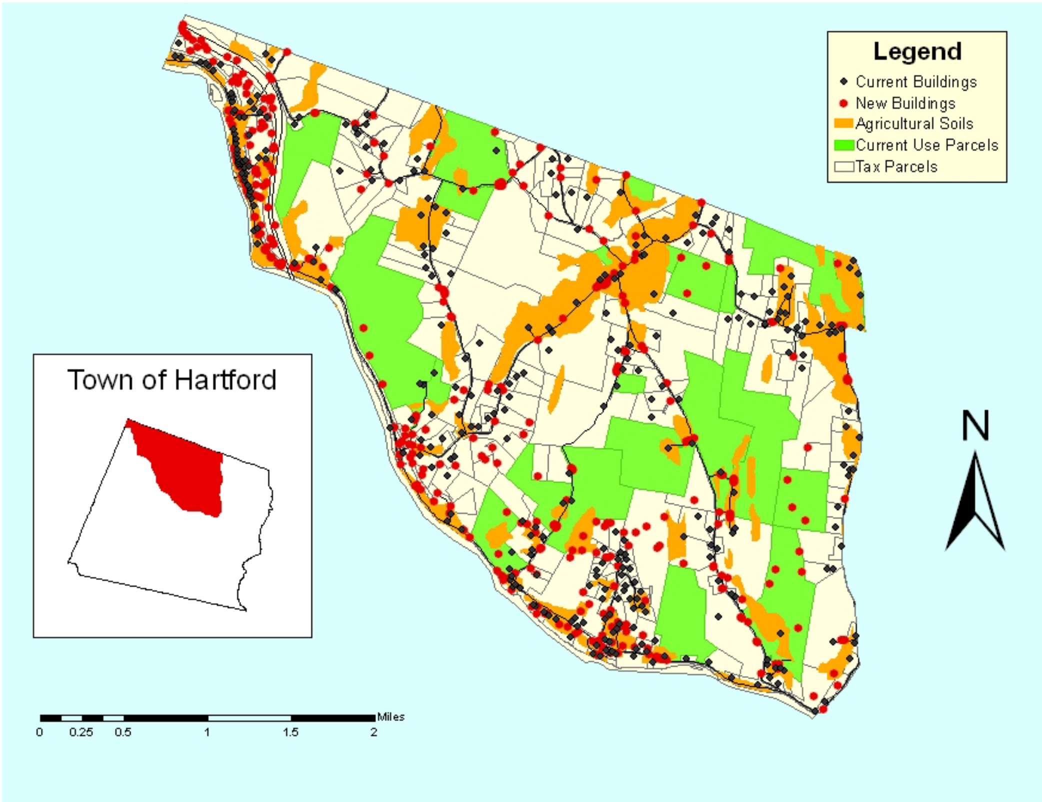


Figure 1.11 – Hartford Build-Out Scenario Three: Clustered Development

The maps that follow show the Build-Out Analysis' model of Hanover growth. Unlike the Hartford maps, because there was no existing data on structures in the study area, all the structures on these maps were modeled by the CommunityVIZ program. Therefore, they are all marked on the map by blue symbols. Though a comparison of the type in the Hartford maps is made more difficult by this lack of exiting structures, the most effective areas of visual comparison on this map come from looking a the less-densely settled areas running north and south through the middle of the study area as well as the edges of the most densely settled corridor along the south-west edge of the area.

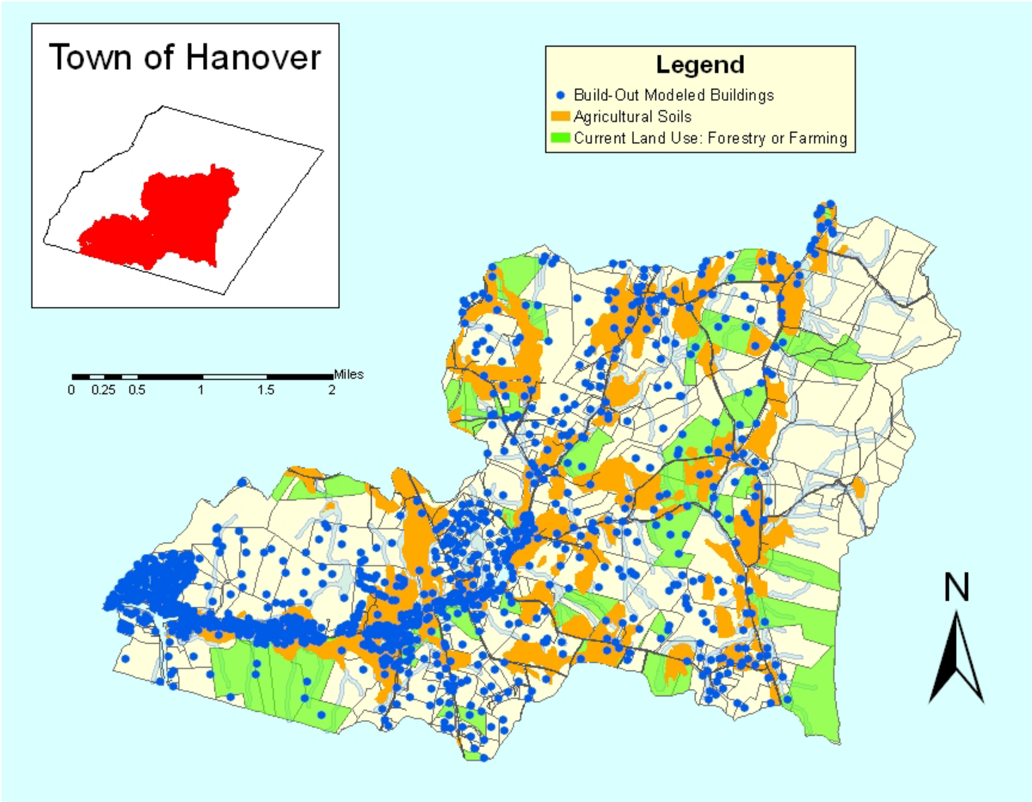


Figure 1.12 – Hanover Build-Out Scenario One: Current (10-Acre) Zoning

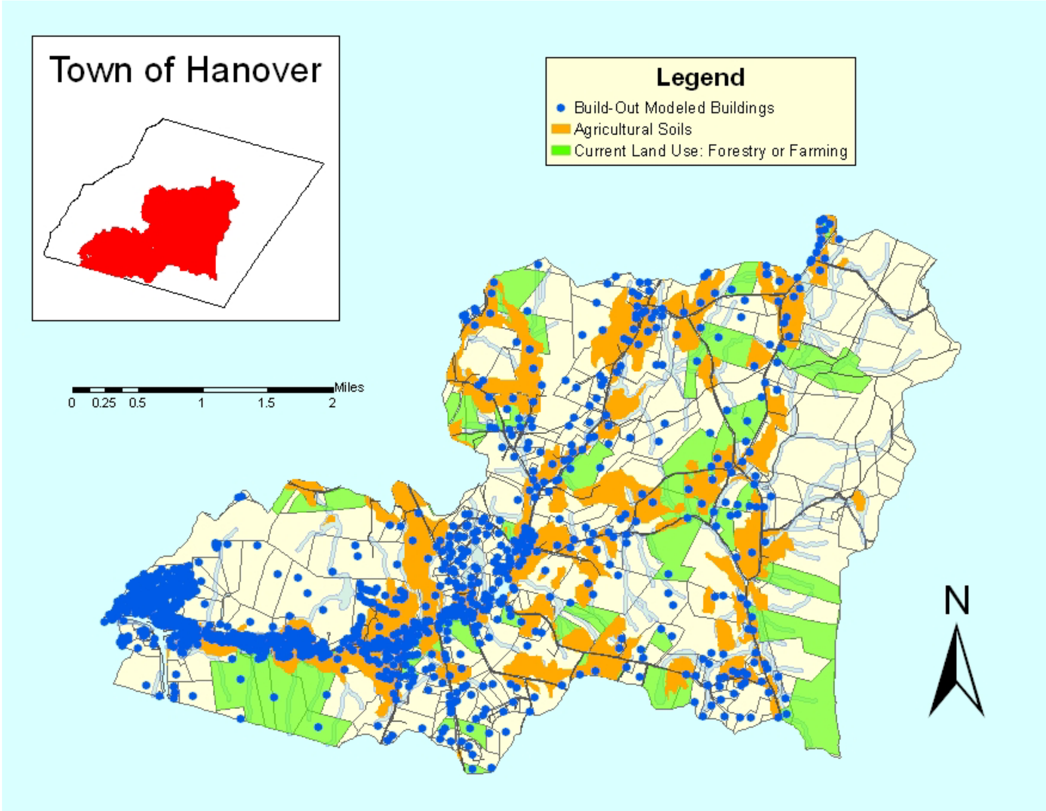


Figure 1.13 – Hanover Build-Out Scenario Two: Low-Density (28-Acre) Zoning

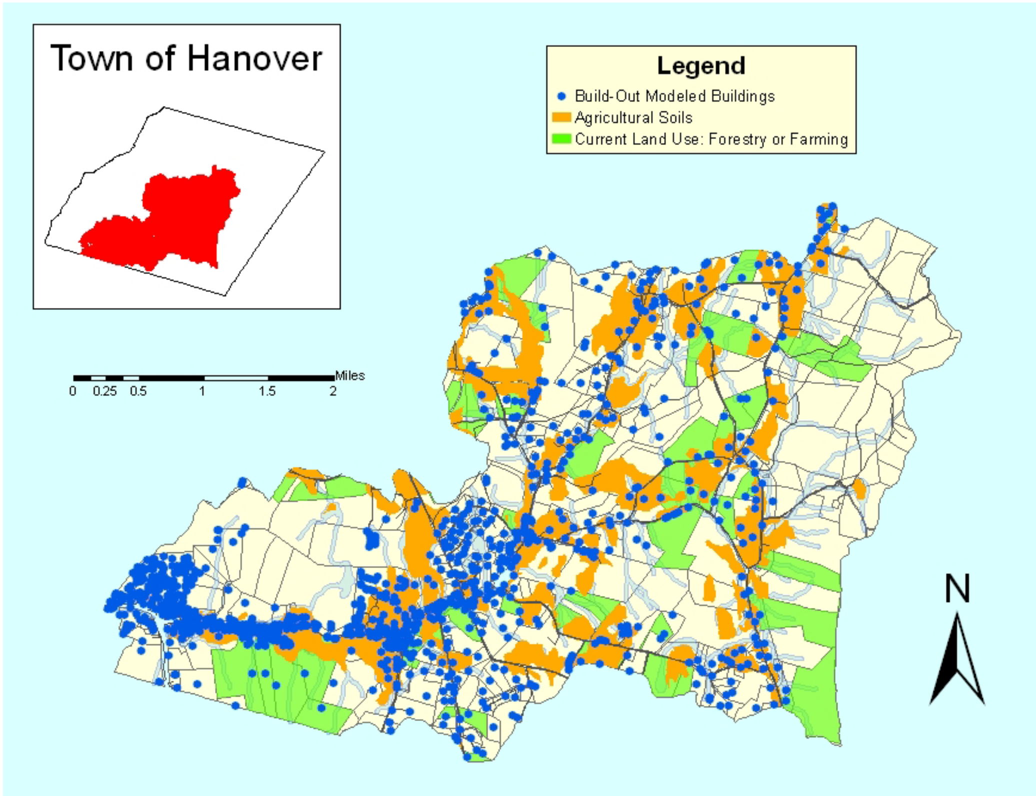


Figure 1.14 – Hartford Build-Out Scenario Three: PRD

Conclusion

Examining the results presented above, the first thing that must be explained is the failure of the Hanover calculations to provide any numbers for protected agricultural soils. This happened because there was no preexisting structures data available for Hanover. As discussed in the methodology, calculation of subdivided and unsubdivided acreage within agricultural resources was made by calculating the number of new houses in each zone on those resources, and then multiplying by the minimum lot size in that zone. Presumably, some fraction of the lots in Hanover predated the most recent zoning amendments, and therefore they were grandfathered in to current zoning even though they were smaller than the new minimum lot size. Following generally accepted zoning bylaws, CommunityVIZ places houses on every available lot, even if those lots are smaller than the minimum lot size of the zone. If structure data had existed for

Hanover, those lots could have been excluded from future development, but because that could not happen, every house in Hanover is counted as a "new" house. This means that there are more houses in Hanover than could be supported by a strict adherence to the zoning law. This is why the Hanover data did not return any accurate numbers for protected agricultural soils in any scenario, and it may also mean that the calculations for currently farmed parcels do not completely reflect the realities of each scenario.

Beyond that, several patterns should be noted. When we compared the current zoning and low density zoning scenarios, low density zoning tended to have a clear advantage in the purely counting indicators. When it came to total houses, houses built on agricultural soils, and houses built on currently active farms or forests, the low density scenario never exceeded the current zoning scenario, and in five of six cases the number of houses was considerably lower. However, in the second comparative measure—land that avoided subdivision and is now foreclosed from further subdivision—the low density scenarios in each town protected either a comparable amount of land, or somewhat less land than the current zoning scenarios. This apparent contradiction occurs because of the large increase in average lot size between the current zoning and proposed zoning scenarios. In some ways, this shows one of the limitations of the CommunityVIZ software: it only can draw houses, not lot boundaries.

When we compared, the maps of the current zoning and low density zoning scenarios, it is easy to see that the number of houses in the rural area decreases and that houses are further apart. However, because the land in between the houses is not unsubdivided, the sole result is a drop in housing density. This is easiest to see in Hartford. Between the current and proposed zoning scearnios, development density is cut in half, from one building per five acres to one building in ten. Minimum lot size, however doubles, meaning that these two changes cancel each other out, and there is still a continuous chain of subdivided lots across the landscape. The only reason that the two scenarios do not leave exactly the same amount of land unsubdivided is the changes in efficiency that occur because of the change from five to ten acre lots. This scenario illustrates the hidden danger of merely setting up low density zoning without also providing for clustering or protection of large continuous bands of open space: even though the low density scenarios put fewer houses on the landscape, all of the available land is still subdivided amongst the various property owners. According to information provided later in this report, the average size of farms in Hartford is 129 acres, while the average size of farms in Grafton Country, NH is 204 acres. Even under the very low-density 28 acre zoning scenario in Hanover, the largest parcels held by any individual private owner would be considerably smaller than the threshold levels.

Comparing these two scenarios and the PRD/cluster development scenarios, the paradox discussed above is reversed. In all cases, the PRD/cluster scenarios have more buildings than the low density scenario, and in a few cases (Hartford's agricultural soils, both Hanover's agricultural soils and currently farmed parcels) the PRD/cluster scenario has more buildings than the current zoning scenario. In Hartford, however, the cluster scenario protects significantly more land in both of the agricultural indicators than do the other scenarios. In Hanover, the data is slightly more muddled, with the PRD scenario protecting more farmland, but less agriculturally important soil.

Partially, this reversal has to do with the nature of the scenario parameters and the pattern of existing development. This explanation is especially relevant when examining agricultural soils. In general, planned developments were laid out along existing roads. Existing roads tend to be built on areas of mild slope, with good drainage and low erosion potential. These areas tend to have the highest concentrations of agricultural soils. This explains why so many houses are seen on agricultural soils in the PRD/cluster scenarios. In Hanover, the number of buildings on agricultural soils increases from 371 in the current zoning scenario to 409 in the PRD scenario, while in Hartford, that number increases from 263 to 292.

This reversal occurs because of the uncoupling of lot size and density in the PRD and clustered development scenarios. In both towns, overall density within a development remains similar to the density in the rest of the zone, while lot size within a development falls significantly. The leftover land created by the separation of density and lot size is therefore protected from further subdivision by the density rules, and as this analysis shows, it is generally of a larger extent than the leftover land in the other two development scenarios. The effect is more noticeable in Hartford rather than Hanover for two reasons: firstly, in its proposed Master Plan Hartford more severely limits lot size than does Hanover. In Hartford, lots in the rural areas are one acre lots, while in Hanover lots only fall to three acres. Secondly, Hartford’s proposed regulations maintain the density of the original zoning districts (RL-3, RL-5, and RL10) through its cluster development scenario, while Hanover's current PRD regulations do not, instead upping housing density to 1DU/3 acres in PRDs in the RR zone.

In general, the protection of significant amounts of agricultural soil in either town might be very difficult—though somewhat more achievable in Hartford. As the results and figures above demonstrate, PRD or clustered development limit the number of houses built on the landscape, and do a better job of protecting large swaths of open space from development compared to low density zoning. However, they force housing closer to existing roads, which commonly run through the highest concentrations of agricultural soils. Clustering and PRD, however, do a very good job of protecting existing farms. The prognosis for each town, therefore, seems to be that the most effective way of protecting existing farming will also foreclose most expansion of farming in the future. This analysis does not attempt to reach a determination of which of these two factors is more important to either town; any judgment would need to be decided in the next evaluation of the Master Plan.

Development Implications for Hanover and Hartford.

- Lowering the allowable density in rural zones effectively limits the number of new residences when compared to current zoning densities, both across the landscape as a whole and on agricultural resources. However, because the corresponding increase in lot sizes, there are no noticeable increases relative to current zoning in the percentage of agricultural resources that avoid subdivision.
- PRD or clustered development in the rural area tends to increase the number of new residences when compared to lower density zoning; residences specifically on agricultural soil tend to show dramatic increases both over low density zoning and current zoning density. However, PRD or clustered development shows dramatic increases in the percentage of currently farmed areas that avoid subdivision.
- Due to the relationships illustrated above, no single scenario provides the best protection for both currently farmed areas and agricultural soils. Any planning decisions looking to protect these resources must prioritize their importance and balance different types of development accordingly.

1.3 - Market-Based Solutions for the Preservation of Open Space

The previous chapter provided background on how to calculate the costs and benefits of open space and farmed lands. It addressed three complementary techniques: land valuation, Cost of Community Services studies and Build-Out analyses. Now, this section turns from investigation to preservation. This chapter examines various market-based programs that could help to protect working landscapes and open space in Hanover and Hartford.

1.3.1 - Transferable Development Rights: The Role of TDR Programs in the Protection of Open Space

Introduction

One of the many market-based options for protecting open space and farmland is Transfer of Development Rights (TDR) programs. TDR programs were introduced as a planning tool in the 1960s, but programs did not come into wide use until the 1990s (McConnell et al. 2004, 1). TDR programs have been used by states, counties and municipalities to preserve land for a variety of uses. The first section of this chapter provides a description of TDR programs, definitions of key terms, and praises and criticisms of TDR. The second section examines three TDR programs within the U.S. and outlines the criteria, goals, and structural and political components of each. The final section explores the feasibility of TDR programs in Hanover and Hartford.

Background and Definitions

TDR programs give landowners permits that approximate the amount of development possible on their parcel of land. These permits can be sold to developers, who can then exceed the density regulations on their land. Several key terms and the types of TDR programs are discussed below.

There are two main types of TDR programs: "single-zone" and "dual-zone" programs. In dual-zone TDR programs, development rights may be sold from a "sending site" to a "receiving site." A development right is one type of right that accompanies land ownership; it is the right to build a structure on a parcel of land. Sending and receiving sites are also referred to as sending and receiving "zones," "areas," "parcels," or "districts." Sending sites designate the lands upon which the program is attempting to limit development. Receiving sites designate lands upon which the program is attempting to guide development. Single-zone TDR programs attempt to limit overall development and do not designate separate sending or receiving sites. As a result of designating separate sending and receiving zones, dual-zone TDR programs may geographically guide development and preserve lands for specific purposes, such as the preservation of open space. The goal of this report is to evaluate ways for Hanover and Hartford to preserve open space lands. Therefore, we focus our research on dual-zone TDR programs.

Dual-zone TDR programs are typically mandatory and zoning-based. Each sending and receiving site is prezoned to a specified "base density," the maximum allowable development density without possession of TDR. Base density may also be referred as the "base zoning." Sending sites are zoned at a low base density in order to limit development, and receiving sites are prezoned at low base densities in order to encourage the purchase of TDR to allow for higher building densities. The maximum allowable development density of a receiving site with TDR is the "bonus density."

When underlying zoning regulations are considered, the "transfer ratio" may be calculated. The transfer ratio is "equal to the amount of development that can be transferred from the sending site divided by the amount of development that can be built on the sending site" (McConnell et al. 2004, 8). In order words, the transfer ratio is the ratio of how much development is possible through the sale of all permits and how much development is possible on the seller's site without the sale of any credits (McConnell et al., 2004, 9). "A high transfer ratio improves the landowner's relative payoff from selling TDR compared to developing her land and thus provides an incentive for the landowner to participate in the TDR Program" (McConnell et al. 2004, 9). Typical transfer ratios are one-to-one up to five-to-one (Pruetz 1997, 53). The TDR program of Indian River County, FL possesses a transfer ratio of forty-to-one, the highest transfer ratio in the country (Pruetz 1997, 53).

The number of transferable credits that a landowner may receive for selling his or her land in the TDR market depends on the method adopted by the TDR program for allotting credit. "For example, the local government can assign credits to each landowner in the sending area based on acreage, based on resource features on the parcel, or based on the value of an easement on the land" (Alliance for Quality Growth 2005, 4). The first, assigning credit based on acreage, is the most common method employed by current TDR programs and is the simplest method available. More involved methods may require site review by a surveyor.

Typically, once a landowner sells his or her development rights of a parcel of land, a deed restriction is placed on that parcel that restricts any future development. The deed restriction is a land preservation agreement that transfers all development rights from the landowner to the municipality. The type of deed restricted depends on the type of land restricted; the deed restriction may be termed an "agricultural easement" for agricultural lands, a "preservation easement" for historic lands, or a "conservation easement" for environmentally-sensitive lands (Pruetz 1997, 5).

The "TDR bank" may serve several functions to support the growth of TDR programs. A TDR bank may help establish a market for development rights. The bank may purchase rights from landowners in sending sites at a time when there is no demand from developers and later sell the rights to developers of receiving areas when demand arises. As a result, a revolving supply of rights is continuously available. TDR banks may also serve administrative duties to assist in transfers, such as: communicating between landowners and developers, providing education to prospective parties, and acting as a broker by managing transfers and maintaining a registry of past transfers (Alliance for Quality Growth 2005, 5). “Most TDR banks are…governmental agencies. However, it is possible for a TDR bank to be a nonprofit organization” (Alliance for Quality Growth 2005, 5). TDR banks may be funded by “federal and state grants, private foundations” or through “the purchase or donation and sale of TDRs” (Alliance for Quality Growth 2005, 5).

Benefits of TDRs Compared to Downzoning and Purchase of Development Rights

Amongst regulatory approaches to protect open space, several other tools exist besides TDR. Downzoning and purchase of development rights (PRD) are two of the most commonly used options. Downzoning is the practice of rezoning an area “so that densities or standards previously allowed on property are changed to further restrict the use of the property” (Etgen et al. 2003, iii). In other words, downzoning modifies either the construction density on a certain parcel of land (e.g. from one or two-acre lots to ten, twenty-five or fifty acre lots) or the permitted uses of the land, or both. Downzoning is useful in protecting open space, because it can prevent the subdivision of large parcels of land, making development significantly less profitable. In more restrictive permutations, downzoning can mandate that land be kept in its current use, preventing all future development. Downzoning acts to constrict the ways in which landowners can develop their land, thereby preserving that land’s agricultural status.

The equitability of downzoning is questioned. Downzoning diminishes the value of affected property, sometimes significantly because the value of agricultural use is generally much lower than development value. Purchase of Development Rights (PDR) and TDR both attempt to compensate a landowner for the difference between the development value and the current use value of the affected land. In a PDR program, the local government or a private entity such as a land trust purchases the development rights of a piece of property. The current landowner continues to use the property, but cannot develop it into a more intensive use, because those rights are held by a different entity. PDR programs successfully transfer the cost of preservation to the public (or the case of a land trust, the larger community of donors), but have one significant drawback: their cost (Quinn 1992). The government must directly compensate landowners for their development rights. The cases where this compensation is most needed are necessarily the places where that compensation comes most dearly. TDR programs can help to offset this problem by compensating landowners for their loss of development value without direct cost to municipalities.

TDR programs have several advantages over PDR: first of all, the cost to the government is considerably lower, because there is no direct compensation for the loss of development rights. Instead, a market for those rights is created, and developers compensate landowners. Secondly, because a market is created for development rights, a more efficient allocation of those rights should be possible (McConnell 2004, 7).

Potential Difficulties of TDR Programs

Potential difficulties associated with TDR programs include resolving community protest, reviving weak markets, and funding administrative costs. Sending and receiving sites may come with community protest from residents who do not want more development in their area.

Incorporating feedback from residents throughout the planning phase is crucial in fostering community-wide support (Alliance for Quality Growth 2005, 6). Suggestions for increasing community involvement during each step of establishing TDR program criteria are discussed in the *TDR Programs in Hanover and Hartford* Section at the end of this chapter.

TDR programs require an active market in order to succeed. TDR program criteria such as locations of sending and receiving areas, base densities, bonus densities, and transfer ratios play a large role in determining demand for TDR. If these parameters are not set carefully and do not reflect underlying demand for various housing densities, there will be little demand for permits and a weak market (Pruetz 1997, 76). McConnell et al. discuss several other major difficulties of fostering a market for TDR programs. First, "the amount of land preserved is variable at any time period, and may come at a high cost" (2004, 5). Landowners may decide at any time whether or not to sell their development rights; therefore, the supply of rights is unpredictable. Such unpredictability may limit development if the availability of rights does not coincide with purchase demand. As discussed earlier, the role of a TDR bank may mitigate this difficulty by maintaining a steady supply of TDR to sell to developers in times of high demand and by purchasing TDR from landowners in times of low demand.

The second difficulty is the potential for weak or "thin" markets (McConnell et al. 2004, 6). According to McConnell et al., thin markets may arise if:

> there are relatively few developers and they have access to information about a large number of potential sellers of TDR, then those developers may have some monopsony buying power…developers are likely to be small in number and well organized relative to private property owners…On the other hand, some areas may have many buyers of TDR but few sellers, leading to monopoly power on the supply side and its concomitant high prices and low numbers of TDR sold. (2004, 6)

A monopsony is a market scenario dominated by few buyers and many sellers. A monopoly is a market scenario dominated by few sellers and many buyers. Governments may step in to reduce either form of market from developing by setting a price cap or ceiling for each credit (6).

Transaction fees may also contribute to market thinness by discouraging sellers or buyers from participating in the TDR program due to cost. According to Pruetz (1997, 165-6), there are seven steps in each transfer process:

1. *Determine TDR Allocations* – the services of a professional surveyor may be required
2. *Conduct Title Search* – the services of a lawyer may be required to ensure that the sending site owner indeed possesses a title to his or her land
3. *Submit Draft Deed Restriction* – used to ensure that allowed uses of the land are consistent with TDR program requirements, the services of a lawyer may be required to review the agreement
4. *Record Deed Restriction* – the deed restriction is executed and recorded in town records
5. *Issue TDR Certificate* – the community issues the total allowable TDR to the sending site owner
6. *Transfer TDR Certificate* – the buyer purchases the TDR
7. *Redeem TDR Certificate* – once the buyer's project is approved by the community, the TDR is redeemed and the development at the receiving site may achieve extra density

Transaction costs may accompany each step in the process. There are two general types of transaction costs: "search and information costs" and "bargaining and decision costs" (Stavins 1995 as cited in McConnell 2004, 6). These include costs paid to the surveyors, lawyers, TDR bank or town staff employed to manage the TDR program and negotiate between sellers and buyers.

Costs to the seller or buyer in terms of time spent completing deed restrictions, negotiating TDR transfers, and seeking approval for development projects, may also deter participation in the TDR program. Towns may decrease monetary costs for sellers and buyers by subsidizing certain fees and providing legal services at no cost to sellers. The need for legal assistance in completing the draft deed restriction may be eliminated by providing model deed restrictions for sellers to follow (Pruetz 1997, 166). The town may also make the process more efficient by serving as or creating an agency to serve as a broker and/or TDR bank, as discussed in the *Background and Definitions* section**.**

Administrative costs of government participation in TDR markets to encourage efficiency and the costs of running a TDR bank or other brokering agency pose another difficulty in TDR programs. TDR banks are generally run by government agencies or non-profit organizations. The more roles and services provided by a TDR bank, the more costly its administrative budget. As suggested in the *Background and Definitions* section, TDR banks may be funded by “federal and state grants, private foundations” or through “the purchase or donation and sale of TDRs” (Alliance for Quality Growth 2005, 5).

The following section will examine three current TDR programs. Program goals and criteria, education methods, and administrative components are discussed. Factors that facilitated the success or limited success of the programs are also discussed. We examined these case studies in order to better inform Hanover and Hartford on best practices for TDR programs.

Introduction to Case Studies

This section examines three TDR programs in the U.S. The first case study is the TDR program of Montgomery County, MD. The next two case studies examine town-level TDR programs in South Middleton Township, PA and Williston, VT. For each program, the following is provided and discussed:

- Goals for adopting the TDR program
- Total land included in program and total land protected as a result
- The process of establishing the TDR program
- Method(s) of determining transferable credits given for preserved land
- TDR program criteria (such base density, transfer ratio, incentives)
- Education methods
- Administrative component

Montgomery County, MD. The TDR program of Montgomery County, MD is the most successful and widely studied TDR program in the U.S. The county’s goals are to preserve agricultural land that was rapidly being lost to urban development in the 1970. According to the 2005 American Community Survey, Montgomery County consists of 495 sq. miles of land. Of this total available land, the program designated 74,000 acres of rural land as sending sites and the rest as non-continuous receiving areas in nine communities (Pizor 1986, 205; Pruetz 1997, 212). By 2004, the program preserved approximately 43,145 acres of agricultural land (Pruetz, 2004).

The process of establishing the Montgomery County TDR program spanned several years. The Montgomery County Planning Commission created a task force to examine tools for protecting rural land. The task force determined that PDR was "too expensive" and that "downzoning seemed unfair" (Pizor 1986, 205). TDR was chosen, and the task force made sure that it would be just one component of a broader program to protect agricultural land from development. The task force understood that "while a land preservation program was necessary to preserve farmland, additional programs would be needed to keep farming viable as a livelihood" (Pizor 1986, 205).

After the success of a pilot program in a small, rural region the Planning Commission sought community involvement and support for rural preservation. "The Commission sought public comment at twenty-four formal meetings, and it assembled extensive information about the number, distribution, and economic health of county's farms" (Pizor 1986, 205). In 1980, the county *Master Plan for the Preservation of Agriculture and Rural Open Space* was adopted and included TDR.

Montgomery County employs a simple method for determining the number of transferable development rights given for preservation of a parcel of land in sending areas. For every five acres, one development right is given. No other requirement for land is required other than being located in a sending area. Base densities of receiving areas were limited to one dwelling unit per five acres and sending areas were limited to one dwelling unit per twenty-five acres. The transfer ratio of five development rights for one additional housing unit was used (Alliance for Quality Growth 2005, 9); "in other words, the County's plan allowed five times as much development if the development rights were transferred to a receiving site rather than used at the sending site" (Pruetz 1997, 210). For example, if a landowner in Montgomery County possessed 25 acres of farmland and wanted to sell all of his development rights, he would receive one TDR for every five acres, or five TDR in total. He would still be allowed to have a maximum of one dwelling on the farmland because the base density of sending areas is one dwelling unit per twenty-five acres. If a developer who owned five acres of land in the receiving area wanted to build one more unit above the base density (one dwelling unit per five acres), he would have to purchase five TDR. Maximum densities, or bonus densities, are different for each receiving site (Pruetz 1997, 212). A bonus density of 40 percent is used in one receiving area (Pruetz 1997, 57).

As discussed earlier, the county began educating its residents during the planning phase of the TDR program while at the same time seeking and fostering community involvement through focus groups and education. After the program became official in 1980, booklets describing the program were distributed (Pizor 1986, 207).

Montgomery County provided administrative and financial support to landowners and developers during the beginning stages of the TDR program. An important decision by county planning staff to facilitate transactions by serving as an informal broker greatly contributed to the success of the program. According to Pizor (1986), planning staff:

> provided the names of people who were interested in buying or selling rights; they met with attorneys and real estate brokers to devise model listing agreements and title search procedures and to resolve questions pertaining to the transfer and recording of rights. Many developers and landowners praised the thoroughness of and the help provided by staff in the responding to start-up questions. (207)

According to Pruetz, "the cost of managing the program is reported to be minimal since the TDR approval process is incorporated within the subdivision review and approval process" (1997, 213). As a result, the TDR transaction process shares the efficiency of the subdivision process as well (Pruetz 1997, 213).

The New Jersey Pinelands TDR Program is another successful and well-studied TDR program. Due to the success of both programs, the Pinelands program has often been compared and contrasted with the Montgomery County program. In contrast to Montgomery, Pinelands did not designate any facilitator for transfers at the start of their program and as a result, “many developers were reluctant to attempt to use development rights, and implementation of the program was consequently slower than in Montgomery County” (Pizor 1986, 207). Farmers urged the Montgomery County planning commission to establish a TDR bank that would “issue loan guarantees with the development rights as collateral and may acquire, hold, and sell development rights” in order to “provide a guarantee value for rights should a strong market fail to develop” (Pizor 1986, 207). The role and components of a TDR bank is discussed in the previous *Background and Definitions* section.

According to Machemer and Kaplowitz, Montgomery County is a rapidly growing area and has been since the 1950s due to a nearby urban center (2002, 786). The success of Montgomery’s TDR program “at accommodating growth, protecting agricultural lands and directing development to appropriate locations continues to increase the desirability of the county as a place to live” (Machemer and Kaplowitz 2002, 786).

South Middleton Township, Cumberland County, PA. Unlike the TDR program of Montgomery County, the TDR program of South Middleton is based at the township level. The goals of South Middleton include protecting open space, working farmland and groundwater resources (South Middleton Township, PA 2007a). According to 2000 US Census Data, the total area of land in the township is 49.47 square miles with a population of 13,000. The South

Middleton program may inform best practices for possible TDR programs in Hanover and Hartford given that its size, population, and preservation goals are similar to those of both towns. However, according to a brief by the Cumberland County Planning Commission, the South Middleton TDR program has received little use (CCPA 2003). According to Timothy Duerr, Chief of Planning, Zoning and Code of South Middleton, the TDR program has preserved 117 acres of farmland to date (personal communication on May 29, 2007).

The TDR Program criteria are outlined in Sections 1632-1634 of the 2007 South Middleton Zoning Ordinance (South Middleton Township, PA 2007b). Sending areas are zoned as Agricultural Conservation or Residential Low-Density zones. Several requirements exist for sending areas (Pruetz 2006, para. 2). According to Pruetz, South Middleton employs an evaluation system for determining the number of transferable credits given for preserved land:

> To determine the number of TDRs available for transfer, sending area landowners must submit a plan of the proposed sending site prepared by a surveyor depicting the property boundaries and all existing buildings, topography, flood plains, easements and rights of way. (2006, para. 3)

The requirement of a site review by a surveyor delays the crediting process. If such fees are paid by the landowners, the costs may prohibit or intimidate landowners from initiating the transfer process. If the broker agency funds the land surveys, costs on the agency may limit development in other areas such as program education, advertisement, registry maintenance and staff support. To facilitate the allocation and transfer process, the Town Engineer and Zoning Officer may survey the land and provide a conservative estimate of conservable land (South Middleton Township, PA 2007b). The method for calculating “baseline acreage,” or how much land is available for transfer, is outlined in Section 1633 of the Zoning Ordinance (South Middleton Township, PA 2007b). Pruetz (1996) summarizes the town’s methods for determining baseline acreage:

> To calculate baseline acreage, the total tract area is reduced by: 1) the area of land already precluded from development by easements or other restrictions; 2) land within rights-of way; 3) the area that results when the number of dwelling units on site is multiplied by the minimum lot size for the zoning district applicable to the sending site; and 4) any part of the site not within the sending area. This baseline acreage is then divided by 2.3 for land zoned AC or by 1.5 for land zoned RL. (para. 3)

Although most TDR programs establish uniform baseline acreage, South Middleton's program determines baseline acreage for land parcels on a case by case basis. The number of TDR allocated depends on the baseline acreage. For example, landowners with transferable lands with at least 15-30 acres of land that meet baseline standards are allocated three TDR (South Middleton Township, PA 2007b). A complete list is available in Section 1632 of the township's Zoning Ordinance.

Receiving areas are located in the Residential Moderate-Density zone (RM), the Residential High-Density zone (RH), and cluster developments in the AC and RL zones. The preservation tool of cluster developments is discussed in Section 1.2.3 of this report. The bonus density allowed to developers depends on the type of housing being developed and is determined using a set of equations listed in Article 8, Section 804 for RM zones and in Article 9, Section 903 for RH zones. The greatest incentive is for detached single-family homes (South Middleton Township, PA 2007b). The minimum lot size of a detached single-family home in the RM zone without TDR is 15,000 square feet. If the developer purchased a TDR, "the [minimum] lot size is determined by the following formula: 37,000 square feet divided by the TDR credits/total acres + 2.5" (Pruetz 1996, para. 4; South Middleton Township, PA 2007b). For example, if a developer owned one acre in the RM receiving area, he or she would be able to develop only 40 percent of the land (or 17,242 sq. feet) due to building coverage restrictions applicable to all RM lands, outlined in Article 8, Section 804 of the Zoning Ordinance. Without purchasing TDR, the developer would only be able to build one dwelling of a minimum lot size of 15,000 sq. ft. If the developer purchases one TDR, the minimum lot size of the dwelling would need to be only 10,571 sq. ft, and would further decrease with each TDR purchased.

The town officials of South Middleton manage the TDR program up to the point of negotiation between seller and buyers: "A person interested in learning the process, obtaining a determination as to the number of TDR credits available on their property or finding which properties have had TDR credits issued would contact the Township" (T. Duerr, personal communication on May 29, 2007). Negotiations are managed independently by sellers and developers:

> all financial transactions are negotiated and carried out between the potential developer and the TDR credit holder. All agreements resulting from those negotiations are between the 2 parties mentioned & do not involve the Township. The agreements are then brought to the Township at the time the developer begins the approval process to use the TDR credits. (T. Duerr, personal communication on May 29, 2007)

No TDR bank has been established by the South Middleton TDR program.

Williston, Chittenden County, VT. The primary goals of the TDR program are to preserve parks, open space, and rural character (Town of Williston, VT 2004; Pruetz 1997, 331). According to 2000 US Census Data, the town of Williston consists of 30.34 sq. miles of land with a population of 7,650. As of 2004, only one transfer has ever occurred in Vermont, which took place in the town of Stowe (Colchester Planning Commission 2004).

According to Pruetz, "the pressure for new development in [Chittenden] County is relatively high compared with the growth rates for Vermont as a whole," due to an IBM plant (Pruetz 1997, 331). That growth is towards Williston thanks to its sewer system. Concerned with this growth, the town adopted a TDR ordinance in 1990. Section 4.7 *Transferable Development Rights* of Article 4: General Regulations was included in the Williston Zoning Ordinance. Sending areas were identified in the Williston Comprehensive Plan *Open Space Master Plan.* Williston County's 2006 Comprehensive Management Plan also encourages methods other than TDR programs for achieving guided development away from preservation zones, such as cluster development and conservation subdivisions as noted in the *Feasibility of a Transferable Development Rights Program for Athens-Clarke County, Georgia* report (Alliance for Quality Growth).

Section 4.7 outlines the sending areas and receiving areas, the transfer rate, base densities, and transfer ratios. Three zones: Village Center, Medium Density Residential, and Agricultural/Rural Residential, are included in the plan (70). Each serves as a sending and receiving area. Transfer ratios are determined as follows:

- From Village Center, at a sending rate of 1 unit per acre, to Village Center, to Agricultural/Rural Residential and to Medium Density Residential.
- From Medium Density Residential, at a sending rate of 1 unit per acre, to Medium Density Residential.
- From Agricultural/Rural Residential, at a sending rate of 1 unit per 5 acres, to Agricultural/Rural Residential and to Medium Density Residential. (70)

Maximum bonus densities are 3 units/acre for the Village Center zone, 3 units/acre for the Medium Density Residential zone, and 2 units/acre for the Agricultural/Residential Zone (70). According to Pruetz, “unlike most TDR programs, which offer a one-to-one transfer ratio or better, the Williston program offers fewer development rights for transferring than for building on site” (1997, 331). This is because “it is impossible to actually achieve the baseline zoning densities allowed by the code due to site constraints,” such as poor soil quality or unsuitability to septic systems (331-2). As a result, the maximum base densities for the sending sites are unachievable (331).

According to Section 4.7.3 *Transfer of Transferable Development Rights* in the Williston Zoning Ordinance, a Deed of Transfer is required to register transferable lands and to determine the number of development rights allocated. Completing and filing the deed is required of both the landowner and developer. The Williston TDR program does not have a broker or bank established to assist landowners and developers in potential transfers. Rather, town officials oversee transfers and have a direct hand in the transfer process; the easement agreement "must be signed by both the landowner and the chairman of the Town Select Board after a recommendation from the Town's Planning Commission" (Pruetz 1997, 331-2). No educational materials are available on the town website for interested parties. Developers are allowed one additional unit of development for each TDR and no other incentives.

As of 2004, no use has been made of the Williston TDR program. According to the minutes of a Colchester Planning Commission meeting, "TDRs have not worked in other areas (Williston and Stowe) most likely because not enough incentives were offered" (CPC 2005). Former town Planner David H. Spitz agrees that "the incentives to use TDR have not been well established" (Pruetz 1997, 332). Moreover, there is little demand for higher density development in receiving areas because of the restrictive maximum bonus densities outlined above. The density bonus with TDR of receiving areas is not much greater than sending site density, and "as a result, there may be little motivation for developers to pay for land in receiving areas, where sewer is available, much less pay for transferred development rights when they do not need the additional density" (Pruetz 1997, 332).

Case Studies – Lessons Learned

The three case studies offer valuable insight into the makings of a TDR program. Below are the key components of each case study that we believe contribute to the success or limited success of each program.

Montgomery County, MD.

- The Montgomery County planning commission created a task force to examine tools for protecting rural land and to determine the best tool for the County.
- The Planning Commission sought community involvement and support for rural preservation through focus groups and educational booklets.

- The TDR program was just one component of a broader program to protect agricultural land from development.

- Montgomery County employs a simple method for determining the number of transferable development rights given for preservation of a parcel of land in sending areas.

- The TDR approval process shares funding and administrative support with the subdivision review and approval process. As a result, the TDR transaction process shares the efficiency of the subdivision process.

- The county began educating its residents during the planning phase of the TDR program while seeking and fostering community involvement, by making education materials widely available and organizing focus groups.

- County planning staff members facilitate transactions by serving as informal brokers.

- Established a TDR bank when urged by local farmers.

- Montgomery County has been a rapidly growing area and has been since the 1950s due to a nearby urban center. The success of the County in preserving its rural character contributes to its desirability.

South Middleton Township, PA.

- South Middleton employs an elaborate evaluation system for determining the number of transferable credits given for preserved land, and the requirement of a site review by a surveyor may delay the crediting process.

- The option of cluster developments for preserving open space and agricultural lands is available in receiving zones.

- The program requires that the amount of land a seller may transfer (baseline acreage) is determined on a case by case basis according to guidelines outlined in the Zoning Ordinance.

- There is no TDR bank.

Williston, VT.

- Williston's 2006 Comprehensive Management Plan encourages methods other than TDR programs for achieving guided development away from preservation zones, such as cluster development and conservation subdivisions.

- Town Planners believe that not enough incentives are offered to potential buyers.

- The density bonus with TDR of receiving areas is not much greater than sending site density.

- There is no TDR bank.

Lessons Learned. The level of planning that took place in Montgomery County surpasses many TDR programs and greatly contributed to its success. A task force determined that the best possible method of land preservation for Montgomery County was a TDR program. South Middleton, PA and Williston, VT encourage cluster development or conservation subdivisions along with TDR, and as a result, developers may choose clustering as a way to increase their density rather than purchase development rights from TDR programs. Montgomery County's TDR program is fully integrated in the Zoning Code and does not compete with other forms of open space planning tools. As a result of focusing on one type of tool, Montgomery County staff may concentrate time and monetary resources into facilitating transfers, administrative tasks, education, and advertising for the TDR program.

The TDR program criteria of Montgomery County are clear and relatively simple compared to the criteria of South Middleton and Williston. The Montgomery County website also provides extensive literature on the TDR program and education for potential sellers and buyers (Montgomery Planning Department 2001). No such education is available on the South Middleton or Williston town websites (Township of South Middleton 2007a; Town of Williston 2007). In Montgomery County, to assist sellers and buyers, the TDR approval process is imbedded within the subdivision review and approval process. The subdivision process was already well established and efficient.

Montgomery County established a TDR bank in the early stage of its program when urged by local farmers. Pizor suggests that because the bank did not actually operate until 1985, five years after its creation and the creation of the TDR program, its existence had no effect on the program during the initial five years (1986, 207). However, we believe that the creation of a bank may have increased farmers' faith in the Planning Commission to answer to their concerns, and the existence of a bank may have increased landowners' and developers' confidence in the newly established TDR program. South Middleton, PA and Williston, VT never established a TDR bank, and as a result, the towns are not able to "provide a guarantee value for rights should a strong market fail to develop" (Pizor 1986, 207). Sellers may be unwilling to sell their development rights without a guarantee of a return.

TDR Programs in Hanover and Hartford

Introduction. In 2005, the University of Georgia Alliance for Quality Growth and the Athens-Clarke County Planning Department joined forces to produce a report entitled *The Feasibility of a Transferable Development Rights Program for Athens-Clarke County, Georgia.* Hartford and Hanover share several of the preservation goals of Athens-Clarke County, including preservation of open space, farmland, and forestry land (Alliance for Quality Growth 2005, 1). According to the report, four main components of a feasibility study for the appropriateness of a TDR program by a local government are:

1) a legal analysis to determine if the local government possesses authority to create TDR ordinances
2) a comprehensive study to identify potential sending and receiving areas
3) economic issues associated with potential TDR markets
4) and an assessment of interest from potential sellers and buyers

Legal Analysis. US Constitutional law provides local governments with the authority to create TDR ordinances. According to the feasibility report:

> TDR programs were given federal approval by the United States Supreme Court in *Penn Central Transportation Co. v. New York City*…The Court in this case did not find that TDRs are necessarily "just compensation" for a taking, if one occurs. However, it did find the ordinance constitutional, and that the TDRs mitigated the financial burden on the plaintiffs and must be considered when considering the impact of the regulation in determining whether a taking has occurred. (18)

State Law. NH RSA 674(21) Local Land Use Planning and Regulatory Powers of Title LXIV Planning and Zoning grants any municipality in New Hampshire the authority to establish a number of innovative land use controls including TDR programs. Any town in Vermont may establish a TDR program in accordance with Section 4407(16) of the Vermont Municipal and Region Planning Development Act (24 V.S.A. Chapter 117). Currently, several towns in Vermont have established TDR programs. These include programs in Stowe, Colchester, Jericho, Williston, and South Burlington (Pruetz 1997, 2003). The last four towns are located within Chittenden County in Northwestern Vermont. Two municipalities in New Hampshire have established TDR programs: the city of Dover and the town of Lee (Pruetz 2004b).

Master Plans. Chapter 5: Open Space Lands of the 2003 Hanover Master Plan mentions the need for a long-range plan to protect open space and the need for “land use strategies that protect appropriate conservation lands [and] connect these lands to promote uses that maintain open space, such as agriculture and forestry” (10). Chapter 2: Land Use of the 2003 Hartford Master Plan specifically mentions TDR programs as a potential strategy for preserving farmland, along with overlay districts and increased density for suitable growth areas.

Zoning Regulations. A section for a TDR ordinance should be included in the town Zoning Ordinance. The TDR ordinance should include: location of sending and receiving areas, procedures for transaction, sending site eligibility, program criteria, transfer options, methods for calculating development rights, deed restriction requirements, receiving zone regulations, and types of administration or assistance available to interested parties (Town of New Gloucester Zoning Ordinance 2006, Article 9).

Zoning should match the goals of the TDR program and revised Master Plan. Incompatible zoning ordinances with TDR program goals have contributed to the failure of TDR programs. According to the Atlanta-Clarke feasibility report:

> Programs that have had less success have often had one of several problems: 1) developers are satisfied with development densities allowed by the existing zoning code and therefore have had little motivation to use the TDR program, 2) rezonings allowing greater density are easily granted by the local zoning body, making the use of TDRs unnecessary, and 3)

> developers use other methods for achieving density, such as clustering/conservation subdivisions, rather than TDRs. (10)

Williston County's 2006 Comprehensive Management Plan and zoning in South Middleton, PA encourage methods other than TDR programs for achieving guided development away from preservation zones, such as cluster development and conservation subdivisions. Such land use planning tools lessen the attractiveness of the TDR program, and may account for the limited success of TDR programs in each town.

Potential Sending and Receiving Areas. Sending and receiving areas must be specified in the local government Comprehensive, or Master Plan and Zoning Ordinances.

Sending Areas for Hanover. Potential sending areas of open space, agricultural, and environmentally sensitive lands for preservation have been identified in the 2003 Hanover Master Plan. In Appendix 3-2: Summary from Scenic Locals Committee Report of the 2003 Hanover Master Plan, continued agricultural use and permanent preservation through conservation easements is recommended for two locations: Etna Farm at Ruddsboro Road and the Trescott Ascutney Viewshed (2).

Receiving Areas for Hanover. Downtown Hanover may serve as a potential receiving area. In the 1998 Hanover '*Something for Everyone' Scenic Locales Report*, Etna Village and Hanover Center were noted as two areas where there exists "competing interests of…very special scenic village character…*versus* the high (and increasing) volumes of traffic and the rate of development (Town of Hanover, NH 1998). Designating these areas as receiving areas would take advantage of their high rates of development in order to preserve the agricultural use of Etna Farm and the Trescott Ascutney Viewshed.

Sending Areas for Hartford. In the Hartford Master Plan, Chapter IX: Natural Resources of the 2003, the establishment of Agriculture and Forestry Zoning Districts in the Rural South to protect forest and agricultural resources is recommended. Maximum density in these areas would be one lot per 28 acres. The Forestry Zoning District "would encompass the three core forest areas (the greater Hurricane Town Forest/Ottauquechee area, Jericho/West Hartford area and the eastern portions of Quechee)." The Agricultural Zoning District would "encompass the prime agricultural lands in Town, especially the Jericho area, the Quechee-West Hartford Road area, the Hillside Road area, the Connecticut River Road area, and the Route 5 South lands."

Receiving Areas Hartford. Chapter 2: Land Use of the 2003 Hartford Master Plan highlights two potential areas for development: the Route 5 South corridor and the Route 14 corridor (93). According to the Master Plan, 58.6 acres of Route 5 South is developable; the acreage of developable land in Route 14 is unknown. Care should be taken that Route 5 South lands marked for development are not included in the Route 5 South lands that may be included in the potential Agricultural Zoning District. Both areas have been zoned for Commercial and Industry, however, water and sewer must be extended to these areas before they are designated as potential receiving areas for development.

Economic Issues. The success of Montgomery County's TDR program is also attributed to organizers' careful designation of sending areas. According to Machemer et al. (2002), organizers recognized that certain lands may not be suitable for preservation:

> Primary reasons given for Montgomery County's success include… the recognition that some farmland in the path of growth at the southern end of the county could not be protected because of rising land values and the reduced desirability of farming in developing areas (9).

An analysis of property values and potential values of open space lands in both towns would assist in the process of designating sending areas. Towns could harness the development potential of certain open space lands that are highly desirable due to proximity to "the path of growth" by designating such areas as receiving zones. In Hanover, land with proximity to the Downtown Main Street area would serve well as receiving areas, as well as land in Etna Village and Hanover Center. In Hartford, the Route 5 South corridor and the Route 14 corridor are within “the path of growth.”

Seller Value of TDR. The report outlines the steps for projecting the per acre value of undeveloped land. First, property tax records should be examined for land values of undeveloped tracts. Second, developers and engineers are consulted. Third, a state-wide survey is conducted to determine the willingness of landowners to sell their development rights. In the Alliance for Quality Growth report, the values derived from all three approaches matched closely. Authors found that “for landowners to voluntarily sell their TDRs and achieve the community’s land preservation goals, landowners should be able to negotiate a price in the range of $6-8,000 per acre of land preserved” (Alliance for Quality Growth 2005, 27).

The Hanover Assessing Department may be able to determine land values of undeveloped land by averaging land values across the town based on the 2006 Current Assessments (Town of Hanover, NH 2006a). However, land values vary greatly under the current assessment methods (Town of Hanover, NH 2006b). In Hartford, the Board of Listers compiles a list of property values each spring (Town of Hartford, VT 2007). Values of undeveloped land may be derived from this list. However, the second step of consulting developers and engineers, and the third step of a town-wide survey to determine the willingness of sellers to part with their development rights should be undertaken before each town estimates the value for undeveloped land.

Developer Value of TDR. Developers purchase TDR to increase the number of units they may build on their lots. Other benefits may encourage developers to purchase TDR, such as “waiving certain design requirements, or…allowing innovative mixed use projects” (Alliance for Quality Growth 2005, 27). TDR programs utilize various equations to determine how much of an incentive each development right gives to developers. Programs may alter these equations during the life of the TDR program in response to feedback from the market.

According to Pruetz, the percent of the density bonus does not determine the success of the TDR program; "some of the most successful TDR programs in the country have a relatively small density bonus" (1997, 57). And, "conversely, programs with some of the highest density bonuses have experienced relatively few transfers" (Pruetz 1997, 57). Pruetz outlines the density bonuses used by several successful programs: Montgomery County, MD – 40 percent, Dade County, FL – 18 percent, and Calvert County, MD – 150 percent (1997, 57).

The density bonuses vary greatly among the three programs above. Most density bonuses are 100 percent or less (Pruetz 1997, 57). Hartford and Hanover should gather input from local developers concerning what they would value most as incentives. The Departments of Planning and Zoning in each town should also consider environmental constraints and community opposition when determining maximum allowable density with TDR. The following section, *Interest from Potential Sellers and Buyers*, suggests several methods for garnering public opinion and support.

Interest from Potential Sellers and Buyers. Incorporating feedback from residents throughout the planning phase of the TDR program is crucial in fostering community-wide support (Alliance for Quality Growth 2005, 6). Within the report is a suggestion for how to increase public involvement and community support for the TDR program:

> TDR expert Rick Pruetz recommends the creation of a Citizens Advisory Committee (CAC), representing various interest groups, to assist with the planning process. These groups include landowners in potential sending and receiving areas, developers, real estate professionals, homeowner groups, and community activists, working with planning staff support. Under Pruetz's scheme, normally a CAC would have been appointed before the beginning of development of any TDR scheme…The CAC could also be crucial in organizing community meetings and hearings to gather general community input on the process and plan. (6)

Hartford recently used a similar method to increase community voice in their most recent proposed Master Plan revisions; through a Master Plan Steering Committee and diverse focus groups, planning staff were able to achieve more community input compared to if they had used surveys (L. Hirshfield, personal communication, April 30, 2007). A similar strategy employed by Hartford to gather community input and support for the Master Plan revisions should be used to gather public input and support for a TDR program. The implementation of a TDR program affects all residents; attention to maintaining interest from landowners (sellers) and developers (buyers) is crucial for success of TDR programs.

Montgomery County sought the interest and confidence of sellers and buyers during the early stages of its TDR program by establishing a TDR bank. Also, real estate firms in Maryland "list TDRs and collect commissions for the sale of development rights" (Pizor 1986, 207). Sole responsibility for transaction execution and filing is not on the seller or developer and as a result, more transfers are undertaken. Establishing a TDR bank requires at least one staff person and start up funds. Hanover and Hartford should each establish their own TDR bank run through the Town Offices. Montgomery County imbedded the TDR approval and transfer process within their subdivision process. Hanover and Hartford have subdivision processes in place headed by the Departments of Planning and Zoning, and should incorporate TDR approval and transfer into the duties of staff from this department. Each town should hire at least one staff person who would serve as the "broker" and coordinate between Planning and Zoning, legal counsel, buyers and sellers.

Once the TDR program begins selling TDR, the bank should be self-funding from revenues of TDR transfers. In *Saved by Development*, Pruetz (1997) provides information concerning how established TDR programs acquired initial funding for TDR banks:

> …San Luis Obispo County, Monterey County, and the Malibu Costal Zone, all in California, received initial funding from the California Coastal Conservancy. State governments can also greatly assist by offering grants and loans…However, where there is local support, communities can raise their seed money themselves. (63)

Hartford and Hanover should partner with local organizations dedicated to preserving land resources. For example, the towns may receive grants from the Upper Valley Land Trust or work with the organization to raise funds for a TDR bank. Vital Communities may also aid in the startup of TDR banks either through advising or monetary resources. Hanover's 1998 *Scenic Locales Report,* recommends that the town research state and federal funding opportunities for land preservation. The Report also notes the existence of a Land Acquisition Fund, "which can be used for land purchase or Capital Improvements" (Town of Hanover, NH 1998). The Fund is replenished by taxes earned when landowners remove their property from NH's Current Use Program, that are not incorporated into the town budget drafted by the Select Board (Town of Hanover, NH 1998). As of June 30, 1997, "the balance in the Land Acquisition Fund was $269,604" (Town of Hanover, NH 1998). Opportunities for municipal, state, federal, or foundation funding for TDR banks exist for both Hanover and Hartford.

Easily accessible sources of information would maintain and develop interest from potential sellers and buyers. TDR program criteria, the transfer process, news of recent successful transfers, and other information of interest for sellers and buyers should be readily available online, in banks, real estate offices, and town offices, as well as distributed during annual town meeting. The role of the broker, or administrative agency could adopt this responsibility. The broker could also directly facilitate transfers by working as a mediator between sellers and buyers; "the presence of a facilitator (the Montgomery County planning staff) during the first transactions under a new TDR program appears to have smoothed many difficulties in Maryland" (Pizor 1986, 210). Pizor also provides specific activities for a broker or facilitator to maintain and develop interest, including: “developing forms for recording transfers, multiple listing forms, model contracts of sale, and question-and-answer brochures and making presentations to affected groups” (210).

Conclusions

The creation of a task force to guide the TDR process would help ensure that preservation goals are met, development is thoughtfully guided, and that supply and demand for development rights is adequate for a healthy TDR market. Several agricultural and forestry zones, and potential development zones are suggested in the Master Plans of both towns. A GIS assessment of Hanover and Hartford would aid in the identification of other possible sites. An analysis of property values and potential values of open space lands in both towns would assist in the process of designating sending areas. The towns could harness the development potential of certain open space lands that are highly desirable due to proximity to “the path of growth” by designating such areas receiving zones.

TDR and PRD (Planned Residential Development), or cluster development as discussed in the *Build-Out Analysis* section are both powerful tools for protecting open space. They may be used in conjunction. In Charles County, Maryland, TDR are used to maximize the value of PRD to landowners (Charles County, Maryland). For example, PRD is allowed in one type of zone only with the purchase of TDR (Charles County, Maryland). Without TDR the “maximum allowable density may be lower than traditional PRD” to encourage the purchase the TDR to build at higher densities (Charles County, Maryland). Densities on a PRD may increase from one dwelling unit per acre to three dwelling units per acre per TDR acquired by the developers (Charles County, Maryland). Hanover and Hartford should closely consider both PRD and TDR as preservation tools.

Projecting the value of undeveloped land would aid in determining an appropriate value of each TDR. The value for developers to purchase development rights should exceed the cost of each TDR. Allowing additional density in the receiving areas is a common incentive. Incentives are decided after approximate values of undeveloped land are determined and should incorporate input from developers. A TDR bank and an administrative staff position should be created to facilitate transfers, provide education, and possibly purchase and sell development rights. The bank and/or broker would serve as the center of information, answer questions, provide necessary forms, negotiate between sellers and buyers, and maintain transaction records.

Earlier we noted that the Montgomery County TDR Program, the most successful in the country, understood that a program to maintain open space and farm land would only succeed if "additional programs…to keep farming viable as a livelihood" were developed as well (Pizor 1986, 205). In the following chapter, *Economies of Scale and the Role of Farming Cooperatives*, we take a close look at farming cooperatives as a one method of maintaining and promoting agricultural livelihoods in Hanover and Hartford.

1.3.2 - Economies of Scale and the Role of Farming Cooperatives

Both Hanover and Hartford, as stated in their Master Plans, wish to maintain the tradition of agriculture present in their respective communities. To help fulfill that wish we examined the idea of cooperative agriculture. Cooperative agriculture is a mechanism that can help small farms deal with disadvantages they experience due to economies of scale. The formation of cooperatives could help to strengthen the existing state of agriculture in both Hanover and Hartford, therefore helping to preserve it. Through the use of cooperative agriculture, Hanover and Hartford may avoid the division of farmland into residential development after farmers are forced by economic circumstances to sell their land. Functioning farms are integral to preserving both open space and the working landscape in both towns.

Methodology

In evaluating the possibility that cooperatives may help Hanover and Hartford, we conducted research on farms to determine a definition of a cooperative, the different types and what the different types provide. We sought information on the benefits of cooperatives as well as the challenges that they present. Two methods were used to gather data on Hanover and Hartford agriculture. First, the Valley food and farm guide from Vital Communities was consulted both for information and for contacts. Secondly, a phone call was placed to each farmer in both Hanover and Hartford. Two interviews were then conducted with the two who responded. Both interviews took place over the phone. Initially the overarching mission of our class project was introduced, followed by our aim of maintaining the working landscape by preserving and perhaps strengthening the farms in the area. Finally, it was stated to the interviewee that cooperative agriculture was the tool for strengthening farming that was being evaluated. The interview began with same three questions for each farmer. From there, further questions where asked based upon the response given. Finally, before concluding the interview, the interviewer summarized the main points made by the interviewee to be sure that an understanding had been reached. At this point we concluded the interview. The two farmers we interviewed were George Miller and Ray West. George Miller owns and operates Val Vu Farm in White River Junction. He is primarily a dairy farmer. Ray West owns and operates Raycin Farms in White River Junction. He raises cattle for beef and also grows blackberries. See Appendix 1C for the details of the interview process.

Why Form a Cooperative?

In Britain, cooperatives were formed in the 1800s as a way to deal with depressed economic and social conditions that were a result of both Britain's struggle with Napoleon, as well as the industrial revolution (USDA 1997, 2). While Hanover and Hartford certainly do not face military struggles, local farmers told us that it is difficult to survive in light of high property taxes. Labor is also a concern as other employment options that are less strenuous offer equal or better compensation. Clearly the farms in this area face a number of economic challenges that cooperatives can help to address.

Cooperatives help farmers in a number of ways: they help to get a service, to find a source of supplies or a market for products, or to combat the increase of input costs to producing agricultural products. Federal and state statutes for cooperative business identify three principles through which these goals are achieved. The first is the User-Benefit Principle, which as the USDA explains, occurs when "members unite in a cooperative to get services otherwise not available, to get quality supplies at the right time, to have access to markets or for other mutually beneficial reasons. Acting together gives members the advantage of economies of size and bargaining power" (USDA 1997, 5). We will discuss the specifics of Hanover and Hartford farms more fully later, but we found that this User-Benefit principle would be especially useful in Hanover and Hartford, where the largest farm size is about 200 acres (G. Miller personal communication on May 21, 2007). A decrease in the number of small farms, which we noted in Hanover and Hartford, is often due to a decrease in support pricing, an increase in input costs, or both (Kumbhakar 1993, 336). While the cooperative cannot control the support pricing or rather the price at which goods are sold, it can help to decrease input costs through collective buying, thereby raising incomes through a decrease in costs. This occurs because cooperatives are able to approach the economies of scale enjoyed by larger individual farms. Therefore, cooperatives can achieve a cheaper price per unit. Acting as individuals buying on a much smaller scale, they will not see the benefits of buying at the cheaper per unit price that larger farms that buy more volume would see. As the USDA explains, "acting together gives members the advantage of economies of size and bargaining power" (USDA 1997, 5).

Other benefits that cooperatives offer are valuable to Hanover and Hartford. Both the User-Owner and User-Benefit principles can help maintain stability and interest in farming which will help to keep these important industries in the community. The User-Owner principle defines ownership of the business to the people who are involved in running it. The people who use a cooperative are the members and owners. It is an incentive to the owners and users to provide the financing and keep the business running, both to protect and encourage growth of their own investment (USDA 1997, 5).

This principle leads into the User-Control Principle, which states that members are also owners; their control of the business is exercised through voting rights. Voting rights are distributed so that each member has one vote; everyone is an equal partner. In certain cases, members may have more than one vote, although this will be based equitably upon their involvement and contribution to the cooperative. This provides members an incentive to participate in the cooperative.

The advantage of the User-Control principle is increased control for the members. Only members can vote to elect directors and to approve proposed major legal and structural changes to the organization. The User-Control principle "keeps the cooperative focused on serving the members, rather than earning profits for outside investors or other objectives" (USDA 1997, 6). This also acts as a tool to keep businesses within the community, because "when many local people share the ownership of a cooperative, no individual or company can take it from your area or simply close it. Only the membership as a whole can make such decisions" (USDA 1997, 6). When the cooperative's members control the decision-making process collectively, and those members are also users and community members, it increases the chances of the business staying within the community rather than being sold to outsiders. In any case, it will make it difficult for an individual to sell their land to another party as they are part of the cooperative and the decision must be made by the members as a whole. Whether or not the cooperative proves profitable, this principle makes it difficult for an individual to decide to sell his land to someone based upon its perceived value for some higher use—in our study, often residential development. By binding the community together as members of an agricultural cooperative, the principles outlined here may serve as one step in helping Hanover and Hartford achieve their goals of preserving open space and working landscapes.

Beyond the principles and services discussed above, cooperatives can help businesses by pooling their resources. Of course, the success of any cooperative depends largely on the fact that it must prove profitable enough for members to continue its use. Cooperative members may find that after pooling their resources they have not grown enough to see the benefits that the cooperative was intended to provide. This could be because the scale of a cooperative in AT the town level has proven too small. In these cases, farmers should look to increase the scale of the cooperative.

Types of Cooperatives

Cooperatives can vary greatly in scale, from local through super local regional and finally multinational cooperatives, all of which are defined by the geographical area in which they operate. The scale that would most likely suit Hanover and Hartford is a local cooperative. The

USDA defines a local cooperative as one that “operate[s] in a relatively small geographic area, typically a single county or an area within a radius of 10 to 30 miles and they usually have only one or two facilities, from which to serve members” (USDA 1997, 20). There are larger farms in the area however, and the incorporation of those farms could increase the volume of business and benefit the cooperative. Among the benefits of larger farms are that they are more efficient relative to medium and small farms on technical, allocative and scale efficiency. In addition, large farms can cope with increases in input prices—the costs that go into producing a product—and decreases in support prices—the price that products fetch when sold—better than small farms because their decline in profit is relatively lower (Kumbhakar 1993, 336). In laymen’s terms this means that larger farms are more efficient and are a better size to achieve the greatest amount of output from their given inputs; large farms do not waste resources on the same scale as smaller farms. The most efficient cooperatives will be those that can most closely mimic the size benefits of the large farms they compete with. Effectively, this means that the larger a cooperative is, the more likely it is to succeed.

In theory, there are hardly any limitations to how large or small a cooperative can be. The scale at which a Hartford or Hanover cooperative should be formed will depend upon the needs of the members and the willingness of larger farms to help support the smaller ones by forming a cooperative with them. As we learned in an interview with Hartford dairy farmer George Miller, this may provide the largest hurdle to successful cooperative formation, as larger farms are less inclined to be interested in joining with smaller farms to form cooperatives (G. Miller, personal communication on May, 21 2007).

The organization of a Hanover or Hartford cooperative would also depend upon the scale at which it was formed. The most basic form is a centralized cooperative. The membership is comprised of “individuals and business entities (including partnerships and family corporations)” (USDA 1997, 25). This structure is most likely to be seen at the local level and would be most applicable to a cooperative formed in the Hanover and Hartford areas only. Federated cooperatives differ in structure in that their members are cooperatives themselves. According to the USDA, “each member of a federated cooperative is a separate cooperative that owns a membership share entitling it to voting rights in the affairs of the federated” (USDA 1997, 21). This structure is most likely to be seen at a regional, national or multinational level. Any cooperative that formed on the local level in Hanover or Hartford could attempt to join a larger federated cooperative.

Finally, mixed cooperatives consist of a combination of federated and centralized cooperatives having “both individuals and other cooperatives as members, who are usually given voting rights representative of their own membership” (USDA 1997, 21). This structure could be used to expand a local cooperative to include farms outside of the region in an effort to strengthen their numbers in order to help them achieve large farm scales of input costs - an interesting option for any local cooperative looking to expand into the larger Upper Valley region.

While it has been stated that a cooperative can help reduce input costs through collaboration and achieve stability through the User-Owner and User-Control principles, cooperatives are beneficial to farmers in three other areas: marketing products, purchasing supplies and providing services. These categories can also be used to help further define the cooperative itself. The role of marketing cooperatives is to “assist members maximize the return they receive for goods they produce” (USDA 1997, 21). While marketing cooperatives are formed in a variety of industries, “most cooperative marketing activity involves either agricultural products or those of producers in related industries such as forestry, aquaculture and horticulture" (USDA 1997, 21). For Hanover or Hartford, a marketing cooperative would work to decrease marketing costs by allowing all local farms to present their products as a whole. In doing so, they will be able to offer a greater volume and variety of products than if they were all working individually. This could help open up new markets for the cooperative.

Purchasing cooperatives are used to gain purchasing power. Just like marketing cooperatives, purchasing cooperatives also have their roots in agriculture. According to the USDA, "purchasing cooperatives were first used by farmers to gain access to affordable, quality production supplies such as feed, fuel, fertilizer and seed" (USDA 1997, 22). Purchasing cooperatives could be very helpful to Hanover and Hartford farms. Of particular concern is the increase in price of feed for cattle over the last five years. In our interview, Mr. Miller noted that larger farms were able to buy feed at a per unit price that was cheaper than the price he pays, although he could not say exactly how much cheaper. (G. Miller, personal communication on May, 21 2007). This idea is supported by statistics from beef feedlots, which show that large lots' economies of scale are significant because they push average costs down. Also, decline in costs due to size is usually associated with larger, more efficient equipment such as mills or feeding equipment, further decreasing cost (Hallam 1991, 162). Purchasing cooperatives would allow farmers to join with other local farmers who must purchase feed for their cattle during the winter. Within a cooperative, they would be able to increase the volume of their purchases and come closer to achieving the cheaper per unit price enjoyed by larger farms.

As the name indicates, service cooperatives allow for the communal provision of a particular service "such as recommending and applying fertilizer, lime, or pesticides; animal feed processing; and crop harvesting" (USDA 1997, 23). Service cooperatives provide things such as packaging and distribution. Another local farmer we interviewed, Ray West, told us that he has to buy feed for the winter because he uses all of his land to graze his cattle during the rest of the year (R. West, personal communication on May, 22 2007). In a cooperative, other members may be able to provide him with excess grazing land, which would allow him to grow grain to supplement his winter feed purchases. Particularly, land owners who do not farm or the many people who could be referred to as "hobby farmers" may be able to help. Hobby farmers are individuals present in the community who have a few animals but are not making their living from farming (G. Miller, personal communication on May, 21 2007). By joining the cooperative, these hobby farmers would receive all the benefits of cooperatives and could also incorporate their excess land into grazing or hay growing lands that could be used by other cooperative members.

Even landowners who have no interest in farming could provide a benefit to a Hanover or Hartford cooperative by joining the cooperative and allowing grazing on their lands. That is the nature of the cooperative business: working together and pooling resources to help one another with marketing, production and service. "These principles and practices have survived and flourished through 150 years of continuous evolution in the business world. They remain the foundation that supports the distinctive cooperative method of doing business" (USDA 1997, 7). These long founded principles could help offset the many challenges seen by local farmers.

What Challenges are faced by a Cooperative?

Despite the many advantages of agricultural cooperatives, there are some challenges faced by a cooperative business, mainly accumulating adequate equity to begin the formation and maintenance of the cooperative (USDA 1997, 5). This lack of equity arises because of the nature of the cooperative itself. As the USDA warns, "because cooperatives pass earnings through to users on a patronage basis, they cannot attract equity from outside sources to the same extent as investor-owned businesses” (USDA 1997, 32). While this is certainly a disadvantage, this also maintains control of the cooperative within the community of its members, and prevents outside investors from dominating the decision-making of the business. In Hanover and Hartford, where farming profits are not particularly impressive, it may be difficult to raise the capital required for setting up a cooperative, a major hurdle any local cooperative would have to overcome.

Another challenge a cooperative faces is that of inefficient transactions between members. In the case of marketing expenses, for example, Porter and Skully see efficiency lost in transactions as a major obstacle. The problem lies in the fact that although increased marketing power will increase transactions, those transactions will take the form of many small ones as opposed to a smaller number of larger ones. Because each transaction requires some sort of outlay of cost, many small transactions are less efficient than few larger ones. This inefficiency stems from the very nature of cooperatives: having many smaller businesses involved in one business (Porter and Skully 1987, 511). It has been argued, however, “that small farms can overcome the disadvantages implied by limited volume sales through cooperative marketing and that farm size restrictions need not imply less efficient marketing” (Hall and Leveen, 596). If marketing cooperatives collaborate not just on marketing power but on individual transactions, cooperative may overcome these potential inefficiencies.

Further challenges to a successful cooperative are inefficiencies in decision-making as all decisions must be made by the group as a whole. This effect would not be as great in a cooperative with a limited amount of members. If Hanover and Hartford established cooperatives at the town level, this problem would not be as great as if they were to form a cooperative at the county or some larger level because membership would be much more limited. The decision-making process will also be made easier if all members share similar goals. Our interviews with two local farmers showed that they saw their major disadvantage as being the high input costs they paid to keep their farms running. These comments, backed up by our research, indicate that lowering input cost would be a common desire of small farmers in the area. Hopefully, this would indicate that they would share similar goals for the cooperative, making the decision-making process inefficiencies minimal (Porter and Skully 1987, 511).

. A final major step in operating a successful cooperative is the cohesiveness of the products. The more complementary the array of products involved in the cooperative, the easier it is to facilitate the use of other ventures. Members have reason to participate when a variety of products and services are involved. Integration within the cooperative is necessary in order to increase business. Hanover and Hartford include a number of farms that produce similar products. Common products include cattle, maple products and vegetables. This cohesiveness seems to only exist to a limited extent, restricted by the relative small size of the farming community and may have to include the county to garner enough resources to really gain some leverage.

The State of Farming in Hanover

According to Vital Communities and the New Hampshire Department of Agriculture, there are five farms in Hanover and Etna. These farms produce dairy products, maple products, eggs and meat. The Muscle in Your Arm Farm in Etna raises sheep and chickens. This farm is a small sized farm with forty sheep and forty chickens. This farm also has a small maple syrup operation (VC 2006). Another Hanover farm, Maple Leaf Farms, shares a common product with Muscle in Your Arm: maple syrup (VC 2006). Maple products require a large labor input not only to process the product but also in terms of packaging. This is a concern because our interviews showed that local farmers feel that it is difficult to find labor, as maple syrup processing is long and laborious. Beyond the question of arduousness, the wages of farm laborers depend largely on how well the farm does as a whole, significantly increasing the uncertainty of those wages. In the end, the amount of labor that goes into the process may in fact push a farm laborer's hourly wage very low.

The Solterra Farm, producing dairy products and eggs is the only other farm besides Muscle in Your Arm in Hanover that raises grazing animals. These farms will certainly be faced with the increase in the price of grain during times in which they cannot graze their animals. They also produce eggs, making them similar to the Muscle in Your Arm Farm (VC 2006). Perhaps they could collaborate in the future.

The two other farms in Hanover, The Dartmouth Organic Farm and the Blue Ox Farm, are crop farms producing a variety of vegetables including beets, carrots, soybeans, melons, radishes and squash (VC 2006). The general trend for crop farms nationally has been a gradual increase in size and a large decline in the number of producers (Hallam 1991, 162). Much of this has to do with the relative efficiency of machinery versus manual labor. As the price of machinery relative to labor decreases, large farms that are highly mechanized can produce enormous yields for little cost. The process of mechanizing a farm inputs large costs. However, the University of Illinois Farm Business Farm Management program reported in 2000 that per acre machinery cost decreases with an increase in farm size.(IT 2001) The study also showed that farms that had the greatest advantage to mechanization were ones that spanned two thousand plus acres – a value far above the acreage of farms in Hanover (IT 2001). Buying machinery to replace labor is not an economically sound option for the small farms in Hanover. Using a cooperative to share farm machinery amongst many farms could help Hanover farms offset those costs.

The State of farming in Hartford

Using data from Vermont Department of Agriculture and Vital Communities it was determined that there are seven farms in Hartford, including Quechee, West Hartford, White River Junction and Wilder. Their produce consists of horse~~s~~, beef, maple syrup products, dairy, hay and forestry products (VC 2006).

The Brookside Farm is a horse boarding facility—they operate as a place where people can keep and ride their horses—not necessarily agricultural uses. One need of Brookside that is shared by the other six farms in Hartford, that could be valuable in terms of forming a cooperative, is its need for food for its horses. Two other farms in Hartford that share similarities with farms in Hanover are Sunrise Farm, a small vegetable farm and Catered Maples which also runs a maple syrup operation (VC 2006). The Bar M Farm, Raycin Farms, Val Vu Farm and Wiesenhof Farm and Forest all raise cattle in addition to producing other farm products. Wisenhof Farm and Forest also offers hay, maple syrup and forestry products. Raycin Farms also offers pork, blackberries and farmstand vegetables (VC 2006).

As with Hanover farms, maple syrup producers require large amounts of labor. Packaging is also a laborious process, something that the formation of a packaging service cooperative could make more efficient. Similarly, the vegetable growers also suffer from the high labor costs of their production. As machinery is not a viable option for small farms, packaging becomes a labor-intensive process with few willing to participate. Again, machine sharing through cooperative purchasing would to help to offset these costs.

In our interviews, George Miller often stressed the cost of feeding his sixty-five cattle. He said that over the last five years, the cost of a bushel of grain had risen from $2.34 a bushel to $4.00 a bushel (G. Miller, personal communication on May, 21 2007). He considered this to be a great threat to his business. Another threat is the high taxes he paid on his property. Price fluctuation in milk also made maintaining a constant income very difficult (G. Miller, personal communication on May, 21 2007). Ray West told us that he is able to feed his fifty-one cattle by grazing them during the non-winter months. However, during the winter he must buy feed. Although he usually buys his feed from within twenty miles, he also acknowledges the increase in price as a problem. In years past, he has even bought from outside the country, in Quebec (R. West, personal communication May, 22 2007). Both of these men told us they believed they were the two largest farmers in the area, making the feed situation even more dire for other farmers. Purchasing cooperatives, focused on cooperative feed purchase, could greatly offset these costs.

How Can a Cooperative Help Hanover and Hartford Farms?

The three biggest problems facing Hanover and Hartford Farms are input costs, finding labor and property taxes. Unfortunately, cooperatives have no way of dealing with property taxes. They are, however, able to help with both input costs and finding labor.

Maple Syrup Production: As discussed earlier, farms find it difficult to secure adequate labor due to the difficulty of the work, the long hours and the often low hourly wage. Many potential workers move into other sectors of the economy that pay them a greater hourly wage and where they can work fewer hours (G. Miller, personal communication on May 21, 2007). The maple syrup operations in Hanover and Hartford are extremely labor intensive. In light of the current labor situation a cooperative may be able to help with the packaging and distributing portions of the operation by streamlining the efforts of a number of individuals. This would require a central location where the packaging and distribution would take place. Capital would have to be raised for such an operation—always a major hurdle. If local farms were able to set this up, however the resulting efficiency gains would benefit all members. It would also reduce man-hours spent packaging that would help address labor concerns. This is an option that has promise.

In addition, Maple Syrup producers would be an ideal industry in which to share machinery costs. Boilers are the most expensive piece of machinery in producing maple syrup. While the boiler is far too large to be moved from farm to farm, sap from multiple farms could be rendered into syrup in a single commonly owned boiler. By communally purchasing and operating a single boiler, maple syrup producers would be able to lower their costs by eliminating the inefficiencies of having multiple boilers spread out amongst multiple operations.

Dairy/Meat Production: Those raising grazing animals in the area face the increase in input costs due to increase in the price of feed. There are six farms between the two towns that raise grazing animals: four farmers raising cattle in Hartford, as well as another cattle farmer and a sheep farmer in Hanover (VC 2006). By forming a purchasing cooperative, these farms would increase the volume of feed they buy each time and could achieve a per unit price closer to those of larger farms. In Hanover alone this may not be possible with only two operations. George Miller believes that 150 head is about average for a national farm. He also says that he has sixty-five cattle and that there may be only one other person in the area who may have as many as him (G. Miller, personal communication on May, 21 2007). Therefore, to meet the average size, it may take at least three farmers to form the cooperative.

A combination, however of the four farms in Hartford and the two in Hanover efforts would be more likely to succeed. To see even more benefits, a county wide cooperative should be considered. Miller cited a large farm in Bradford that he thought to have 1000 cattle or more. While he acknowledged that buying feed for 1000 cattle would certainly lower the per unit price as opposed to his sixty-five, he felt that the farmer in Bradford would be unwilling to form a cooperative (G. Miller, personal communication on May, 21 2007). Nonetheless, with the price of feed increasing and feed being a common cost amongst multiple farms, a purchasing cooperative would help increase the purchasing volume and bargaining power of small farms while reducing the input cost of feed for all members.

1.3.3 - Cooperative Forestry

Forestry Introduction

In the same way that cooperative agriculture unites several smaller farms to create a more economically viable joint farm, cooperative forestry seeks to combine forestry efforts by aggregating inefficient plots to create larger and more efficient areas to manage. Inefficiently sized plots are those that cover a surface area of less than 50 acres. According to the USDA Forest Service:

> The average per-acre cost of preparing a timber sale, harvesting and regeneration goes up as the size of the sale goes down, particularly as it drops below 50 acres. With over 60 million forest acres in ownership of 10-50 acres, it is obvious that many timber harvests will encounter that higher cost structure. (Butler & Leatherberry 2003, 12)

Because of their small size, lots below 50 acres are unable to sell enough products to cover their operational costs. Cooperatives work by aggregating economically inefficient lots until a viable size is achieved. In this chapter we will attempt to typify the forest industries of both Hanover and Hartford. Based on a cooperative forestry project done several years ago we will perform a cost benefit analysis on each town's forestry industry and identify ways in which cooperatives would be beneficial.

Forestry in Hanover, New Hampshire

Current Use. Under the New Hampshire Current Use program, foresters and farmers are given a property tax break incentive to maintain both the productivity and health of their lots. To be considered eligible for Current Use, the land must be able to provide "value-added agricultural products," which are described as being any product that can be processed beyond its natural state during harvest and then sold. The lot must be larger than 10 acres and to remain eligible must produce $2,500 in annual gross profit from crops it produces (NH Department of Revenue Administration 2007). Even though Hanover Forest district zoning requires a minimum lot size of 50 acres (Town of Hanover, NH 2006c, 16)., it is possible to maintain that lot size but only enroll 10 acres of land with Current Use. Table 1.24 below is a breakdown of the lots within Hanover that participate in the Current Use program. The "Documented Stewardship" column indicates properties that are formally enrolled as practicing forestry in the Current Use program.

Table 1.24 – Land Breakdown in Hanover, NH

Acres in Current Use	Forest Land in C.U.	Forest Land Acres With Documented Stewardship	% of Total C.U. Acres
19,550	13,062	4,655	15%

(New Hampshire Department of Revenue Administration 2005)

Although there are likely to be active foresters outside of Current Use, because of the potential impact of tax breaks on operating costs we make the assumption that the 4,655 acres listed above represent the majority of forested lots in Hanover. (J. Bouton, personal communication on May 22, 2007) the total forest area of Hanover is 26,412 acres (The New Hampshire Chapter of The Nature Conservancy 2000). This acreage is roughly double the amount of forest enrolled in the Current Use program and six times the amount of land that is currently forested. This disparity between open forest and the amount of land being actively forested indicates a great deal of potential growth for the forestry industry in Hanover.

Forestry in Hartford, Vermont

Current Use Vermont. The State of Vermont also supports a Current Use program. Eligible forests are:

> any land which is at least 25 contiguous acres…Land which is not capable of growing 20 cubic feet per acre per year plus open land not to be restocked within two years under the provisions of a forest management plan cannot exceed 20% of the total eligible land appraised at use value. (Guenther & Morrison 2006, 32)

Unlike New Hampshire Current Use, Vermont Current Use only requires that the lot be maintained in such a way that it is productive, producing 20 cubic feet per acre per year of agricultural output. Hartford also allows owners to register a lot as being forested even if 20% of the lot is unproductive.

Table 1.25 was compiled with the aid of the Windsor County Forester's Office (J. Bouton, personal communication on May 22, 2007). Table 1.25 contains the amount of acreage from Hartford that is currently enrolled in the Current Use program. The table contains summations of the total acreage from the 55 individual Current Use lots in Hartford, Vermont. This table differs from the previous table of Hanover Current Use lots in that here, Forest Acres refers to total forested acres and not simply registered acres of forest.

Table 1.25 – Appraised Value in $USD of Hartford Current Use Parcels

	Town Total	% of Total
Agricultural Acres	1,000	22%
Forest Acres	3,464	77%
Non-Productive Forest Acres	59	1%
Total Program Acres	4,523	100%

(Windsor County Forester 2006)

Although the 3,464 acres of forested land in Hartford is less than the 4,655 acres maintained in Hanover, it does represent a more significant amount of the forest enrolled in Current Use. Current Use doesn’t cover nearly as much land in Hartford as it does in Hanover but what it does cover is mostly forestry.

Cooperative Forestry

Fragmentation and Cooperative Forestry. Cooperative forestry should be attractive to Hartford foresters because it can take advantage of Hartford’s fragmentation. In a situation where fragmentation is high, cooperative forestry can be an attractive option. In a non-cooperative situation a significant number of landowners are deterred from maintaining and protecting their land for long-term benefits because of their small lot sizes. Even though the core forests of Hartford are still clustered in large plots of land, they have been parceled in such a way that roughly 75 of all the plots are 50 acres or smaller. (K. Douville, personal communication, May 2, 2007) It is beneficial for these smaller plots to form a cooperative and split the returns rather than to individually face high operating costs and possibly be forced to cease operations. Although fragmentation is bad for maintaining core forests and habitats it greatly simplifies forest harvesting. The more roads there are into the forest the easier it is to get to the desired crop. With so many small interconnected lots, cooperative forestry could spread very quickly and be effective at luring small lots into practicing forestry.

Cooperative Federal Aid. In addition to the fragmentation related benefits of cooperative forestry, cooperative programs are also attractive because they receive government funding. In 2004, the federal government allocated $4,539,659 to the funding of 3,267,000 acres of Non-Industrial Private Land in New Hampshire and $3,730,157 to the funding of 3,612,000 acres of Non-Industrial Land in land in Vermont in 2005. (US Forest Service Department of

Agriculture 2004, 1-2) The federal government values cooperative forestry programs because they increase "the cost effectiveness [of forestry] through the use of partnerships in delivery, increase values through sustained productivity of forests and are voluntary and non-regulatory" (US Forest Service Department of Agriculture 2004, 1-2). By dividing the state funding by the amount of forest present we are able to determine the worth of a cooperative acre in New Hampshire and Vermont to the government. One acre in New Hampshire equals $13.90 ($4,539,659/3,267,000) and one acre in Vermont equals $1.03 ($3,730,157/3,612,000). This tells us two things. The federal government sees more value in developing cooperative programs in New Hampshire and that if these amounts actually have a substantial impact on a local forester or owner those people should be willing to engage in cooperative forestry to realize these savings. Currently a large number of Current Use forest in Hanover goes unmanaged.

Cooperative Forestry Analysis. To perform our cooperative forestry cost benefit analysis we will start by identifying a cooperative case which mirrors the forestry industries of Hanover and Hartford. Vermont Family Forests (VFF) is a non-profit conservation organization that is currently exploring the benefits of cooperative forestry. (Vermont Family Forests 2002, 7) In the 2001-2002 VFF report, "Conserving Our Forests and Our Community: A Report on VFF Research and Demonstration Projects," VFF investigates their effectiveness to date. The cooperative project combined lots from the Vermont towns of Bristol, Starksboro, Ripton, Ferrisburg Shelburne and Monkton, and encompassed a 3,159 acre region just south of I-89 in northwest Vermont. After one year Vermont Family Forest had harvested 163 acres of land for 116 thousand board feet of product volume. (Vermont Family Forest 2002, 9) This case is a good baseline comparison because of the sites proximity to the Upper Valley and because our estimates for forested land in Hanover and Hartford (4,655 acres and 3,464 acres respectively) are of comparable to the size to the VFF project. The project was conducted over one year and so all of our costs and revenues will be on an annual basis. Table1 1.26 contains the expected production returns if we assume proportional increase harvest due to holding more acres.

Table 1.26 – Production Targets Proportional to VFF Performance

	Acreage	Harvested Acres	Harvest Volume (board feet)
VFF	3,159	163	116,135
Hanover	4,655	240	171,133
Hartford	3,646	188	134,039

Only because of their similar size can we assume that the harvest results are scalable. Now that we have and estimate for forestry production in Hanover and Hartford we can calculate the expected revenue from sales. Expected average mill prices are presented in Table 1.27 in dollars per thousand board feet. The prices represent sales for average quality timber and were gathered through interviews with buyers and suppliers. (Northern Woodlands 2007)

Table 1.27 – Average Mill Prices

Dollars per thousand Board Feet	VT	NH
White Ash	300	250
Beech	170	192
White Birch	113	200
Yellow Birch	356	350
Black Cherry	713	633
Sugar Maple	744	758
Red Maple	305	325
Red Oak	419	475

(Northern Woodlands 2007)

To accurately calculate a sustainable level of return we will need to assume the forests in Hanover and Hartford are selling a similar mix of products to sawmills. Even if the prices are more attractive it is unlikely that either town would only be selling Sugar Maple and Black Cherry (two very valuable products). We can best approximate a general timber mix by taking the total amount of volume sold in each town and splitting it equally between the seven hardwoods. The revenue calculation is carried out below in Table 1.28.

Table 1.28 – Town Revenue Calculation

	VT Price/MBF	Hartford Volume (MBF)	NH Price/MBF	Hanover Volume (MBF)
White Ash	$300	19.15	$250	24.45
Beech	$170	19.15	$192	24.45
White Birch	$113	19.15	$200	24.45
Yellow Birch	$356	19.15	$350	24.45
Black Cherry	$713	19.15	$633	24.45
Sugar Maple	$744	19.15	$758	24.45
Red Maple	$305	19.15	$325	24.45
Total Volume		134.04		171.13
Town Revenue		$51,719.78		$66,203.94

The revenue for each town is calculated by multiplying the timber price by its sold volume for each species and then summing the revenue for each sale. The expected sales revenue for Hanover is $66,203.94 and the expected revenue for Hartford is $51,719.78. Hanover's total revenue is greater than Hartford's only because Hanover is currently foresting more land. Neither region experiences the benefit of significantly higher mill prices.

Costs. Now that we have calculated the expected revenues generated by the town's enrolled Current Use forestry we can explore the underlying costs which support them. Costs were divided up into two types: Variable Costs and Fixed Costs. Variable costs are the costs associated with everyday operations. In terms of forestry these are fees like paying for loggers, and transportation. Every day you have to pay people for supplying these services. Fixed costs are one time costs. These are capital expenses to purchase heavy machinery or the installation of small roads for better timber access. There is an upfront cost to purchase the item and except for occasional maintenance costs you are not continually paying for its utility.

Variable Costs. As previously mentioned the main variable costs associated with forestry are paying for a logging crew and the transportation cost of delivering timber to the mill. With the help of Northern Woodlands Magazine we have made some assumptions about operational forestry costs. The price of hiring a logging crew is entirely dependant on the accessibility and quality of the timber being harvested. Because loggers are paid hourly they must be compensated more for jobs which will prevent them from taking other opportunities. No matter how valuable a hardwood species may be if it's difficult to reach it is eventually not worth the time/expense to harvest. Average logger costs can range from $100/MBF to $250/MBF. (Northern Woodlands 2007) Continuing the assumption that we are still selling average timber we estimate and average logging crew cost of $175/MBF. Our transportation costs are the prices for trees "that have been felled, limbed, brought to a landing, made into logs and delivered to a mill. Trucking logs to the mill typically costs from $45 to $75/MBF but can run higher on long hauls" (Northern Woodlands 2007). With 3 sawmills in White River Junction and many more in Windsor County (Vermont Department of Forests, Parks and Recreation 2007) we will assume an average transportation cost of $60/MBF and that few trips will be long hauls. With an average logging cost of $175/MBF and an average transportation cost of $60/MBF our total variable cost is $235/MBF. With our original output assumption of 171MBF and 134MBF for Hanover and Hartford respectively, Hanover can be expected to pay $40,216.30 in variable costs and Hartford, $31,499.20. Current Profit is displayed in Table 1.29 and it is the difference between revenue and variable costs.

Table 1.29 – Current Revenue

	Revenue	Operational Cost	Current Profit
Hanover	$66,203.94	$40,216.30	$25,987.64
Hartford	$51,719.78	$31,499.20	$20,220.58

Fixed Costs. Currently neither project carries fixed costs. We have assumed that we can pay for loggers to harvest the trees and for and truckers to prep and transport that harvest to a mill. However, in the interest of increasing profits it would be beneficial to pay some fixed costs.

Instead of paying the same variable costs it is possible to save money by paying a one time fixed cost to replace that variable cost. One example would be purchasing a truck to lessen the burden of transportation costs. In order to include both towns we will assume that we spend $20,000 of the remaining profit on a second truck. After researching truck prices it is clear that $20,000 will buy you an old but effective logging truck. (Forest Equipment Sales 2007) Even if the added trips supplied by the truck only makes a 20% decrease in the transportation cost (It's a cheap truck and new costs have appeared due to fueling and maintenance) that is still savings of $12/MBF. (20% of $60/MBF = $12/MBF). Keeping in mind the volume outputs we presented earlier, we'll see annual savings of $2053.60 for Hanover and $1608.47 for Hartford. With just one truck it will take 10 years to recover that initial $20,000 fixed cost for Hanover and even longer for Hartford. This is why cooperatives are beneficial.

Cooperatives and Fixed Costs. In a cooperative the fixed costs can be split. Until now we have treated the forests of Hanover and Hartford as if they were managed by one entity, but if we now consider them to each be run by two people who agree to harvest separately and thus use the truck at different times you have two owners who are still reducing transportation costs by 20% but each only paid half of the fixed cost to purchase the truck. This also means that a positive return on investment can be made on the truck in half the time it took the one owner. As the number of users increases the individual expenditure on fixed costs becomes lower. This does not only apply to transportation costs. The cooperative can cut the logging costs as well. Purchasing supplies like loaders, bulldozers, fellers and other machines means the loggers hired don't have to supply those tools. By installing strategic timber routes throughout the property it becomes simpler for loggers to get whatever machines they do still need on site. And because of the cooperative it is possible to split the fixed cost between members. Fixed costs are a way of lowering constant variable costs and cooperatives are a powerful way to reduce those fixed costs.

Cooperative Forestry Problems. The largest downside to forestry is that it is difficult to attract the support of larger lots. Many more lots could be served and enticed to join if the larger more profitable landowner shared resources with those smaller members. This is however, unlikely. Cooperatives involve a lot of compromises and a large, profitable forester may not see the need to do more work for what is most likely little reward.

Conclusion

Even with the 50 acre forest zone lot size limit in Hanover much of its Current Use forest land isn't forested. This is probably due to the remote nature of Hanover's eastern forest zone. Very few roads lead out there and it is probably very expensive. In Hartford, even though fragmentation has caused many of the forest lots to be reduced to sizes that are no longer profitable it has also supplied them with many more forest access roads then Hanover enjoys. Cooperative Forestry is a great solution to both of these problems. By sharing in transportation costs it would be less costly for Hanover individuals to get loggers out to their property. While in the past a truck would have left the eastern forest zone half full, a cooperative could ensure that the most timber possible made it out and to market. In Hartford, cooperatives would be useful in aggregating the numerous small inefficient lots. Especially for lots that are so small they haven't considered forestry, this is a great opportunity to get them involved. Although not controlled at the town level, Current Use programs are a great incentive for citizens to do something positive with their land. There are many enrolled in the program that do not participate and still others who own land and choose not to enroll. To make cooperative forestry as successful as possible, Hartford and Hanover need to aggregate lots as long as the market can bare it. It would be beneficial for the towns and citizens to participate in Current Use and cooperative forestry. Progress in this direction would save the citizens on property taxes, revitalize a source of revenue and provide both towns with a strong industry to rely on.

1.4 Conclusions and Recommendations

Land Valuation

Land valuation attempts to put a value upon open space, first by measuring what people actually pay to use—or protect—that open space and then measuring how people feel about the relative importance of protecting open space. Understanding how the governments and the citizens of Hanover and Hartford value the open space available in both towns will allow for more efficient planning decisions.

- **Both towns should investigate the intrinsic value of land when making planning and land use decisions. A better understanding of the value citizens place on the land, whether it is for utility or aesthetic reasons, will allow for more informed decisions.**
- **Both towns should investigate linking their survey or focus group data with an identifiable qualitative value. Understanding the tradeoffs between qualitative and quantitative value will also allow for more informed decisions.**

Cost of Community Services (COCS) Studies

COCS studies show that open space and farmland are often more valuable to their town than residential development. Though development brings in higher property tax revenues, the burden of supplying services and infrastructure to that development ends up costing the town considerably more money.

- **In order to quantify the expenses of residential development versus open space protection, both Hanover and Hartford should conduct COCS studies.**
- **If COCS studies show that Hanover and Hartford are subsidizing low density residential development, both towns should consider impact fees or commuter fees to internalize the infrastructure costs of residential development.**

Build-Out Analysis

The build-out analysis we conducted for Hanover and Hartford allowed us to compare low density development and clustered development scenarios to a base scenario using the current zoning ordinances. This comparison illustrated the different impacts of each scenario on agricultural resources and the dramatic increase in protected open space that occurs under the cluster development scenario.

- **Both Hanover and Hartford should investigate the relative importance of current farming and future farming expansion. Using the Master Plan and zoning ordinances, growth should be guided away from the agricultural resources most important to that determination.**
- **Both towns should implement zoning regulations that uncouple overall density from lot size: in Hartford, the recommendations of the proposed Master Plan should be implemented. In Hanover, PRD should be expanded into the RR zone.**
- **To improve the possibility for GIS modeling of growth scenarios in both towns, Hanover and Hartford should coordinate with the respective regional planning commissions to update their GIS databases, and should continue database upkeep on a regular schedule.**
- **Using the most current data, build-out analysis under various growth scenarios should be modeled on a regular basis, possibly as part of the Master Plan evaluation process. Comparing each build-out analysis over time will allow an opportunity to evaluate the success of various development plans and to test the viability of new development scenarios.**

Transferable Development Rights (TDR) Programs

TDR programs are one method of preserving land in Hartford and Hanover. By modeling a TDR program off of the strategies of past successful TDR programs, Hanover and Hartford should be able to design, administer and fund successful local TDR programs.

- **Hanover and Hartford should each organize a task force that represents diverse interests to determine the best planning tool for preserving open space, agriculture, forestry, and environmentally sensitive lands. Should the task force choose a TDR program, each town should:**
- **Incorporate feedback from residents and other interested parties, and begin educating the community throughout the planning phase by organizing a citizens' committee and focus groups.**
- **Designate sending and receiving areas based on the preservation goals of the Master Plan. Hanover should also be advised by the 1998 *Scenic Locales* report.**
- **Use the approaches outlined in the *Economic Issues* section of this report to determine approximate values of undeveloped land within Hanover and Hartford and to assess public interest.**
- **Gather feedback from developers concerning the types of incentives they would like accompanied with the purchase of TDR.**
- **Establish a TDR bank that would guarantee a value for TDR and garner trust in the new TDR market. The towns should also establish an administrative unit to handle TDR transfers, paperwork, and coordinate between sellers, buyers, planning staff and legal counsel.**

- **Seek funding or assistance for the TDR bank and program through regional foundations such as the Upper Valley Land Trust or the Upper Valley Lake Sunapee Regional Planning Commission. Private, state and federal funding should also be sought.**
- **Make education on the TDR program available online or through print material in town offices and local real estate offices. The materials should clearly outline program criteria such as the location of sending and receiving sites, transfer ratio, and development incentives.**

Economies of Scale and the Role of Cooperative Formation

The three major problems facing area farms are rising property taxes, labor shortages and high input costs. Cooperative agriculture can have affects on the latter two of those problems. Through the creation of purchasing cooperatives, Hanover and Hartford livestock farms could lower their feed costs, while forming a service cooperative could help maple syruping operations to lower their labor costs.

- **Maple syrup operations should consider a service cooperative in an attempt to make packaging and distribution more efficient. Cooperatives should be considered at the town, county and region-wide scale.**
- **A feed purchasing cooperative between the four farmers with cattle in Hartford could benefit those farmers, especially if they were to include the Hanover cattle and sheep farms. A feasibility study should be conducted. This should also be considered at the county level.**

- **The more farms that join a cooperative the more power that cooperative has. Any effort to form local cooperatives should also be extended to the greater Upper Valley farm communities.**

Cooperative Forestry

Cooperative forestry allows for the pooling of resources across numerous forestry operations, avoiding high input costs and increasing profitability for forestry. Beyond the economic incentives of cooperative forestry, it can also help to prevent further fragmentation of core forests. Using a cooperative forestry analysis allowed us to make a determination of the profitability of cooperative forestry in Hanover and Hartford. This analysis showed that while Hanover and Hartford, as well as the states of New Hampshire and Vermont have made steps towards making cooperative forestry more attractive, more can be done.

- **Both the Hanover and Hartford should enroll as many lots as possible into their perspective State Current use programs.**
- **Both towns should also propose and increased Current Use tax break for those lots that are both maintained and entered into cooperative organizations.**
- **Both towns should investigate cooperative forestry between public and private lots.**
- **Hartford should consider setting a 50 acre minimum zoning limit in rural areas similar to Hanover’s.**

SECTION 2

ENVIRONMENTAL ISSUES OF EXURBAN SPRAWL

2.1 - Fragmentation

2.1.1 - Introduction

Fragmentation is one of the greatest anthropogenic challenges to ecosystems. Residential developments, roads, agriculture and forest clearing bisect and change landscapes, creating smaller patches of habitat. Along the edges of forest fragments different conditions are created which affect wildlife and plant life, however fragmentation can cause changes in habitat that are felt up to two kilometers deeper into the fragment. In this chapter we discuss how land-use affects fragmentation, and explore the specific implications of fragmentation from working landscapes and roads in the context of Hanover and Hartford. Finally, using GIS we present the implications for fragmentation and the preservation of core habitat of possible zoning scenarios in the two towns.

2.1.2 - The Development of Road Networks

One major cause of forest fragmentation that results from development is the creation of road networks. Roads are an integral part of exurban development, and thus we present a history of transportation in the area to provide background for the environmental problem of fragmentation.

During the 19th century, horse-drawn wagons and buggies dominated American transportation on land, and there were only farm-to-market roads and early turnpikes to accommodate this type of transportation (Flad 1997, 118). In 1893, the first U.S.-made motorcar was sold; by 1908 the Ford Model T began mass production of cars so that more people could have access to them (Flad 1997, 118). Two years later, the number of motorcars in America approached 0.5 million, and by 1926 there were 20 million cars on the road (Flad 1997, 118). As automobiles developed, the citizens began to demand more and better highways. In response to this, the Federal Aid to Highways Act established the Interstate Highway System (Flad 1997, 119). Urban scholars propose that this program had the most impact in shaping America's urban areas in the past half century, through the creation of sprawling suburbs and the destruction of America's cities (Flad 1997, 120).

While highways stimulated future economic growth, today most road systems in rural areas of North America grow in order to meet increasing transportation demands (Baldwin 2007, 405). Baldwin found that in Maine, from 1986 to 2003, an estimate of 1848 km of new paved, public roads were created; this amounts to 5% of the existing 37,243 km of public roads in 2003 (Baldwin 2007, 407). Many of the new roads that were created between 1986 and 2003 were relatively short (average of 325m) and local in function. The Town of Hartford has a total of 382 km of roads maintained by the town, while Hanover has 200 km of town maintained roads (VCGI). In looking at the Baldwin study, we would expect this number to increase with the development of the two towns. However, planning of residential developments such that long cul-de-sacs and dead ends are avoided will minimize the number of roads that need to be constructed and later maintained, as well as the environmental costs of each additional kilometer of road (Baldwin 2007, 407).

2.1.3 - Fragmentation and Core Habitat

Along with the development of road networks, the influx of greater development into exurban areas has had significant effects on the continuity of the landscape. Fragmentation, defined as "the process whereby habitat is reduced from its original extent to a series of smaller patches," continues to go hand in hand with exurban sprawl (Glennon 2005, 8). The process of fragmenting land can occur in multiple ways, but most commonly occurs from road building, housing development, and agriculture. The resulting landscape is characterized by “a series of remnant vegetation patches surrounded by a matrix of different vegetation and/or land use” (Saunders 1991, 20). In addition to decreasing the total amount of native habitat available, the remnants’ isolation plays an important role in determining a species success. The multiple components of isolation include: time since isolation, distance from other remnants, connectivity, changes in the surrounding landscape, remnant size, shape, and position in landscape (Saunders 1991, 20-25). This division of the landscape creates island patches for some species, isolating them from other populations. The degree of separation between habitat patches in order for it to be isolated from other patches varies from species to species. A road is by no means an insurmountable barrier for highly mobile taxa such as birds and mammals, however for some less mobile taxa such as plants and insects, it may be. Fragmentation also leads to a change in the hydrologic cycle of the affected areas. The alteration of the surrounding tracts of land changes the ways in which the ecosystem deals with rainfall. With less biota in place to catch and store the rain, there is a general increase in runoff complete with, “increased surface water flows leading to increased erosion and transport of particulate matter” (Bormann 1974, 225-77).

Roads can alter the chemical environment. The use of heavy metals from both transportation combustion and road-salting (in the winter months), produces elevated levels of lead, aluminum, cadmium, iron, manganese, titanium, nickel, zinc, and boron. The cumulative effect of these on the environment can be seen with reduced plant productivity, further decline in population from exposure, and road kill (salt attracts some larger game animals) (Trombulak 2000, 22). Roads also tend to be an avenue in which exotic species enter native habitats (Trombulak 2000, 24). Invasive non-native plants have found a habitable home in Hartford and

Hanover. While many non-native species of plants have successfully established in the Upper Valley, four have been identified as invasive: Wild Chervil (*Anthriscus sylvestris*), Garlic Mustard (*Alliaria petiolata*), Glossy Buckthorn (*Frangula alnus*), and Black Swallow-wart (*Cynanchum louiseae*). Invasive species typically out-compete local varieties for resources such as sun and soil nutrients by shading or crowding them out (HCC 2007, 4).

In our examination of fragmentation issues in Hanover and Hartford, we used core habitat as the parameter of habitat quantity for a given species. Core habitat is determined using edge effects, a subset of fragmentation factors. An edge in the context of our study is defined as a sharp boundary, often between a forest and neighboring pasture, road, or residential development (Donovan et al. 1997, 2064). Core habitat is the area within the patch in which an individual does not experience any edge effects. The extent of the buffer between the edge and the core habitat region varies between species.

One edge effect is the altering of the microclimate. The resulting climate tends to be more extreme in nature. The change in albedo will allow a higher daytime temperature because of the decreased albedo and a lower nighttime temperature. The resulting temperatures have an impact on both the local species and soil. Those species that thrive in the shade "become restricted to the interior parts of the remnant, with different species requiring different distances from the edge" (Saunders 1991, 20). In addition to radiation fluxes within these microclimates, wind plays a role in disrupting some terrestrial species in edges. The fragmentation of land areas automatically increases the sheer forest perimeter exposed to non-habitat. Thus, any incoming wind is not only focused on the whole patch, but also on more and more fragmented edges. There are two problems that can come from such an increase in fragmented surface areas. The first concern relates to the power of wind. Whereas a species might have been accustomed to protection from larger species or ‘preferred’ the inner parts of the land, now species must face the wind head on. This biggest result of new encounters with the wind is direct physical damage to the plant species (Saunders 1991, 21). Furthermore, the power of the wind may shear off pieces of bark and reduce the communities of bark-inhabiting invertebrates while also affecting the breeding success of birds (Saunders 1991, 21). The wind as a pure physical force accounts for only half of the damage these species must now face. The increased exposure to the wind further hurts the vegetation through increased evapotranspiration, reduced humidity, and increased dessication” (Lovejoy 1986).

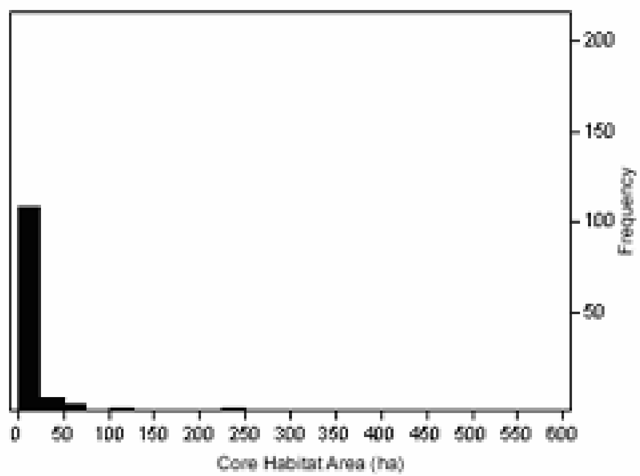


Figure 2.1 - Frequency of area sizes in hectare per core habitat/fragmentation in Hartford, 2003. Data taken from our GIS analysis.

2.1.4 - Hartford Land-use Change Study

To provide site specific background on land-use change and its environmental effects we referred to a study done by Victoria Solbert in 2007 (Solbert 2007). The study looked at the ecological effects of historical land-use change in Hartford. By looking at the amount of forested area in Hartford, it was determined that the amount of forest has increased in the past 150 years. In 1850, about 28.6% of Hartford was forested; in 1870, about 24% was forested; in 1939, about 50% was forested; and in 2003, 57% was forested.

Table 2.1 – Change in percent of Hartford forest

Change in Forest	
Year	*% forested*
1850	*28.57*
1870	*24.17*
1939	*49.7*
2003	*57.6*

In the context of our analysis of forest fragmentation in Hartford and Hanover, the historical land-use data are important because the age of a forest that makes up core habitat is a good indicator of habitat quality, primarily through the effect on the diversity of the forest. Forest age is related to forest diversity because many species have functional characteristics that favor older forests over younger forests (Graae & Sunde 730, 2000). By looking at the forest cover change from 1939 to 2003, we can determine the older areas of forest and thus identify core habitat that has a greater likelihood of supporting greater species diversity. In the following photograph, the areas in green represent older forest, and thus show areas where greater conservation emphasis should be placed.

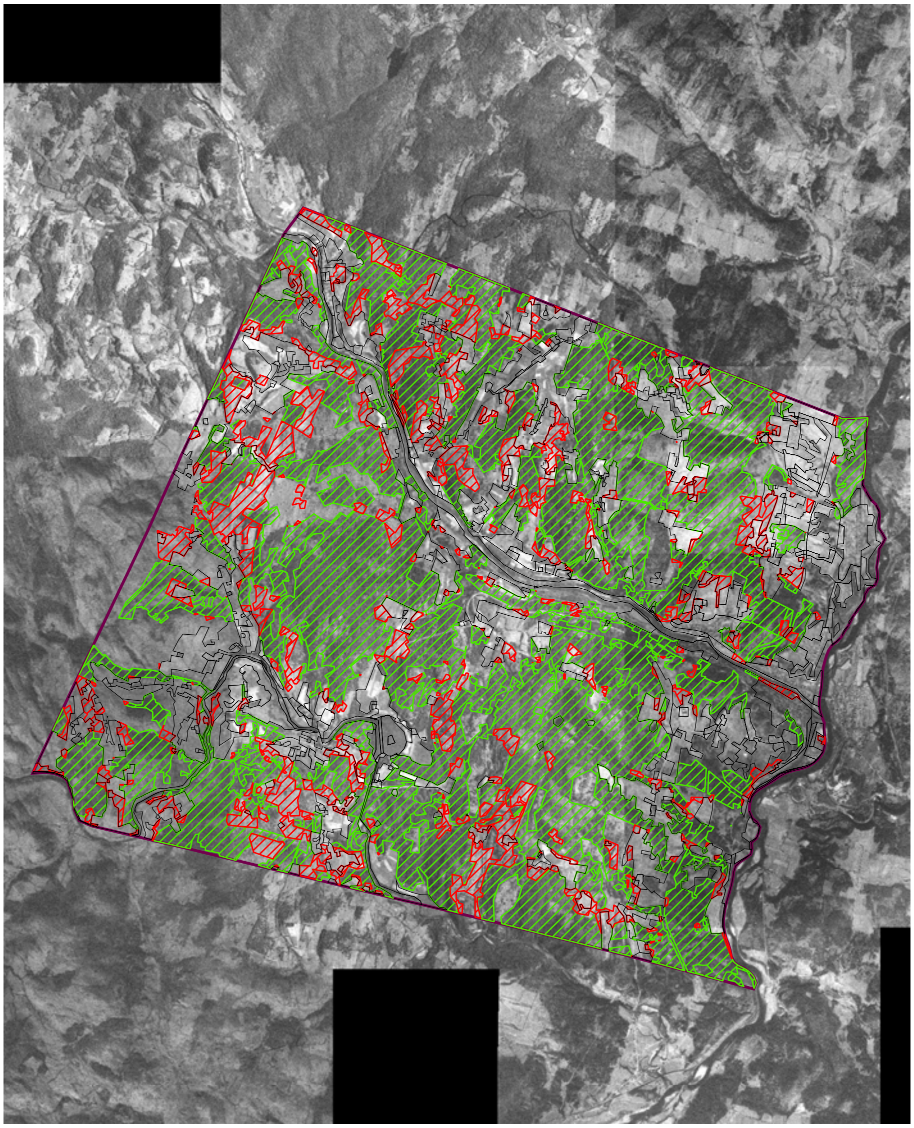


Figure 2.2- Hartford Forested Areas (2003) overlaid on an aerial photograph. Forested sections in green represent forest present both in 1939 and 2003 while sections in red represent forest that has regenerated since 1939 (Solbert, 2007).

2.1.5 - Working landscapes and Fragmentation: A Case Study of Ovenbirds

In addition to roads, working landscapes (agriculture and forestry) also play a role on fragmentation and the subsequent edge effects. The spread of agriculture has and still continues to be an important factor that causes forest fragmentation and loss of forest area (Hanski et al 1996, 578), because farming causes a permanent change in the landscape structure through the clearing of forests to create open fields (Bayne 1997, 1426). Forestry can also cause fragmentation depending on the way an area is forested. For example, the amount of area harvested, the location of harvest, and the rate of harvest are all important factors because certain natural habitats of animal and bird species are being removed. Since core habitat is a parameter for edge effects, a subset of fragmentation, it is important to identify certain species that can indicate the intensity of the edge effect.

In order to measure the extent of this edge effect in relation to increased agriculture and forestry, Ovenbirds (*Seiurus aurocapilla)* have been studied as an indicator species. Specifically their survival rate and reproductive success is used to determine the consequences of fragmentation. These small songbirds, olive brown on the back and white on the underside with bold dark streaked spots, breed in deciduous or coniferous/deciduous forests in northern North America during the summers and migrate to South America and the Neotropics for the winter (Horn & Donovan 1994). Ovenbirds are indicator species for closed-canopy, mature forests because they are strongly associated with these particular habitat features (Carignan & Villard 2002, 49). Furthermore, they serve as “convenient integrators of a number of ecological processes and so can represent appropriate biomonitors of factors that may be too complex to monitor individually” (Hobson & Rempel, 2001). Since Ovenbird populations are prevalent in the border region of New Hampshire and Vermont, they make for an acceptable case study for both Hartford, VT and Hanover, NH (Smith College, 2005). Even though Ovenbirds are an indicator species for other animals within the deciduous cover, it is important to note that some species’ data will be more or less sensitive to the effects of forest fragmentation.

Past studies of Ovenbirds within deciduous forests can further provide insight into the health of the Hartford and Hanover ecosystems. Since fragmentation caused by agriculture and forestry leads to increased threats to the ecosystem via edge effects, it is important to understand the characteristics of the edge regions that are disruptive. Studies have found that there was lower reproductive success in small forest fragments than in contiguous forests mainly because of increased nest predation along forest edges which were created by agriculture (Bayne & Hobson 1997, 1425). Increased nest predation along forest edges has been attributed to an increase of generalist predators such as corvids, which invade forest patches from the surrounding farms (Bayne & Hobson 1997, 1425). A study on the predation rate for Ovenbirds in northeastern North America showed that if the fragmented edge is within 0-100m of the breeding site, there is a 43 percent chance of depredation. If the edge is between 100-200m of the nesting site, this percent drops to 16. And lastly, if the edge is further than 200m the rate climbs again to 32 percent (Burke & Nol, 2000). Using this we determine that within 100m of the forest edge, edge effects are felt by the Ovenbird. This number is thus used as the amount of the buffer in our analysis of core Ovenbird habitat in Harford, which appears in the next section.

In regards to the working landscape and fragmentation specifically in Hanover and Hartford, forestry and agriculture are the main causes. Currently in Hanover and Hartford there is no consensus on how to practice forestry (Bouton 2007). The type of forestry that is performed by the landowners in these small towns is selection cutting, mainly because of the small size of the plots (NHTHC 2007). Essentially, the land owners are able to do as they wish except for "heavy" cutting on large plots of land that are larger than 75 acres (Bouton 2007). In New Hampshire, clear cutting is primarily practiced in northern remote areas of the state (NHTHC 2007).

Fragmentation, whether it is caused by forestry or agriculture, tends to have the same effect on species. There was not much difference in predation along edges created by forestry fragmentation as opposed to agriculture (Bayne & Hobson 2002, 1426). Thus, we can make the assumption that landscape changes, via forestry or agriculture, have a similar effect on Ovenbird data. Despite this similarity, there are some differences to consider. Forests fragmented by logging had less of an edge effect because after timber harvest landscapes usually go through a short-lived open field stage, which is then quickly followed by succession (Hanski 1996, 583). Thus, the open stage may be too short to allow generalist predators to colonize (Hanski 1996, 583). On the other hand, agriculture causes a permanent change in the landscape structure, allowing generalist predators to colonize more easily (Bayne & Hobson 1997, 1426). Furthermore, clear-cut forests and agriculture provide different vegetation at the edges. Clearcut edges often have little transition vegetation to attract animals and birds compared to the interior of forests, while agriculture creates more diverse edges that have higher shrub density and insect abundance which may lead to an increase in predation rates (Bayne & Hobson 1997, 1426). Additionally, agriculture increases food production and thus food supply to animals and birds, leading to an increase of generalist predators, while clear cuts do not provide any additional food (Bayne & Hobson 1997, 1426).

2.1.6 - GIS Fragmentation Study

The goal of our GIS analysis was to determine the areas of core habitat that currently exist in Hartford and how these areas will change as structure density increases. Core habitat is defined as the specific area that is essential for the survival of wildlife. In a study done by the Hartford Conservation Commission they defined core habitat as a dense forest 152.4 meters (or 500 feet) from any road or house. The reason for the 152.4 meter buffer is that it is currently the buffer recommended for Hartford and Hanover zoning. We then repeated the study using a species specific 100 m buffer which was used so the effects of the various build-out scenarios on Ovenbirds could be analyzed.

Methods

The data collection involved downloading core habitat and structures (E911) data. A 152.4 meter buffer was created around the structures layer. Each structure is represented as an individual point, and when this buffer is created it allows a 152.4 meter area surrounding each of the points. After this 152.4 meter surrounding area is delineated around each structure, this data set is changed from a point data layer to a layer based on a grid. In this form, each grid represents a 30 meter by 30 meter area. This grid data set, referred to as “raster,” allows the area within the 152.4 meter buffer to be reclassified with the number 0, while the area outside of the buffer is reclassified as 1. This buffer layer can then be multiplied by the core habitat layer (where core habitat area is classified as 1). After this calculation is performed, the area represented by 1 is the remaining core habitat.

This same process is used for each of the zoning scenarios created by the CommunityViz program (refer to the Economics section 1.2.3 for more information on this program). CommunityViz takes the current zoning regulations and creates a build-out analysis, showing the maximum number of structures that could be built under the given parameters. The parameters for this model can be changed to reflect different zoning regulations. Using these layers, the same processes are done using the 152.4 meter buffer to determine the area of core habitat. Once the 152.4 m buffer layer is created for the scenario output, the union function is used to join the current structures and the existing structures. This layer can then be converted into raster, reclassified and multiplied by the core habitats.

The area of core habitat remaining can then be compared for each of the different build-out scenarios. In Hartford the scenarios were only run for Zone 3 (See section 1.2.3 for a discussion on the reasons for the selection of Zone 3). There were four build-out scenarios total: the current structures, current zoning regulations, cluster scenario where buildings are built around roads already in existence, and proposed 10 acre building regulations. We also repeated this analysis for Ovenbirds by using a 100 m buffer (see *2.1.5* for results).

Results

The results for Hartford are summarized in the table below:

Table 2.2 – This table shows the current core habitat under the current zoning regulations and proposed zoning regulations.

Zoning Type	Core Habitat (km^2)
Current Structures	5.31
Current Zoning Build-out	1.53
Proposed Zoning (10 acre) Build-out	2.28
Cluster Development Build-out	3.96

The results show that at build-out under the current zoning regulations an additional 3.63 square kilometers of remaining core habitat in Zone 3 is within 100 m of a structure, and can no longer be characterized as core habitat. However, under the cluster zoning, which would concentrate new structures around roads that are already in place, only 1.29 square kilometers of current core habitat are reclassified. Maps of core habitat and zoning scenarios follow.

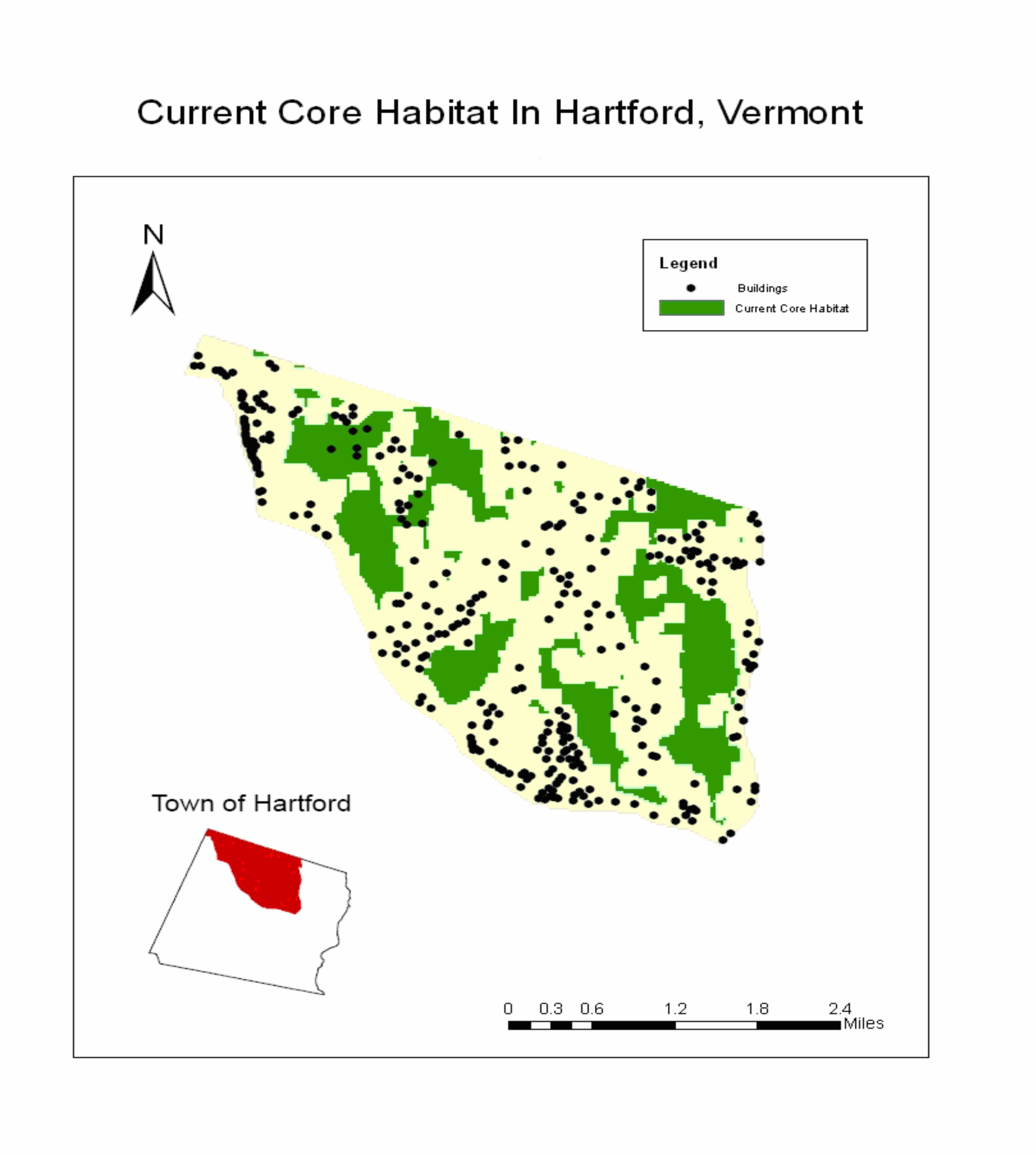


Figure 2.3 – This figure shows the areas currently defined as core habitat with the structures that currently exist. The black dots represent the structures and the green area represents core habitat.

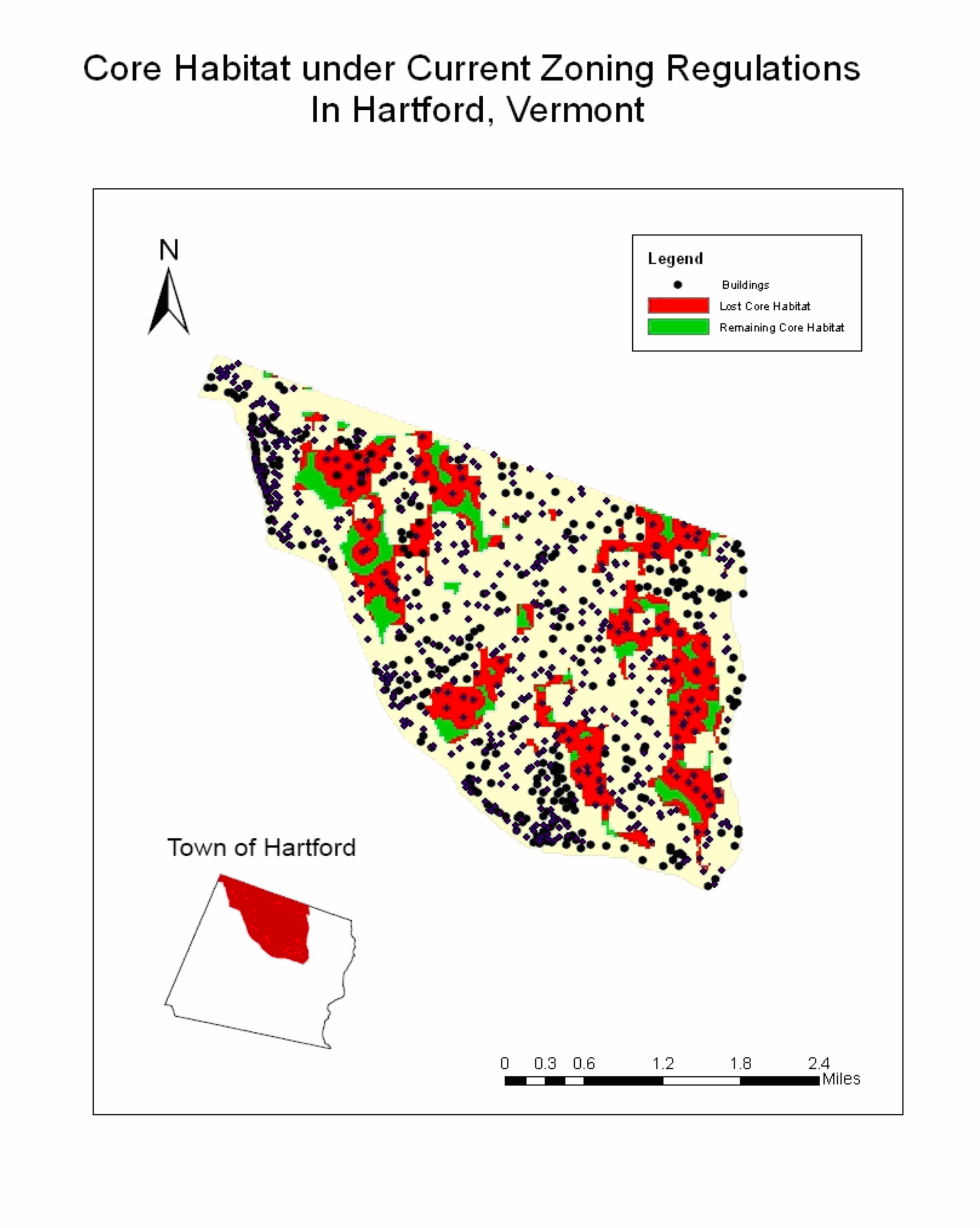


Figure 2.4 – This figure shows the buildup analysis under current zoning regulations. The areas in red show areas which can no longer be defined as core habitat, and the green shows the remaining areas of core habitat.

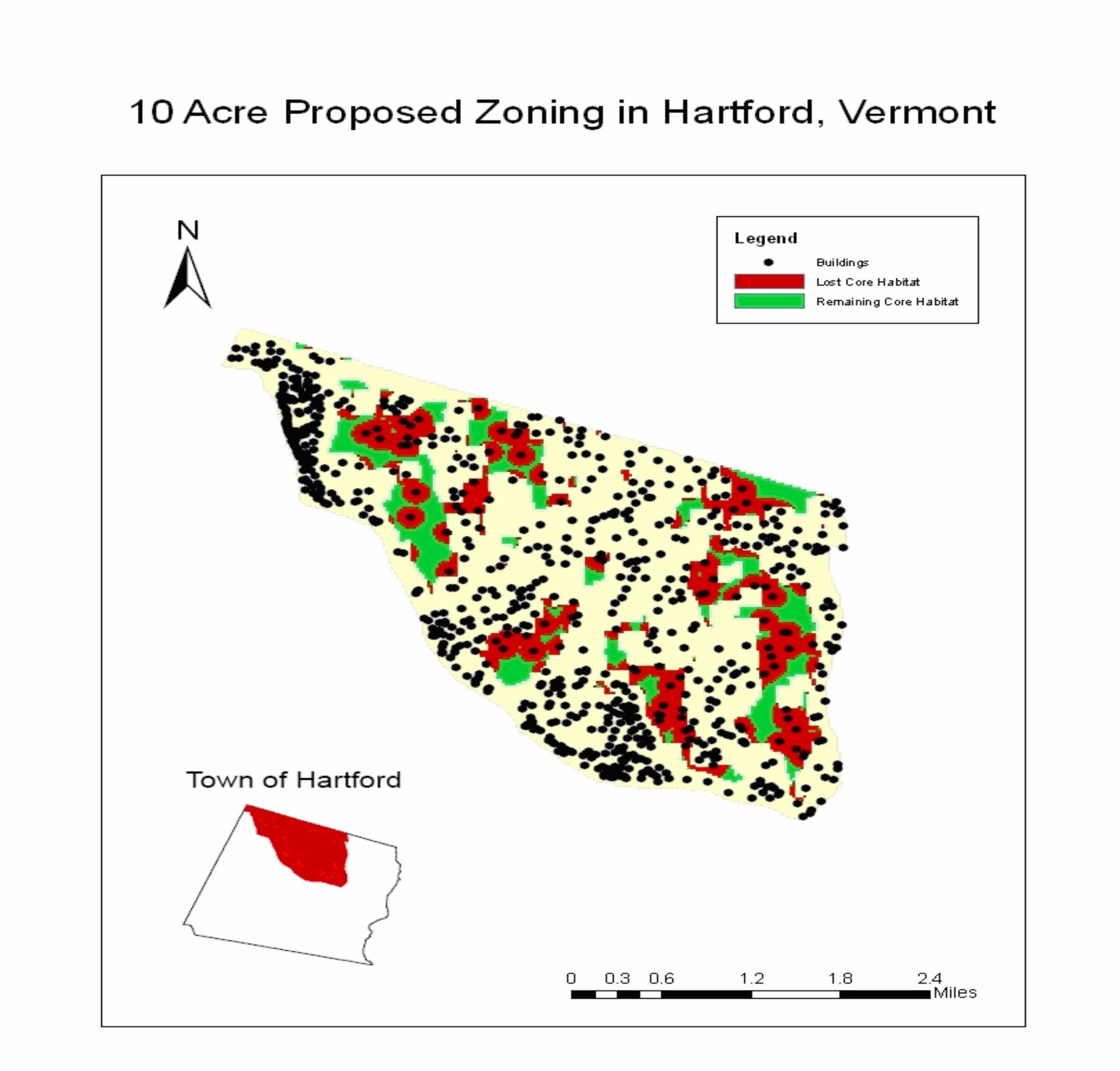


Figure 2.5 – This figure shows the results from the proposed 10 acre build-out analysis. Again, the areas in red represent areas which can no longer be defined as core habitat.

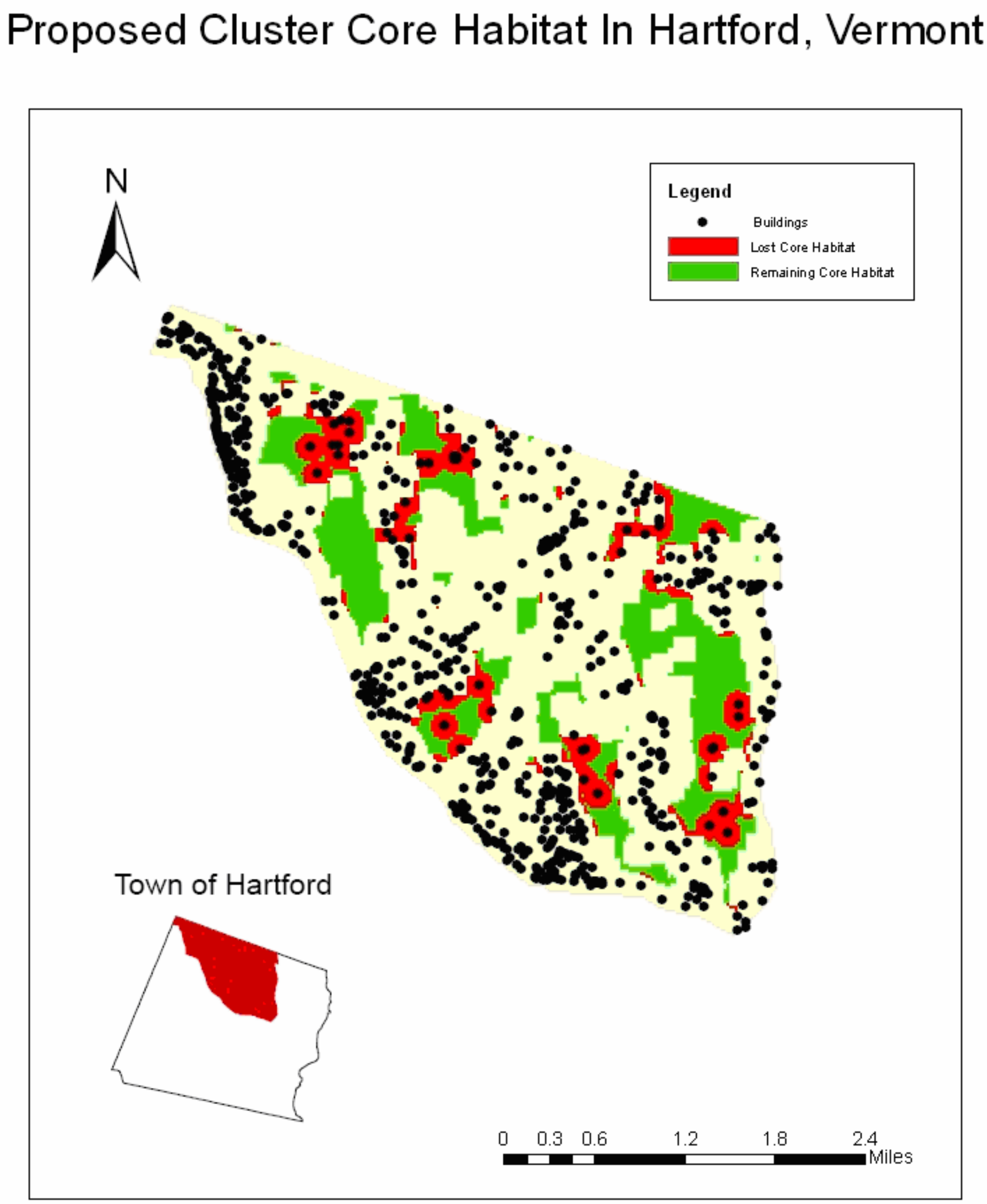


Figure 2.6 – This figure represents the final build-out analysis, using cluster zoning. This would allow for structures and new developments to occur near roads which already exist.

We also analyzed the current core habitat within Hartford Zone 3 that is classified by using the Ovenbird specific 100 meter buffer. Using GIS analysis of the region, combined with the Burke and Nol study, we can model various build-out scenarios for Hartford, and infer the effects upon local Ovenbird populations. In order to best protect the Ovenbird population and Ovenbird nesting success, it was important to take into account the highest success zone, and thus the zone with the least amount of edge intrusion which occur at 100m and inwards from the core habitat edge. Essentially forest 100m beyond a road or structure is considered core forest while the first 100m is considered the forest edge for Ovenbirds. Using this, we seek to determine the amount of core forest for Ovenbirds that currently exists in Hartford and that will exist under future development. As it is, Hartford Zone 3 contains 5.8 square km of core habitat. Using current development practices we used a build-out scenario to determine the future amount of core habitat under current zoning (See Figure 1.9 in Section 1: The Economic Implications of Sprawl). In this case the core habitat area of the Ovenbird decreased to 3.1 square km, which is a 46 percent decrease from the current core habitat. When we ran the build-out to model a clustered development zoning scenario, Hartford Zone 3 was left with 5.1 square km of Ovenbird core habitat, which is only a decrease in core habitat of 13% from current levels.

In order to maximize the Ovenbird population, which is used to indicate the general health of the ecosystem, it is important to protect core habitat. In the face of development in Hartford, conservation of core habitat would be most successfully achieved through practices that cluster development on smaller lot sizes along existing roads. While the buffer requirements and sensitivity of other species may be greater or less than those of Ovenbirds, the well-documented sensitivities of the Ovenbird made it an ideal candidate for our analysis. Analyses of other well studied species such as black bears, moose, and red eyed vireos may allow for further understanding of the potential implications of various zoning regulations. Maps of the Ovenbird specific core habitat can be found in Appendix 2B.

2.1.7 - Conclusions & Recommendations

The conclusions derived from the GIS build-out analysis show that cluster development should be further explored for Hartford as well as Hanover, which has similar habitat and development patterns. Clustering allows for the largest area of current core habitat to continue to be defined as core habitat. The other zoning scenarios allow for structures to be created in areas where roads do not currently exist and that are currently low in structure density. Clustered zoning would allow for greater populations of local species such as Ovenbirds to persist without declining as residential areas in Hartford and Hanover continue to develop.

In addition to modifying zoning regulations, core habitat may also be maintained by policies that encourage working landscapes. Forestry in particular provides a means of maintaining core habitat while reaping economic benefits.

2.2 - Water Quality

2.2.1 - Introduction

The problem of exurban sprawl is ultimately due to population increases via in-migration. The environmental problems of this population increase are for the most part created by the construction of new homes and the development of roads. With development more construction occurs and more roads are built, which places demands on the environment with lasting impacts. In the previous section we looked further into the effect of exurban development on forest fragmentation and the possible implications of different development scenarios on core habitat. However, development has many other effects on the environment. One of the most important environmental consequences of development is its impact on water quality, which is achieved primarily through increased storm runoff. Therefore, in this section we look at the effect of development on water quality. Through sampling in Hanover and Hartford we seek to determine whether exurban development is negatively impacting water quality in the area.

2.2.2 - Effects of Roads on Water Quality

The number of roads in the United States is increasing. According to recent studies, “in the U.S. there are 6.2 million kilometers of public roads used by 200 million vehicles” and the density of roads is 1.2 km per square km (Forman & Alexander 208). Roads are detrimental to hydrology since they often alter the physical and chemical properties of nearby streams. When roads are constructed they change the surface on which water flows from soils to pavement. Water has the ability to infiltrate and be absorbed by the soils, whereas pavement does not. The water simply flows over the pavement and creates new flow paths, where previously some of this water was able to infiltrate into the ground (Forman & Alexander 216). This is especially true for roads constructed on hills. The water becomes more concentrated and causes the channels and streams to be higher on the slopes then would naturally occur, resulting in longer channel length and more first order drainage basins (Forman & Alexander 208). During storms, the decrease in surface area of soils allows for less of the water to be absorbed and a greater percentage to continue flowing on the surface, leading to flooding. The same is true when snow melts (Forman & Alexander 208).

There is a correlation between the percentage of roads and flood frequency. The greater the area of roads, the less absorption capacity, the less permeable surface, and a greater occurrence of floods (Forman & Alexander 217). The USGS states that the “bulldozing of land for houses and subdivisions...increases the chance of flooding and harms the water quality of the streams” and the chance of flooding increases due to the increase in land erosion and the transport of sediment into streams (USGS 1). These events also “alter channel morphology, increase stream discharge rates, reduce percolation, affect aquifer recharge, and affect the extent of runoff” (Forman & Alexander 217).

2.2.3 - Groundwater

While we focus primarily on surface water in our assessment of water quality, groundwater quality is also an important consideration. Nitrogen and specifically nitrate concentrations are frequently used as indicators of groundwater quality. Sources of nitrate are domestic sewage treatment (septic systems) and fertilizer. Thus nitrate can indicate both the impacts of residential development and the impacts of agriculture (Gardner & Vogel 2005, 343). Environmental factors that impact the presence of nitrate in groundwater are the use of nitrogen fertilizer, the amount of cropland and pasture, population density, how well soils drain, depth of the water table and the physical characteristics of the aquifer (Gardner & Vogel 2005, 344). Gardner & Vogel (2005) conducted a study of the island of Nantucket. They identified a 1000-

foot radius of wells and accounted for variables such as percentage of undeveloped land, forest cover, paved surface, wetlands, high density development, medium density development, low density development, agriculture and presence of septic tanks in order to identify the impact of land-use on groundwater nitrate concentrations (Gardner & Vogel 2005, 346). Their findings were intuitive, essentially that groundwater nitrate concentrations increase with the number of septic tanks, high density residential development, and agricultural land and decrease with forest and undeveloped land (Gardner & Vogel 2005, 349). Relating to our study area, 86.4% of Hartford homes use a septic tank, and Hanover likely has a similar, but probably somewhat smaller proportion of homes using septic systems due to its greater degree of urbanization (Hartford Master Plan 2006, Utilites 8).

In the context of the Upper Valley, the Gardner & Vogel findings affirm that development negatively impacts groundwater quality. Both agriculture and residential development, especially rural residential development with septic systems, decreases water quality while the presence of forests and undeveloped lands positively correlates with high water quality. Due to the greater number of septic systems in Hartford, we expect decreased water quality to be a larger issue than in Hanover. Therefore, in order to ensure high groundwater quality, forests and undeveloped lands should be preserved in Hartford and Hanover. Given comparably sized sub-basins containing forest, agriculture, or residential areas, run-off and nitrate content will increase with development (Poor & McDonnell 2007).

2.2.4 - Surface Water

Our study focused on assessing the impact of exurban development through a surface water quality study of Hartford and Hanover. Roads directly impact surface water quality, primarily through runoff, and thus they are discussed earlier in this chapter, but agriculture and residential development themselves also impact surface waters.

Effects of Land-use

The effect of land-use on surface water quality is similar to its effect on groundwater quality. In an analysis of surface water in Ohio, Tong and Chen (2003) found that the presence of nitrogen, phosphorous, and fecal coliform is positively correlated with commercial, residential and agricultural development and negatively correlated with the presence of forested land-use (377). This study demonstrated that most forms of exurban development negatively impact water quality, while the preservation of open space and forested lands helps to protect water quality. However, other factors and characteristics of development affect water quality in different ways.

Surface water can be affected both by point and non-point sources. Point sources of pollutants, such as wastewater treatment facilities, have direct and specific impacts on water quality, but non-point sources such as agricultural and urban run-off also have significant impacts on streams and rivers (Atasoy et al. 2006, 399).

Wastewater treatment facilities are the primary point source of water pollution in the Upper Valley. In Hartford two municipal wastewater facilities service four of the five villages. The Quechee system discharges into the Ottauquechee River while the White River Junction system discharges into the Connecticut River (USEPA, 2007). The town hopes that the existing extensive wastewater system will accommodate denser development and more intensive land-uses than septic systems (Hartford Master Plan Utilities, 6). However, to date 86.4% of the town relies upon septic systems, which are pumped by private contractors (Hartford Master Plan Utilities, 8). The Town of Hanover disposes of sewage from the town of Hanover, Etna and Greensboro Roads, and sections of Lebanon within the Mink Brook watershed. Prior to 1960 the town was serviced by five sewer systems that discharged directly into the Connecticut River. Six pumping stations now feed the water treatment facility near the mouth of Mink Brook, which discharges into the Connecticut River. The facility handles wastewater from 1,930 connections and approximately 250,000 gallons of sewage annually from private septic systems, delivered by private septic pumping services (Hanover Master Plan 2003, 11.21).

In looking at land-use and development in North Carolina, Atasoy et al. look at the effects of residential land-use and land conversion on water quality while controlling for point sources of pollutants and agricultural sources. In this way they analyze the specific impact of residential land-use on water quality. Water quality is determined by nutrient pollutant loadings (Atasoy et al. 2006, 407). In their findings, both the amount of residential development and the timing of this development have impacts on surface water quality. More specifically, the process of converting land to residential use, such as the act of construction, has a significant impact on water quality that is often different from the eventual land-use itself (Atasoy et al. 2006, 407). In applying this to residential development in the Upper Valley, both the amount of development and the timing and location of this development will impact surface water quality.

Despite the sheer volume of waste that passes through waste treatment facilities, compared to point sources, non-point sources in the Upper Valley may constitute a larger threat to water quality as they are not directly regulated and spur from a greater watershed area (Atasoy et al. 2006). These sources include run-off from agricultural land as well as lawns and roads.

Another important aspect of surface water quality, as it relates to land-use, is the impact of development at the watershed scale. This frequently poses issues from a land-use planning framework, because watersheds often transcend political boundaries, and thus regulation of land-use in the watershed frequently requires cooperation among several parties. In looking at land-use planning and its effect at the watershed scale in Ohio, Wang determines that the biological integrity, or the ability to support and maintain a balanced, integrated and functional community as assessed by twelve factors including water chemistry, fish population, macroinvertebrate populations, river habitat quality, land-use and cover, of watersheds is negatively impacted by increasing intensity of development, both urban and agricultural (Wang 2001, 27). The Wang study justifies looking at water quality on the watershed scale, and thus our group seeks to analyze the link between water quality and exurban development through an analysis of watersheds in Hartford and Hanover.

2.2.5 - Local Public Water Supply

In looking at water quality in Hanover and Hartford, it is important to understand the source of the municipal water supply. The Town of Hanover and Dartmouth College currently rely on three reservoirs on two separate tracts covering a total of 110 acres and containing 500 million gallons at normal level to fulfill its entire public water supply. The land immediately surrounding these tracts totals 1,250 acres and has been protected and maintained since the 1880s by the Hanover Water Works Company (Town of Hanover Open Space Priorities Plan, 2).

The Town of Hartford relies upon two different water systems which provide three-quarters of the town with its drinking water: the Hartford and Quechee Water Systems. The Hartford system draws water from a groundwater aquifer through two gravel pack wells in Wilder to supply 2,042 customer accounts (86% residential) in White River Junction, Wilder and Hartford Village (Hartford Master Plan Utilities, 2). The wells are capable of supplying 800 and 900 gallons per minute. In 2005, 114 million gallons and 165 million gallons were pumped from the two respective wells. The Quechee water system also relies upon a groundwater aquifer, which in 2005 supplied more than 56 million gallons to 750 customer accounts (Hartford Water Quality Report; Hartford Master Plan Utilities, 5).

Since the town of Hanover relies on a system of reservoirs, surface water quality is an important factor in maintaining the integrity of the town water supply. Thus, our study on development and surface water quality applies well to the town of Hanover. Hartford, rather, depends on ground water for municipal uses. While we do not focus on the relationship between exurban development and ground water quality, this is a potential area for future research.

2.2.6 - Effects of Road Salt on Water Quality

Sodium chloride is an indicator of the total dissolved solids from anthropogenic sources, as the majority of salts in inland water sources are runoff from deicing agents such as sodium chloride. Other pollutants such as phosphorous and nitrates also runoff into water sources, and alter the nutrient loading of the aquatic and riparian system. Ions from deicing agents can present human health risks, particularly if they percolate into groundwater sources.

In 2005, a study was conducted in the White Mountains of New Hampshire, New York and Maryland to determine the amount of chloride in the streams. The national trend suggests that concentrations of NaCl are increasing and in the study areas, sodium concentrations in freshwater are 25% of the sodium concentrations in seawater (Kaushal et al. 2005, 13517). Urban streams have 100 times the sodium chloride concentration as rural forested streams. If this trend continues to increase at its current rate there will be lasting consequences. In rural areas in New Hampshire, the salt concentration rose to 100mg/liter throughout the year. In the winter, its peak concentration in urban areas is about 5 grams/liter (Kaushal et al. 2005, 13518). The toxic levels for species are: 30mg/liter for terrestrial plants, 100mg/liter for aquatic plants and invertebrates, and 250 mg/liter for freshwater life and human drinking water (Kaushal et al.

2005, 13517). Salt concentrations need immediate attention since they clearly have grave ecological impacts. Even if salting were to completely cease immediately, the level of salinization in water would take some time to recover.

Beyond affecting surface water, deicing salt contamination enters groundwater and is transported through the groundwater system. In Mirror Lake, located in New Hampshire directly off Interstate 93, the sodium chloride concentrations have been carefully studied. Between 1977 and 1997 these concentrations tripled (Rosenberry 1999 et al 179). In this case study, water reaches Mirror Lake through precipitation events, surface runoff, and during the winter a groundwater stream (Rosenberry et al 1999, 190). Sodium chloride is used as an indicator of anthropogenic runoff, because natural concentrations of sodium chloride in a freshwater lake are near zero. During the summer months, the hydraulic gradient changes, and instead of the groundwater flowing into the stream, it actually flows out of the lake. Below the stream, groundwater measurements were taken and sodium concentrations were detected as far down as 0.6 m (Rosenberry et al 1999, 194). When the hydraulic gradient was low, the level of contamination was high. It is also believed that after the summer when the hydraulic gradient is reversed, it causes the contaminated groundwater to be flushed back into the lake. This corresponds with the test results observed during this study of a sharp increase in salt concentration in Mirror Lake in the fall (Rosenberry et al 1999, 194). Although the effects of deicing salt are noticeable in Mirror Lake, the impact does not appear to have continued into the entire groundwater system. However, if this problem is not addressed the levels of chloride will continue to escalate to dangerous levels in Mirror Lake.

The Town of Hanover uses multiple types of salt for various road types and weather conditions. For temperatures above 17 ºF, a less expensive sodium chloride road salt is used.

When the temperature drops below 17 ºF a chemical blend of sodium chloride and magnesium chloride is used, and it is effective to 4 ºF. This blended salt also contains a molasses like compound that makes the salt bounce less when it hits the roads and works at a lower temperature. However, it costs twice as much as rock salt (Kulbacki 2007). Strictly sand is used on gravel roads in Hanover because these roads are a lower priority to clear than main paved arteries. Aside from budgetary concerns, salt thaws the surface of the gravel and can damage the surface. Furthermore, salt has a tendency to accumulate in potholes and pockets. While sand has no appreciable environmental impact, sodium and magnesium chloride easily ionize, increasing the salinity of the liquid they are suspended in. The Town of Hanover annually uses approximately 1,900 tons of salt and 4,000 tons of sand (Hanover Master Plan 2003, 11.17). The Town of Hartford was contacted in regards to their salting procedures and did not respond; therefore we assume that the town follows a similar protocol.

2.2.7 - Water Quality Study

Introduction

One way to test the water quality of streams, rivers, and lakes is to measure the amount of total dissolved solids (TDS) present in the aqueous solution. Dissolved solids refer to “any minerals, salts, metals, cations or anions dissolved in water” (Oram 2007). Usually TDS include inorganic salts, such as calcium, magnesium, potassium, and sodium, and small amounts of organic matter (Oram 2007). There are several reasons that cause the total dissolved solids to be at an elevated level within bodies of water (Oram 2007). Natural sources that increase TDS are mineral springs, carbonate depositions, salt depositions, and seawater intrusions; some unnatural sources are deicing road salt, agricultural and stormwater runoff, and drinking water treatment chemicals (Oram 2007). Since TDS is a measure of the sum of cations and anions in the water, there is no qualitative way to determine the nature and amount of individual dissolved ions (Oram 2007). Therefore, TDS is used as an indicator of general water quality; it cannot tell us the presence of specific dissolved solids but high levels of it could indicate that possibility of the water to be corrosive, salty, or the water to interfere with hot water heaters (Oram 2007). In addition, TDS can affect the stream biota, but the effect depends on the sources and identities of the dissolved solids present in the water (Renshaw 2007). Toxicity to aquatic organisms is affected by the specific combination and concentration of ions, as well as the species and life history stage; therefore level of toxicity is not predictable simply from TDS concentrations (Chapman et al 2000, 210). TDS toxicity studies could be conducted for specific sites and organisms to ensure that the results apply to the environment in question (Chapman et al 2000, 210). If a stream has a high TDS level, then further tests are necessary to identify what solids are actually present (Renshaw 2007).

One simple way to determine the amount of total dissolved solids in water is by measuring conductivity. There is a linear relationship between the amount of total dissolved solids and conductivity, meaning that high levels of dissolved solids will cause high conductivity levels (Renshaw 2007). If one is comparing the conductivity of individual substances, then different substances contribute differently to conductivity (Renshaw 2007). However, in our studies of the rivers in the area, the compositions of ions should be similar enough that there is no need to isolate the amount of each ion (Renshaw 2007). Organic substances make little contribution to conductivity by themselves, but it is rare to have only organic pollutants in the water systems because they are almost always associated with inorganic ions. Therefore, water systems with high levels of organic pollutants will also have a high conductivity level (Renshaw

2007). For these reasons testing for total dissolved solids can be the quick and easy way to test the water quality and determine the effects of urbanization on streams.

The Environmental Protection Agency (EPA) has established two categories of standards for water: Primary Standards and Secondary Standards (Oram 2007). Primary standards are based on health considerations while Secondary Standards are based on taste, odor, color, corrosivity, and staining properties of water (Oram 2007). There is no Primary Standard for TDS, but the Secondary Standard for TDS is 500 mg/L (Oram 2007). The relation between TDS and conductivity is $TDS = 20 + 0.7E$, where TDS is in mg/L and E is conductivity in microsiemens (μS) (Renshaw 2007). Therefore, the Secondary Standard for conductivity is 686 μS.

The goal of this water quality study within Hartford and Hanover is to identify streams in areas of high and low urbanization and to sample the water in these streams. Using GIS, the area of each drainage of the selected sites can be quantified and the area of roads and structures within each of these drainages can be calculated. The density of roads and structures will provide further information as to the level of urbanization occurring within the drainage.

Methods

Using GIS, the drainage areas within Hartford and Hanover were defined. They were defined using the ArcHydro Tool add in which uses the Digital Elevation Model (DEM) and streams layer for each town to define the drainage area. Once the drainage areas were defined, a USGS topographic map was used to aid in selecting drainages that were representative of low, medium, and high levels of urbanization within each town. Google Earth and local knowledge of the streams were incorporated into this process of site selection. Using these materials, eight watersheds were chosen (see Table 2.3).

For Hanover, Mink Brook was selected. Mink Brook is a good choice since it flows through a range of land-uses and road densities. The headwaters lie in Etna in an area of minimal to no development, and then as it nears Greensboro Road, it runs through an agricultural area. The section of Mink Brook on Greensboro Road represents mid-level development. Mink Brook then flows through urban Hanover. Hewes Brook was selected as another sample site and represents an area of mid-level urbanization.

For Hartford, six sites were chosen. Tigertown Stream is in an area of little development and has one dirt road which the stream follows. Jericho Road, Dothan Brook and Jericho Brook are two examples of mid-level development. Quechee Lakes and another unnamed stream near the Hartford Cemetery were selected as urbanized streams.

After the sites are selected and the drainage areas are defined for each stream, a polygon of the selected drainages is outlined. This polygon is then used to clip the roads layer. We next calculated the area of each drainage, and the length of roads within that drainage.

Results

The GIS and water sample results for each watershed are summarized in tables below.

Table 2.3 – Analysis of Hartford and Hanover Drainage Basins

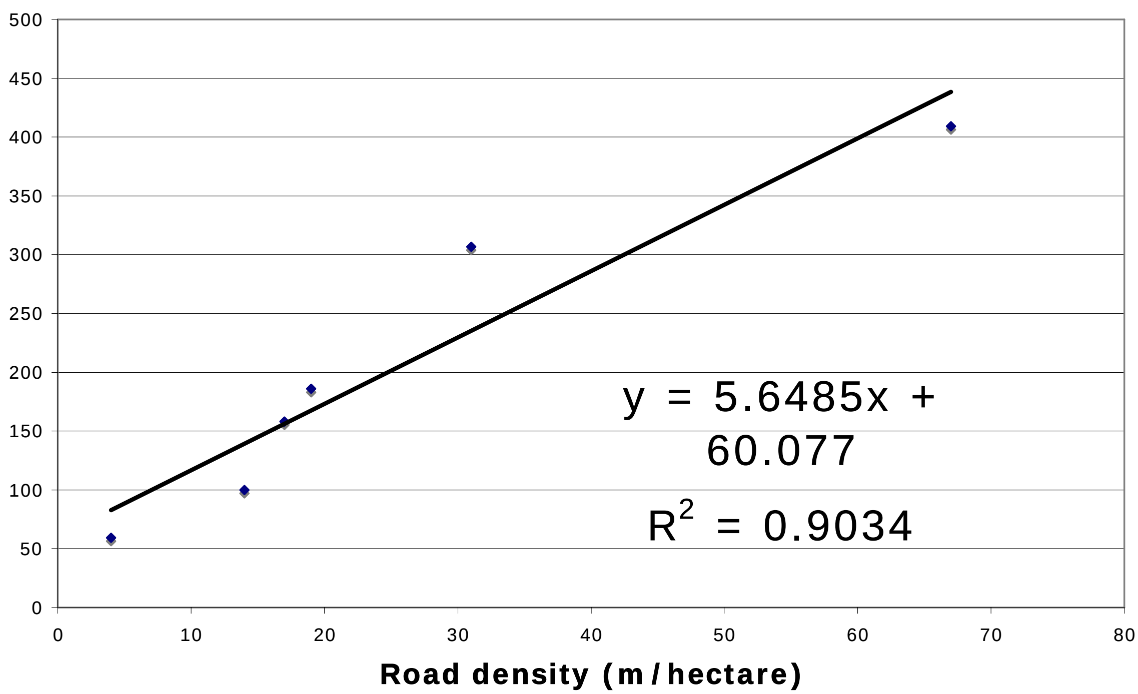
Hartford Drainage Basins	**Area (ha)**	**Length of Roads (m)**	**Roads per Area (m/hectare)**	**# of Structures**	**Structure Density (#/ha)**
Dothan Brook	1307	22149	17	399	0.31
Cemetery	277	18621	67	409	1.48
Jericho Brook	699	10113	14	56	0.08
Jericho Road	291	5470	19	50	0.17
Tigertown	501	2069	4	5	0.01
Quechee Lakes	214	6736	31	69	0.32
Hanover Drainage Basins					
Hewes Brook	2834	12301	4		
Mink Brook	4812	72237	15		

Table 2.4 –Analysis of Conductivity at different sections of the rivers in Hartford and Hanover

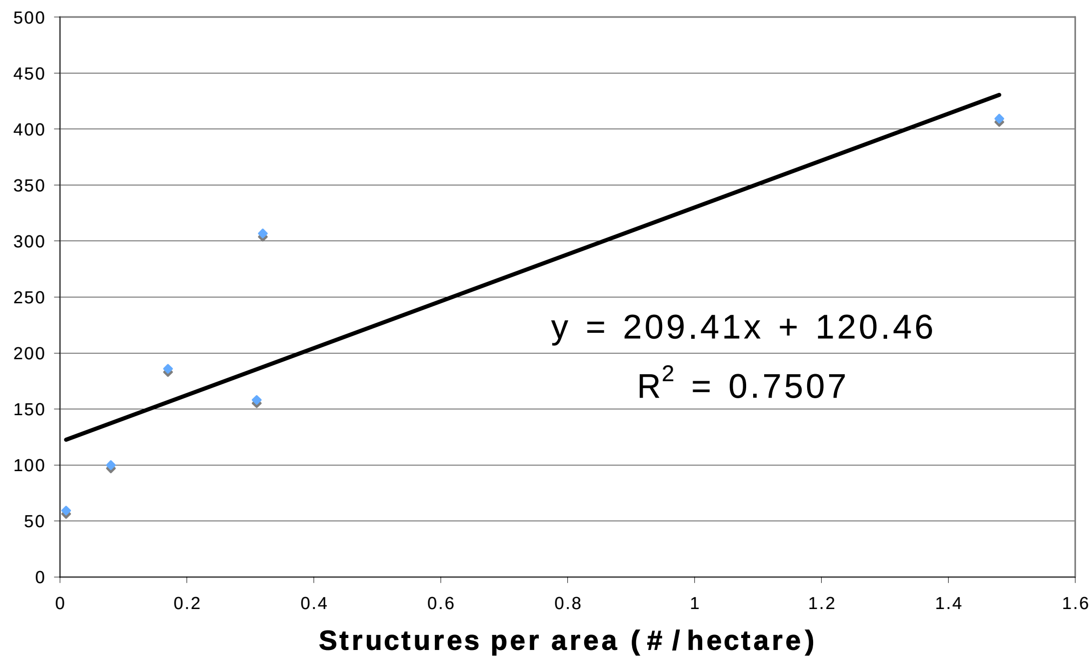
Hartford Drainage Basins	**Conductivity (μS) Whole river, average**	**Headwater**	**Midstream, average**	**Mouth**
Dothan Brook	158.3	170	119	225
Cemetary	409.3	269	482	477
Jericho Brook	99.8	66	102	127
Jericho Road	185.9	243	171.8	200
Tigertown	59.2	47	53.3	89
Quechee Lakes	306.6	302.5	312.5	303
Hanover Drainage Basins				
Hewes Brook	60.25	42	60.5	78
Mink Brook	81.6	52	79.4	160

The GIS analysis showed that the density of roads varies from site to site, indicating higher levels of urbanization with higher density. The sites exhibit a variation in the densities of both roads and structures (Table 2.3). In testing the average conductivity of each drainage we determined that the order of the drainages for the average conductivity for the entire length of the rivers from the highest to lowest was Cemetary, Quechee Lakes, Jericho Road, Dothan Brook, Jericho Brook, Mink Brook, Hewes Brook, and Tigertown Stream (Table 2.4). In comparing Table 2.3 to Table 2.4 one can see that the order of highest to lowest for both road density and conductivity were fairly similar; the orders in descending order for structure density and conductivity were comparable as well. To further support this, a regression analyses was done to determine the relationship between road density and conductivity, and between structure density and conductivity. Regressions were run for average conductivity of the stream, for the headwater of the stream, for the average of midstream, and for the mouth of the streams.

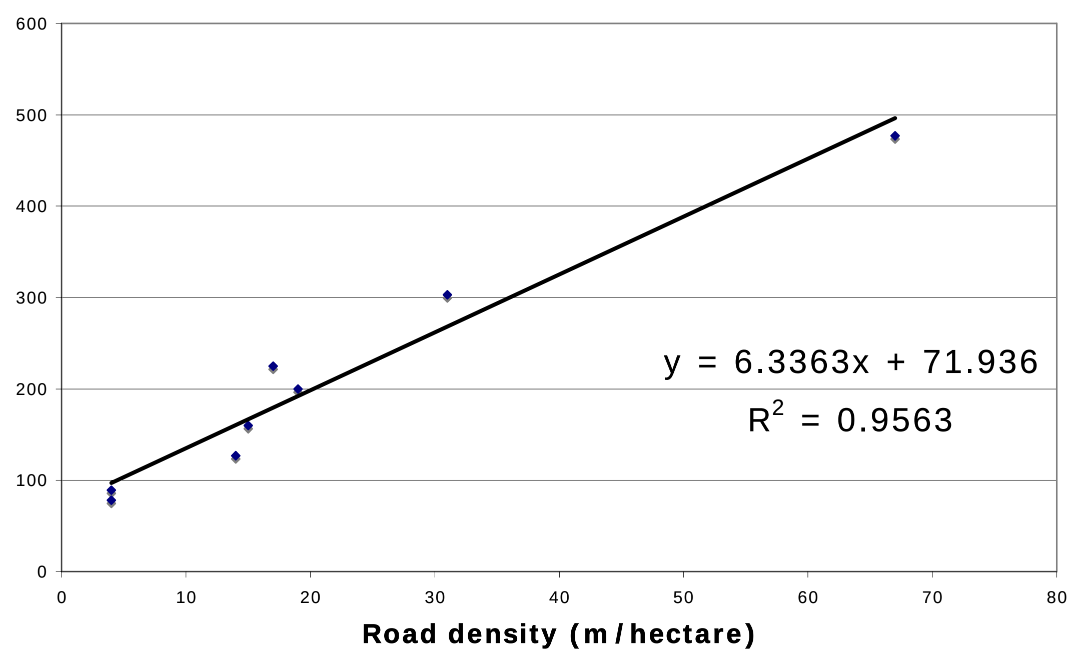
Graph 2.1- Average conductivity of the whole river vs road density in Hanover and Hartford drainage basins

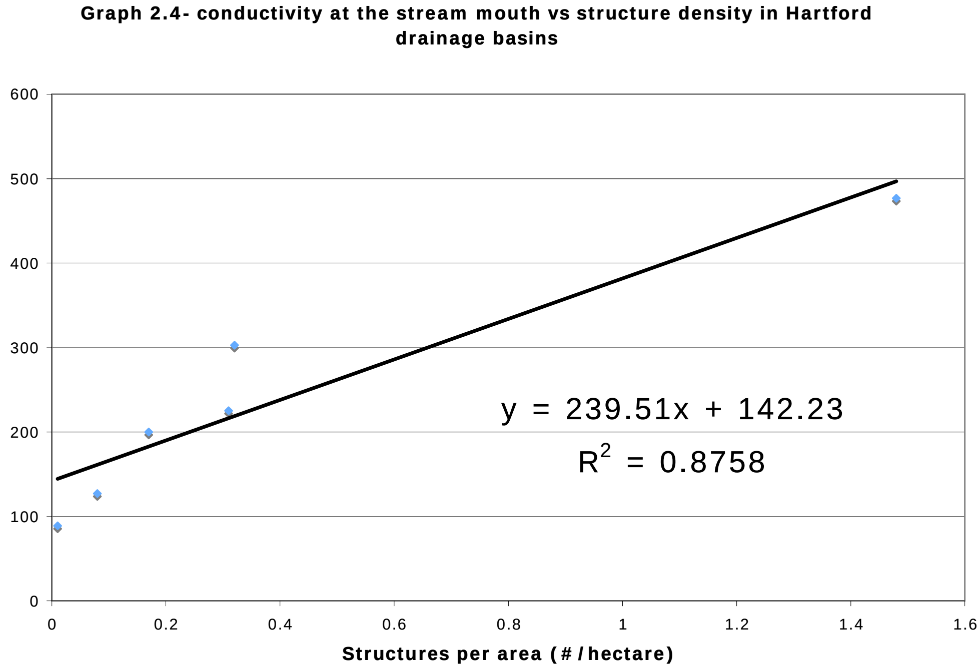


Graph 2.2- Average conductivity of the whole river vs. structure density in Hartford drainage basins



Graph 2.3- conductivity at the stream mouth vs road density in Hanover and Hartford drainage basins





(See Appendix 2C for more regression graphs)

The explained variance (r^2) of road density against average conductivity of the entire river was 0.90, which demonstrates a strong correlation. The explained variance of structure density against average conductivity of the entire river was 0.75. The relationship between road density and average river conductivity was slightly stronger than between structure density and average river conductivity, but overall there is a strong relationship between road density, structure density and average river conductivity.

A regression was also run for river mouth conductivity. It was hypothesized that the river mouth sampling sites show the most effects of human developments on water systems. The explained variance of road density against the river mouth conductivity was 0.96, which shows a strong correlation between the two. The explained variance of structure density against the river mouth conductivity was 0.88, which confirms our hypothesis that increases in structure density are related to increased river mouth conductivity. These results conclude that road density and structure density correlate with high stream conductivity.

Table 2.6 – Conductivity of Mink Brook from headwater to mouth in order

Mink Brook	**Conductivity (µS)**
Headwater	41
Headwater	63
	58
	60
	67
	68
	83
	85
	92
	91
	111
Mouth (at Connecticut River)	160

In our studies, the effects of human development over the entire stretch of the river were observed. In Mink Brook conductivity readings from the headwater to the mouth were taken. These reading show that as distance from the headwaters increases, conductivity does as well. At the headwater the conductivity was 41µS and at the mouth the conductivity was 160µS, showing a dramatic increase. As it was stated earlier, Mink Brook starts in Etna where there is minimal to no development, then runs through an agricultural area, and finally ends in the Connecticut River after going through urban Hanover. Therefore, it can be stated that human developments do indeed impact water conductivity and thus the general water quality.

However, the highest conductivity level seen during the whole testing was at the midstream of Cemetary with 482µS. This is lower than the EPA Secondary Standard for conductivity, which is 686µS. Therefore, all of these streams are below the standard conductivity or TDS levels set by the EPA, and so we characterize the overall water quality in Hanover and Hartford as very good.

2.2.8 - Conclusion and Recommendations

From both background research and our sampling in Hartford and Hanover, it has been shown that residential development negatively affects water quality. By identifying particular watersheds, and analyzing the characteristics of the watersheds in terms of road density and structure density, we can identify watersheds that should be protected from further exurban development. Watersheds are not always accounted for in zoning regulations because they do not follow convenient political boundaries, but in order to preserve water quality it is important to regulate on a watershed scale. If Hartford wished to protect streams with very high water quality, our data suggest they should limit further development in the Tigertown and Jericho Brook watersheds. Protection of the watershed could include changing the zoning regulations in the area, clustering development in other less sensitive areas, or even changing road salting and paving policies. Water quality is an important environmental indicator, and so future development planning in the area needs to account for impacts on Hartford and Hanover surface waters.

Recommendations:

- **Water quality in Hanover and Hartford is quite good, as evidenced by the fact that none of our data exhibit conductivity levels above the EPA secondary standard. Hanover and Hartford should continue to prioritize water quality in their land use and zoning decisions, however, because our results did show differences in the conductivity of watersheds with a high presence of exurban development and relatively pristine watersheds.**

- **The towns of Hanover and Hartford should continue to monitor water quality, and focus specifically on the watershed scale in order to prevent exurban development from impacting local watersheds.**
- **Watersheds with extremely high water quality should be protected from further development if at all possible. Such watersheds include Tigertown stream and Jericho Brook in Hartford. Ways to protect these watersheds include changing zoning regulations to favor clustered development in watersheds that already show the presence of development. As well, land-use decisions should be made that take into account entire watersheds regardless of the presence of political boundaries, as this is the best way to protect water quality on the watershed scale.**

SECTION 3

THE SOCIAL IMPACTS OF LAND-USE

3.1 - Introduction

Planning future land-use in Hanover, NH and Hartford, VT needs to take into account the social ramifications of land-use. As one person in Hanover put it, there needs to be a balance between environmental needs, affordable housing, and economic diversity (Hanover Survey Participant May 2007). Land-use planning should attempt to find this balance.

This section will focus on how to include the social impacts of development in land-use planning. It will relate rural culture and affordable housing to socioeconomic diversity, and discuss the importance of these social aspects. Next, it will discuss the land-use survey that we conducted for Hartford and Hanover, including our expectations, surveying locations, problems we encountered, and our results. Finally, this section will include our policy recommendations for future land-use planning.

3.2 - Socioeconomic Diversity

Socioeconomic diversity is the idea that all socioeconomic classes are able to exist in one area. Socioeconomic diversity is important to municipal planning for several reasons. First, diversity is an important condition "of a good (vital, well functioning) human settlement" (Talen 2005, 215). Second, diversity is important to the economic health of an area (Talen 2005, 215). Third, it is a way to achieve social equity. Finally, it is a "basis of sustainability" for communities (Talen 2005, 216).

Rural economies, compared to those of urban areas, have a significantly lower level of economic diversity, which dictates aspects of rural society. As described by Tickamyer & Duncan in their regional comparative study of rural poverty, in the Northeast, "the structure of economic opportunity in a given place or time provides the context for the behavior of the rural poor" (Tickamyer & Duncan 1990, 73). The implications from the dynamics of rural economies translate onto other aspects of rural poverty, especially because "there is too little work, and the lack of diversity in the economy extends to social and political institutions, creating a highly stratified and unequal social structure" (Tickamyer & Duncan 1990, 81). In rural areas, a high percentage of those who are impoverished are employed, however, because of the structure of rural labor markets there are less opportunities to be financially successful (Lichter et al 1994, 397). The structure of work opportunities has prevented poor and rural residents and communities from escaping poverty (Tickamyer & Duncan 1990, 69).

Labor in rural areas is often seasonal and low paying and residents do not necessarily have the ability to reach beyond their initial capacities, especially with a lack of educational opportunity (Lichter et al 1994, 399). Although there is historically a lack of a middle class in rural areas (Duncan & Tickamyer 1988, 245), in Hanover and Hartford, Dartmouth College and Dartmouth Hitchcock Medical Center provide jobs that increase the median income of the area and have created a strong middle class in the area. In Hartford, the median household income is $51,286. This is well above the national median household income of $46,326. In Hanover, the median household income is even higher at $72,470 (U.S. Census Bureau 2000). Even though the median household income in both towns is above the national average, however, both Hartford and Hanover residents are concerned that the area is getting too expensive to live in.

One Hanover resident, when asked what her biggest concern about future land-use in Hanover is, responded, "Cost factor. I don't think my children will ever be able to afford to live here" (Hanover Survey Participant May 2007). Another Hanover resident was also worried "that so many great folks [Hanover and Hartford natives] won't be able to live here" (Hanover Survey

Participant May 2007). Asked the same question about Hartford, a Hartford resident expressed concern that Hartford “will contain more Quechee-like developments for wealthy flatlander retirees instead of affordable housing for the region's middle-income workers who want to live in Hartford” (Hartford Survey Participant May 2007). A second Hartford resident is “concerned that the land is going to cost too much for native Vermonters who will have to move out into more rural areas such as Tunbridge and Chelsea which will cause them to commute further” (Hartford Survey Participant May 2007). This shows that residents are worried about the loss of socioeconomic diversity. They are concerned that only the wealthy will be able to continue to live in the area, while the middle and lower income residents will be pushed out.

3.2.1 - Rural Culture

One reason that socioeconomic diversity is so important to Hanover and Hartford is because it is tied to preserving rural culture. As the two towns become more affluent, only people with high incomes–the “wealthy flatlander retirees” mentioned by one Hartford resident above–can afford to live in them. This has the potential for pushing out the farms and small businesses that are essential to the culture of the region. One Hanover resident stated that they were concerned about the “loss of our cultural tradition (people and landscape)” (Hanover Survey Participant May 2007). In this section we present a definition of rural culture and some possible methods to preserving it in the two towns.

Rural culture is part of the appeal of towns like Hartford, VT and Hanover, NH. It is what draws tourists to the area and entices people to move here. The New Hampshire Office of State Planning states:

> When communities frame master plans around preserving rural character, people are seeking to hold onto and promote traditional rural or small-town values of family, community, independence, responsibility, self-government, conservation, entrepreneurship, and strong work ethic in a fast-changing world. (2000, 1)

The Vermont Council on Rural Development focuses more on the historical context of rural culture. They believe that, “Stone walls and Town Halls, downtowns and open lands all help to shape who Vermonters are and the values they share” (VCRD 2004, 7). Another aspect of rural culture is outdoor recreation. The Upper Valley has many places to hike, bike, fish, hunt, canoe and enjoy other forms of outdoor recreation. The loss of places to recreate to increased development concerns residents. In this paper, we define rural culture as a mixture between the layout of the town, the cultural beliefs, such as the belief in a strong work ethic, and a socioeconomic mix that includes agricultural workers. These are all elements of rural culture in Hartford and Hanover.

Another important part of Hanover and Hartford culture is the town government. New England towns have a unique town government structure, compared to most areas of the country. The Board of Selectmen is the executive body of town government. Most commonly, the Board consists of three or five elected townspeople. The Board’s responsibilities include selecting members of committees, boards, and commissions, unless it is voted during town meeting that members will be chosen by election open to registered voters of the town (Zimmerman 1999, 42). Other places in the country have a City Council, a more representative type of government.

The Select Board in Hanover and Hartford also appoints a Town Clerk or Manager. The Town Clerk or Manager performs the administrative and clerical duties of the Board of Selectmen and is a full-time, year-round position (Gilgore 1955, 23). Between annual sessions, elected citizen boards and officials must see that the decisions voted upon during the town meeting are put in force. The Board of Selectmen, or Town Clerk or Manager, issue a warrant which advertises the location, date and time, of the town meeting, including all items of the fixed agenda (29). In areas outside of New England, there is no town meeting. Since this system of participation is unique to New England towns, it has become an integral part of the town culture.

Although the rural cultures of Hanover and Hartford are slightly different, there are also commonalities. For example, the system of town governance is similar in both towns. Furthermore, the Hanover Master Plan notes that, “there is a tradition of thought, activities and inter-municipal cooperation that extends across town, county and state boundaries” (Hanover Master Plan 2003, 1). So, rural culture is not constrained by town boundaries.

Because rural culture is important to Hanover and Hartford, town decision-makers should consider preserving rural culture as they plan the future path of the two towns. The New Hampshire Office of State Planning notes:

> Master plan committees, planning boards, zoning boards of adjustment, conservation commissions, and boards of selectman or city councils may not see how some of their land-use policies and regulations can lead to land-use patterns that convert rural character into sprawl. (2000, 1)

Therefore, it is important for these groups to keep in mind how important rural culture is, and special care might need to be taken to ensure that it is not destroyed in the process of developing the towns.

One way to preserve rural culture is to conserve the open space that is the hallmark of rural areas. To do this, it is important to maintain existing agricultural and forest-based business in the region. Farms and forested areas generally involve large tracts of land, so by maintaining them, open space is also preserved. Maintaining farms does not have to come at the expense of other development of the region, but rather creating vibrant farms can be a part of development. The New Hampshire Office of State Planning believes that “farmland and farming will become all the more valued and valuable as more of the state becomes urbanized” (2000, 1).

Farms are also important because they provide local produce and their existence helps towns keep their traditional feel. They help to keep socioeconomic diversity in the area by providing jobs that require a lot of hard work. At the end of the day, as one farmer put it, farm employees make about the same amount as McDonald's employees, on a per hour basis, because of how many hours farmers have to work (G. Miller, personal communication on May 21, 2007). Farms are traditionally passed down from one family generation to the next, so they truly are a part of the culture of the area.

Another way to preserve rural culture is to take a more active role in incorporating rural culture into business, a system that the Vermont Council on Rural Development calls a creative economy. They note that, "Vermont's heritage, arts, and culture serve as foundation for the Vermont brand so essential to the success of the state's tourism industry, as well as its manufactured, handcrafted, and agricultural products" (2004, 8). To enlarge the creative economy, VCRD recommends that Vermont expands markets for creative goods and services, unifies the promotion of these goods and services, holds special events to highlight cultural life, and provides technical support to emerging culturally-based businesses (VCRD 2004, 14-15). Therefore, community planning should include the cultural sector. At one discussion group, the downtown was identified as an important area where culture and business should be mixed (VCCI 2004, 10).

A third way to preserve rural culture is to incorporate it into education. Hartford could use a 'Vermont Content' curriculum (VCRD 2004, 17) and Hanover a 'New Hampshire Content' curriculum for K-12 students. In Vermont there is currently a Framework of Standards and Learning Opportunities related to the arts and humanities. The purpose of this program is to improve the curriculum in these areas and to prepare students for statewide learning assessments.

According to the Vermont Council on Rural Development, the implementation of this framework, however, is not equitable across all of the public schools in Vermont (VCRD 2004, 17). The VCRD, therefore, suggests that a “Vermont Content” education be coordinated in all public schools (17). In New Hampshire, the Department of Education suggests that public schools incorporate local and state history into their curriculum. This is done subject by subject, however, and therefore is not interdisciplinary in scope. For example, the social studies framework suggests that students in grades 3 and 4 learn about laws and policies made at the local and state level. In grades 5 through 8 it is suggested that students learn about the local, state, and national level laws (K. Relihan, personal communication, May 22, 2007). In both states, it is up to the local community to choose to teach local content.

Currently in Hanover and Hartford, students do go on field trips to farms (Principal Ashley, personal communication May 29, 2007) as well as learn about colonial times (The Ray School, personal communication May 29, 2007). This is a step in the right direction, however, more emphasis needs to be placed on the local processes of government. Furthermore, the community should be involved in this education process through “partnerships between K-12 schools, town libraries, and cultural organizations” (VCRD 2004, 17). Community involvement is important because it ensures that learning about town government or about farms is not just a field trip once a year, but rather this education takes place all year long.

In summary, conserving open space, bringing the cultural and business sectors together, and encouraging cultural education are all ways to preserve rural culture.

3.2.2 - Affordable Housing: What Do Communities Need?

A second way for land-use planners to maximize socioeconomic diversity is to support the development of affordable housing. The lack of affordable housing is one of the greatest challenges present in rural communities that encompasses both economic and social inequities. It compromises the ability for homeowners to have a residence that fits their income level and social needs.

Affordable housing can be defined as housing "which costs no more than 30% of the income of the occupant household" (Andrews 1998, 1). According to a report in *Meeting America's Housing Needs*, recent housing trends have exhibited a decline in the supply of affordable and decent quality housing (Andrews 1998, 1). This is the result of an increase in real costs and a decline in real incomes for the urban and rural low and middle classes (Andrews 1998, 1). Housing in rural communities is often insufficient for impoverished residents because of their lack of economic purchasing power as well as the dearth of housing that is suitable for their cultural and social needs. Affordable housing issues are not limited to the poor; for middle income residents it can often be difficult to procure suitable housing, as there is generally a limited variety of housing options in rural communities.

For impoverished rural residents, the housing issues are: lack of transportation options, greater demand than supply of inexpensive housing, and lack of economic opportunities near affordable housing. These problems make it difficult for the impoverished to culturally and economically place themselves in the community landscape for a sustainable period of time. Often stricter state building codes and local land-use regulations have a "disproportionately negative effect on housing for poor people" (Fitchen 1992, 184). An example is zoning regulations that require lot sizes of at least 5 acres for mobile homes, which locks out the presence of any low-income trailer owners (Fitchen 1992, 184).

There has been some change, as these issues have been addressed on large scales. Some relatively recent changes to federal programs have focused on aspects such as greater flexibility in the housing programs, an increased position for the state and local governments, and a greater inclusion of population demographics and geographic areas that have been underserved by current housing markets (Family Economics and Nutrition Review 1999, 95). Furthermore, government policies have been directed towards greater percentage homeownership with the inclusion of new tax policies and program incentives (Family Economics and Nutrition Review 1999, 95). The relationship between the rural poor and the state of their community's housing has a substantial and visible impact on the rural landscape. For example, rural poor residents are impacted when local decisions are made that favor conservation over the development of affordable housing.

Often, the lack of low-income housing overshadows similar middle class issues that are even more prevalent in some communities. In Hanover and Hartford it is known that there is a need for low-income housing; according to the Hartford Housing Authority despite many changes over time, there is still a shortage of affordable housing. However, it is often forgotten that there is also a need for a great range of housing beyond the simple divide of Hartford's Haven, a homeless shelter, and expensive properties, for example. A lack of affordable housing for the middle income demographic is present in rural communities in two capacities: the need for available affordable housing for new residents and for the longer established residents.

This is becoming an increasingly important issue for Hanover and Hartford with the growth of Dartmouth College and DHMC. The new middle income residents of an area in search of affordable middle income housing are often young and relocating to a region for employment purposes or for long-term settlement. For rural middle income residents who have been in the area for longer there is often the fear of being excluded from local housing options. In the case of Missoula, Montana, there is concern that the "average Missoulian can scarcely afford such prices and are being pushed out of the housing market" (Ghose 2004, 538). This is true in the case of Hanover as families with higher earning levels are being attracted to the town by the college and the hospital, which can have an adverse effect on residents who have been in the area for longer. Affordable middle income housing is becoming an increasing problem in rural areas, as there has been a disconnection between local community needs to keep a strong working middle class and the affordable housing demands.

Housing in Hanover and Hartford

The property prices and income levels of the town dictate the actual price of what can be considered as affordable housing relative to the socioeconomic dynamic of the town. In Hanover, affordable housing is an important element in the consideration of growth and progress in the town, as will later be evaluated in the discussion of our survey results. In Hanover there are 2,218 single-family housing units and 885 multi-family units. Currently in Hanover the only town owned affordable housing is only for the elderly and the infirmed. The Affordable Housing Commission is in the process of their first major affordable housing project, although it will be a year before it is completed and in full operation. Due to the influence of Dartmouth College, the development of affordable housing is in Hanover aimed at ensuring professors and higher-paid administrators the ability to live in close vicinity to the center of campus. As of now the affordable housing in Hanover does not include a place for those at the lower income levels who are employed by the college such as janitors and DDS employees.

There is pressure for growth in Hanover both from those who can afford the higher housing costs and from those who support the construction of more moderate housing (J. Hornig, personal communication on April 4, 2007). Currently, the options for affordable middle income housing in Hanover are dictated and developed by Dartmouth College. The Dartmouth Real

Estate Office offers properties for rental and sale. There are 280 apartments, duplexes, and houses for rent, which provide “transitional accommodations for new employees” (Dartmouth College Real Estate Office). The majority of the duplexes are 1.5 miles from the center of campus in the Rivercrest neighborhood and houses located in the Fletcher Circle and Chandler Drive neighborhoods, which are 1.25 miles from campus. Dartmouth has significantly fewer properties for sale, although the college real estate is in the process of developing more units. Two miles east of campus, the Grasse Road project currently has 55 homes owned by college employees with a projected 130 in the next phase of development. Dartmouth Real Estate’s “for sale” housing option is designed “to provide college employees with the opportunity to purchase single-family homes in Hanover at more affordable prices than can be found in the market” (Dartmouth College Real Estate Office).

The Grasse Road development is a controlled rent development for young professors who are able to sell back the property at purchase price plus inflation when they move out of the neighborhood. Prices are controlled by the college under what the market prices would be as the for-sale prices are “subject to the college retaining an option to repurchase the property at a capped price” (Dartmouth College Real Estate Website). The problem with this development is that it is not near mass transit and there is not enough traffic to support extending the Advance Transit system up in that direction, because it would add approximately $30,000 to each house (J. Hornig, personal communication on April 4, 2007). Since the goal is to keep the properties at an affordable price, it would not be in the best interest for the developers in looking for potential residents to further increase the price. Due to the high cost of property in Hanover, Dartmouth Real Estate’s affordable housing projects are aimed more at making Hanover property affordable for the middle class and not for those in lower income levels.

Hartford has a more diverse spectrum of housing due to the five village centers within the town: Quechee, White River Junction, Wilder, Hartford, and West Hartford. In Hartford, there are 5,493 housing units with 1/3 rented and 2/3 owner-occupied. According to the “Upper Valley Housing Needs Analysis: Summary Report” from August 2002, the Hartford area experienced strong economic growth in the past decade, which has resulted in a housing shortage and especially an affordable housing crunch (Upper Valley Housing Needs Analysis: Summary Report 2002, 2). Like Hanover, however, this analysis points out that finding rural affordable housing is increasingly difficult for the middle class as well: “Middle-income household[s], earning up to $40,000 per year, have difficulty finding suitable housing at an affordable price” (Upper Valley Housing Needs Analysis: Summary Report 2002, 3).

The housing affordability crisis in Hartford is characterized by average home prices increasing by 33% between 1998 and 2002, about three times faster than the average household income, while rents have risen by 10% (Upper Valley Housing Needs Analysis: Summary Report 2002, 4). In Hartford, there is a push for affordable housing, especially because of employment opportunities created by DHMC combined with the lack of housing options for their employees. (C. Wooster, personal communication on April 2, 2007). Current Hartford residents are being pushed out of the area based on income levels, as a median income is only 70% of what is needed to buy a median income house (C. Wooster, personal communication on April 2, 2007). As a result of this, these strong concerns for affordable housing were important considerations in the formation of questions for our survey in both Hartford and Hanover.

3.3 - Land-use Survey of Hanover, NH and Hartford, VT

In an effort to understand the social dynamics surrounding land-use, conservation of the working landscape and the rural culture in Hanover and Hartford we assessed the opinions and perspectives of residents through a survey. We conducted this survey in order to expand on earlier studies from the two towns' Master Plans and because there currently is dearth of research on conserving the working landscape and rural culture in the area. We set our response goal at a total of 400 respondents, with approximately 200 respondents from both Hanover and Hartford. This goal number of respondents was higher than was absolutely necessary, but it would give us a stronger representation of the towns' beliefs compared to fewer respondents. We hoped this would allow us to gain a greater understanding of how land-use is understood and which methods are currently practiced in each of these towns.

The main goal behind our surveying was to collect data on how Hanover and Hartford residents comprehend and rationalize their interactions with the landscape and the value they place on maintaining its current state. Additionally, through our research and surveying we hoped to gain a greater understanding of the knowledge that Hanover and Hartford residents possessed of their respective towns and whether they desired to become more active in town decision-making processes. Furthermore, we consulted the " Guiding Growth in Rural Hanover – A Survey for Rural Residents," which was compiled in 1999, the 2003 Hanover Master Plan, and Hartford's "Summary of the Hartford Community Participation Process for the Master Plan Update," compiled from focus groups from the town's master plan update in 2003 to assist in the shaping of our questions.

The next step in our research was to create a survey. The major questions we needed to answer were: How do we do start that? What questions do we include on the questionnaire? What is the difference between a questionnaire and a survey? For the explanations to these questions we sought advice from professors and social science literature. We quickly realized the importance of creating a document that would be representative of what information we were actually trying to learn from the Hartford and Hanover residents. So we as the researchers set out a clear goal of what we wanted before we sat down to write the survey. The following discussion includes the specific considerations we took into account while creating our questionnaire to conduct our survey.

3.3.1 - Surveying Methodology: What is a Survey?

A social survey is a type of research strategy (Aldridge 2001, 5). It is a tool that researchers can utilize to gather and analyze data regarding a topic of their choice. Social surveying gives us access to the knowledge and observations of other people who reside in or know about the given area that is representative of our topic (Weiss 1994, 1).

The goal of our research, as is similar in most survey strategies, was to collect the *same* information from all the individual respondents. We asked all the different participants the same questions. The information we gathered from our respondents were the variables; these variables can be classified into three broad types (Aldridge 2001, 5). We used these types to form the basic structure of our survey.

- *Attributes*- these were the basic characteristics we collected such as age, residence location, and land ownership and if so, the number of acres owned.
- *Behavior*- these refer to questions such as: What? When? How much?

  Example from our survey: "What type of neighborhood do you see as the best model for future rural growth in Hanover?" See Appendix 3A for complete questionnaire.
- *Opinions, beliefs, preferences, attitudes*- questions designed to collect these four characteristics are aimed at the respondent's point of view. This type of question is shown in our survey when we asked participants to rank different important areas surrounding land-use decisions.

The most popular survey design method in order to gather and analyze these variables is known as the Cross-Classificatory method. This method, also the most fundamental and flexible, considers each of the respondents as one unit, known as stand-alone, rather than part of a family or organization. While we did make note of location when we were surveying, the only important pre-analysis distinction in our report was whether the respondents resided in Hanover or Hartford. The analysis of stand-alone cross-classificatory surveys revolves around the comparison of the respondents to the data received (Aldridge 2001, 31). One of the reasons this approach is so popular and where its strengths lie is its ability for the researcher to separate a sample into many different categories to explore the separate dimensions of the research topic (Aldridge 2001, 31). We utilized the JMP statistical analysis program to take advantage of this flexibility and we compared variables within our survey against each other. For example, we compared the overall land-use knowledge against how often people attended their individual town meeting, to see if there was an association between the two. A full report of all our cross-classificatory analyses is at the end of this chapter.

3.3.2 - Qualitative versus Quantitative Data

All researchers in the social sciences using the survey method simultaneously utilize both qualitative and quantitative data (House 2004). The qualitative side tends to focus on ideas and conceptual frameworks. In social science reports, this qualitative research is found within precise studies of small groups, such as focus groups. In quantitative research, there is more of an emphasis on problem solving, extraction of principles with wide applicability, and a generalization of results (House, 2004). Each category is important in surveying, and some general advantages and problems revolving around the two are discussed below.

In open response or qualitative question types, the beauty lies in the freedom and spontaneity given to the respondent (Warwick 1975, 134). The respondent is able to follow his or her own logic, free from numerical constraint or any imposed scheme. As Stanley Payne (1951) pointed out: “Courtesy may require that when we ask a person’s opinion we should at least give him the opportunity to state the ideas on the subject that are uppermost in this thinking, even though they may not be important for the purpose of the survey.” To this end, we had one qualitative, open-ended question at the end of our survey: “What is your greatest concern about the future of land-use in Hanover (or Hartford)?” The result of this tactic can lead to “quotable quotes” which can often give the report color and authenticity (Warwick 1975, 134). The quotes used to begin this chapter came from responses to the question above.

In addition to these general advantages, there are three more areas where the qualitative questions prove helpful. First, open-ended questions are helpful in determining the range of responses that will be prompted by any given question. This provides the opportunity for the researcher to think of something that was not identified as being important before. This opportunity appeared again and again, as people were ready and excited to let us know what was going on in the area. Secondly, the free response is helpful when there are questions on the survey that respondents were not familiar with, areas where a “no response” actually says something. In a closed response question type the respondent could be providing data that actually did not exist. Lastly, after a long list of closed-response questions, allowing an open response question can warm-up the situation between the interviewer and the respondent. Since our open-ended question was at the end of our survey, it was a perfect transition from surveying to discussion, which was important to the overall experiential learning.

Problems, however, do exist with qualitative data. The major problem stems from not being able to code the data, making analysis difficult. Also, with open-ended questions, the range of responses can be enormous, not only in subject matter but in length, taking up valuable time from both parties involved in the interview. Because of this codification difficulty, for our cross-classificatory data analyses we used data from our quantitative responses, not from our open-ended question.

Most of the advantages surrounding the closed-type, quantitative questions can be inferred from the discussion above. First, this type of question is easier to answer, easier to code and analyze, requires less skill of the interviewers, and shortens the interview (Warwick 1975, 135). However, it may increase the response rate; as people generally are more willing to “check the box” or “circle” what they feel might be about right on a question they really have no idea about. This could lead to data that is inconsistent or does not really exist.

Surveys are often characterized as a pre-eminently quantitative research strategy, but this is a misperception (Aldridge 2001, 29). As an advantage to researchers, surveying allows simultaneous collection of both types of data. For example, an open-ended question (qualitative) that follows a long list of “rank the importance” items (quantitative) is not simply a device to move on. Actually, the list of closed items from the quantitative questions preceding the open-ended question can open up important insights into respondent motivation and perceptions (Aldridge 2001, 30). This tactic we followed directly, as our long list of questions requiring respondents to rank items by importance was followed by our open-ended question, which hopefully prompted some of the people to respond who might not have otherwise. While the length and depth of open-question responsiveness may vary and has its limits, the interaction between collecting simultaneous qualitative and quantitative data is not mutually exclusive and is an important part of the survey process.

3.3.3 - The Questionnaire

While there are numerous methods used to collect this data, the one that we used and the most popular form is the questionnaire. The aims of question wording for questionnaires are to obtain complete and accurate information that is relevant to the purpose of study, to maintain the cooperation and good will of the respondent and to remain ethical and show respect for the respondent (Warwick 1975, 140). When we were out in Hartford and Hanover surveying, we knew we were representative of Dartmouth College and kept this in mind with how we presented ourselves, and our purpose. Below are some guidelines we took into consideration while writing our survey.

- *Are the words simple, direct, and familiar?* We tried to avoid the two extremes of language: technical jargon only familiar to those with training, and slang or local expressions that can sometimes patronize respondents.
- *Is the question presented as clear and specific as possible?* We avoided asking items that were too general or too specific, or otherwise ambiguous, another major problem in wording. The best way for our team to avoid this was to have a clear view of what exactly we were trying get from the respondents.
- *Are there any questions that are "double barreled?"* A double barreled question occurs when the interviewer is attempting to save time and space by attempting to ask questions covering two or more issues in the same question. We avoided having two part questions. This leaves the respondent feeling that they may have a split answer; knowing yes for part but not sure for the other, or vice versa.

- *Are there any leading questions?* These questions push the respondent in the direction of a certain answer, either by implication or suggestion. An example relevant to our project could have been: Don't you agree preserving open-space is important? We tried to make the questions as straightforward and neutral as possible.

3.3.4 - Question Sequence Rationale

The order of the items in a survey questionnaire should take account of the expectation, logic, and limitations of both the respondent and the interviewer (Warwick 1975, 148). We opened the survey with five questions of demographic data that we employed to assist in categorizing the data and also to ease the respondents into answering the questionnaire. Additionally, demographic questions are relatively simple for people to answer and provide a means by which to captivate respondents to the survey. Our demographic questions included: age, residence, urban, suburban, or rural, number of years a resident of the Upper Valley, landownership and if so, how many acres owned. These questions gave us a means by which to quantify the perspective of the respondent and also gave us background on our pool of respondents.

The next set of questions were the focus of our survey and concentrated on the knowledge the respondents had of land-use issues and the value they placed on different aspects of the working landscape, open space, and rural culture. This included: involvement in town meetings, knowledge of environmental impacts of land-use, the working landscape as a means to preserve town culture, neighborhood models for future town growth, and the cost of locally grown items. The final set of questions consisted of scoring the importance of issues affiliated with land-use, such as conservation, water quality, recreation, affordable housing, employment, socioeconomic diversity, and rural culture. Finally, as mentioned above, we ended the survey with a free response question focusing on concerns about the future of land-use in the respondents' respective town. Please see Appendix 3B for a collection of the free response results.

3.3.5 - Expectations and Discussion

From the responses to our questionnaire and our analysis of the data, we generally expected the data to confirm a lack of education on land-use issues, an overall lack of participation in local government, and that socioeconomic diversity and rural culture were very important to residents for both Hartford and Hanover. To support these expectations and to justify our manipulated data, we referred to the "Guiding Growth in Rural Hanover – A Survey for Rural Residents," the 2003 Hanover Master Plan, and the "Summary of the Hartford Community Participation Process for the Master Plan Update." Additionally, we expected there to be differences in the results between the two towns based on the general demographic data and our visits to Town Meetings and board or council meetings.

In regards to rural culture in Hanover, the data from "Guiding Growth in Rural Hanover – A Survey for Rural Residents," led us to believe that respondents would be concerned with the preservation of the current landscape and the conservation of land. Hanover's Master Plan of 2003 addresses issues of socioeconomic diversity in Chapters 8 & 9, where the planners discuss issues such as business and housing growth and change. Land-use is discussed in Chapter 3, which provides future frameworks for decisions on land-use and the goals of the community in relationship to its future land-use. These chapters further shaped expectations we had for our data analysis and participation giving us a context and framework for understanding town governance and community relations. Based on the importance placed on growth management, housing, land-use, open space, and the significance of public involvement in town governance processes in “Summary of the Hartford Community Participation Process for the Master Plan Update,” we expected our Hartford assumptions to be supported.

The Hartford Planning Commission thought it was important to have community focus groups to address Master Plan issues and in the summary of the result of the focus groups, it was suggested that “ongoing or periodic communication be provided to the Hartford community in the form of newsletters, updates, or web site information,” demonstrating that the town government saw community education as a major goal (LandWorks 2003, 3). Our expectation of the importance placed on rural culture was based on findings from these Master Plan focus groups that there was a desire to encourage development in already developed areas only, to protect natural areas and to enact this protection in conjunction with surrounding communities for regional preservation (LandWorks 2003, 5). Although socioeconomic diversity was not directly examined in the focus group report, we expected it to be significant in our results based on recommendations in the report encouraging having low-interest loans or grants for energy efficiency and life safety in Hartford (LandWorks 2003, 10).

3.3.6 - Problems We Encountered

We encountered several problems with our survey, the first being the number of responses we received. Because there was such a limited amount of time during which we were able to survey the public, we only surveyed a few times. The questionnaire itself also had a few questions in particular that later proved to be problematic. The first of which was a small typo on a question that had people ranking the importance of something on a scale of 1 to 5. In previous questions, the ranking was based on 1 indicating the least importance and 5 indicating the most importance. In one question, the ranking was flipped and 1 indicated greatest importance. People became confused and we had to throw out the question until we later changed it to have the correct ranking of least to greatest. This same question was also problematic for a second reason. It included a list of items such as water quality, job availability, rural culture etc. and we asked people to rank these items according to how important they were. Any number could be repeated. This was not clear because when looking at this question in reference to our previous 1 to 5 ranking questions, many people stopped to ask whether the questions were independent of each other and if every answer could be a 1 or a 5. A third problem with this question was the tendency to rank every item the same. Many people answered all 5's, even though 'more affordable housing' and 'open space' are two ideas that are often times difficult to integrate.

Other inquiries we received during the surveying process were related to the wording of questions. Many people who lived in condominiums did not know whether this implied home/land ownership or not. We interpreted the joint ownership of a plot of land to be ownership and that owning a condo is the same as owning a home. This confusion may have impacted our survey results. People were also unclear on how to answer the question that involved classifying their surroundings as urban and rural, with suburban being the middle ground. Rural homes do not have municipal water and/or sewage, but people who did have these commodities did not know whether they were suburban or urban. We had meant for people that lived in town centers to identify their surroundings as 'urban,' people in more residential areas to identify with 'suburban,' and people in the far out reaches of the town to identify with 'rural.' However, the confusion surrounding this question may have also impacted our results.

Before we created our questionnaire, we asked members of our class in other groups if they would like to contribute to our survey by adding a question that had significance to the research that they were doing. Many people had concerns and questions regarding housing development models that we could not answer concisely. This question based upon three models of development density was very subjective to varying interpretations of density. People were directed to choose whether they would like to see low density neighborhoods, low density community developments, or high density community developments as the model for future neighborhood growth in Hanover or Hartford. Each of these developments was paired with an example of an existing neighborhood to provide relevant context to the person taking the survey. However, even with these examples many people did not understand the differences between the three types of development. Many people pointed out specifically that they did not know where the “Trescott Road development” was that had been attributed to low density community developments in Hanover, and insisted that there was no development there.

3.3.7 - Surveying Locations

•*Friday May 4, 4-6 p.m. Hanover Co-op*

This was our first attempt at surveying the public. We set up a table at the entrance of the Co-op in Hanover with candy ready, providing an incentive to fill out our surveys; clipboards on which people could fill out the questionnaires privately and a box to deposit them in once they were filled out. These were the basic preparatory materials with which we surveyed everywhere we went. We noticed that the people who stopped at our table were either older people who seemed to know a lot about land-use and were involved in the Hanover government or young mothers who had children in tow. It was difficult to get many surveys because most people seemed very rushed.

•*Saturday May 5, 11-1 p.m. Quechee gas station*

One of our group members stood outside of a gas station waiting for patrons of the convenience store and people who were filling up their car with gas. This was less successful than the tactic of tabling outside of the Co-op. One woman responded very harshly by saying that she did not want to take the survey because she was ready to get out of Quechee. Another person who was friendlier and filled out the survey said that he and his neighbors ended up buying a tract of land that they now own commonly just so the land would not be developed and they could enjoy the open space.

•*Tuesday May 8, 7:30-9 a.m. Town Voting at Richmond Middle School in Hanover*

We assumed that we would be more successful finding residents who were willing to fill out our questionnaire at the polling booths for town meeting voting early in the morning. When we arrived, however, we were informed that there probably would not be many voters coming into the polls as there was only one uncontested candidate for a place on the Select Board. The volunteers were very accommodating and let us set up near the exit of the polls. A few community members came, but the majority of the respondents to our questionnaires were the people working the polls.

•*Tuesday May 8, 6:20 p.m. Bugbee Senior Center in White River Junction*

We surveyed concurrently to a Hartford meeting on the Master Plan in the hope of finding more respondents. When we arrived however, people were not interested in taking the survey on their way into the meeting. We decided to come back later, after the meeting was over. We had high hopes for this meeting because we were told by Chuck Wooster that there were some revisions being made to zoning policies in town (C. Wooster, personal communication on April 2, 2007). We hoped that this relevant topic would spur some interesting comments at the end of our survey. We came back to White River Junction at 7:45 p.m. and caught a few people as they came out of the meeting. Although we did not get many responses, we ended up having interesting conversations with two different gentlemen.

•*Tuesday May 8, 5-7:45 p.m. Town Meeting at Richmond Middle School in Hanover*

We went to the Richmond Middle School for the second time in one day without high expectations for a well-attended meeting as we had been told that there were no controversial issues on the table other than the legalization of medical marijuana. However, standing at the entrance to the gym, we got a lot of people as they came in. The general age demographic of the people attending the meeting was people 45 and above.

•*Friday May 11, 6:30-8 p.m. P&C grocery store White River*

Two members of our group stood at either side of the grocery store doorway and approached patrons. It was difficult to get people interested in taking the survey and they ignored our attempts. Though this was disconcerting, 11 people filled out our questionnaires. This seemed like a fair amount considering that the general rate at which we had been receiving surveys was about 8 per hour. The patrons of the store seemed to be of a lower socioeconomic class than the people we had seen at the town meetings, and were less informed as well. Many people seemed to be in a rush, which is a difficult obstacle to tackle when surveying the general public.

•*Saturday May 12, 9 a.m. - 11 a.m. Norwich Farmer's Market*

Standing outside of one entrance to the market, we seemed to receive two Hanover questionnaires for every Hartford resident that filled out a questionnaire. The responses were very mixed, as was the age demographic of the people whom we surveyed.

3.4 - Data

There were 101 responses to the questionnaire in Hanover and 44 responses in Hartford. We first found averages for basic demographic data in Hartford and Hanover. This data is displayed in Table 3.1.

Table 3.1 – Questionnaire Results

	Hanover	Hartford
Average Age	47.19 years old	43.03 years old
Average years in town	19.4 years	20.8 years
Landowners	90% of respondents	80% of respondents
Own less than 1 acre	36% of landowners	23% of landowners
Own 1 to 5 acres	41% of landowners	40% of landowners
Own 5 to 10 acres	7% of landowners	9% of landowners
Own 10 to 50 acres	10% of landowners	11% of landowners
Own more than 50 acres	2% of landowners	17% of landowners
Urban	52% of respondents	43% of respondents
Suburban	25% of respondents	7% of respondents
Rural	23% of respondents	50% of respondents
Environmental knowledge	3.34 (out of 5)	2.95 (out of 5)
Importance of the working landscape to preserving rural culture	4.42 (out of 5)	4.34 (out of 5)
Model Housing A- unplanned low density developments	41.75% of respondents	63.57% of respondents
Model Housing B- planned low density developments	34.06% of respondents	21.05% of respondents
Model Housing C- High density developments	24.17% of respondents	15.78% of respondents
Conservation of Open Space	4.24 (out of 5)	4.48 (out of 5)
Water Quality	4.67 (out of 5)	4.81 (out of 5)
Affordable Housing	3.88 (out of 5)	3.81 (out of 5)
Socioeconomic Diversity	3.97 (out of 5)	3.85 (out of 5)
Rural Culture	3.55 (out of 5)	4.08 (out of 5)

From analyzing the table above, there are some general trends that the residents of Hanover and Hartford share. Residents of the towns found that the working landscape and its relationship to preserving rural culture were important. Both towns also found the conservation of open space to be important. These two rankings are reflections of how people tend to prefer the land-use in the upper valley, which is maintaining the current rural state. From the Hartford Master Plan: "agriculture and open lands are also very important resources that distinguishes the character of Hartford." We found that "character" and rural culture were similar terms here. Furthermore, the Hartford Master Plan finds that development should occur in already developed areas to preserve the town's natural assets. From Hanover Master Plan: "Hanover's open space lands are among the Town's most significant assets." Also from the Master Plan, "The lands may be in their natural state to serve important environmental and/or aesthetic functions, or they may be used for agriculture, forestry, and/or outdoor recreation." This shows that how people feel about the conservation of open space and rural culture is adequately reflected in their towns' Master Plans. However, both towns seemed to have a lower ranking of importance when it comes to the social aspects of land-use. For example, both towns ranked the importance of affordable housing and socioeconomic diversity lower than that of conservation of open space and the working landscape.

3.4.1 – Contingency Table Analyses

In order to gain a greater understanding from Hartford and Hanover land-use questionnaire data, we performed contingency table analyses and multivariable analysis of variance (ANOVA) tests with a focus on chi-squares and f-tests, in JMP, the statistical analysis program we used. A contingency table is defined as a “tabulation of the frequency with which cases occur in combinations of categories from two or more variables” (Smithson 2000, 294). It is a "*cross-classification* of the categories in the variables" for correlation analysis and exhibits the frequency of the desired occurrences in the data (Smithson 2000, 294). From the contingency table we used the chi-square statistic to show the difference between the observed and the expected values and to determine the significance of an event. Chi-square statistics measure "the total amount of squared error from the predictive model that has provided the expected frequencies (f_2)" (Smithson 2000, 301). The equation is:

$$X^2 = \Sigma \frac{(f_0 - f_e)^2}{f_e}$$

This test is important for our data analysis because it exhibits the presence or lack of an association between the two or more variables. For example, chi-squared testing was used to determine if there was an association between the importance of socioeconomic diversity and whether the respondent was from Hanover or Hartford. For our multivariable analyses we performed ANOVA tests which employ two or more independent variables to determine "whether or not each independent variable has an effect [on the dependent variable] and whether those effects are independent or not" (Smithson 2000, 350). From our analysis we used an f-test, which shows the statistic to compare the variation between experimental conditions and the variance of scores within (Smithson 2000, 235). The equation for this analysis is:

$$F(df_b, df_w) = \frac{S^2{}_b / S^2{}_w}{\sigma^2{}_b / \sigma^2{}_w}$$

This test is pertinent to our data analysis because it shows different data associations amongst more than one independent variable. Then we were able to relate these associations back to our initial research and the expectations we had regarding our Hartford and Hanover surveys. One occasion for use of this type of test was looking at if people lived in urban, rural, or suburban areas (independent variables) and the amount of environmental knowledge they believed they had. For both chi-square tests and f-tests a result is significant if the correlation is less than 0.05. In our calculations below we signify “chi-square” with: χ^2, followed by two variables in subscript, which are the degrees of freedom. Please see Appendix 3C for contingency tables.

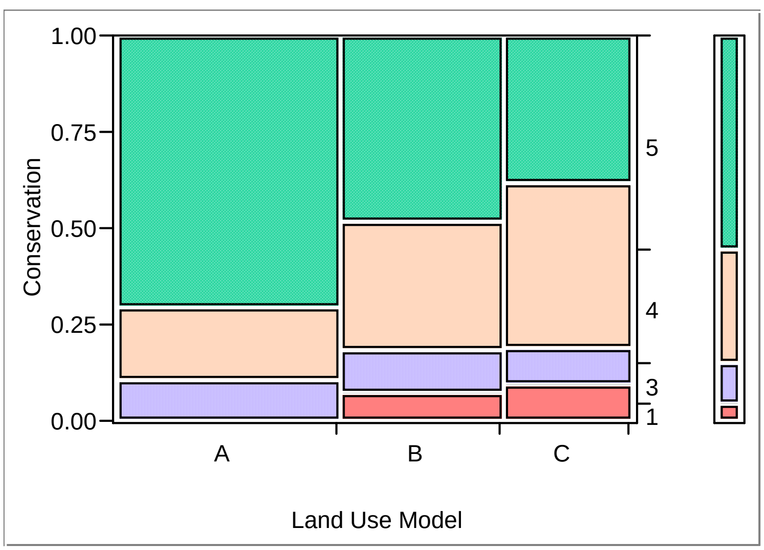
To form the mosaic plot, JMP placed one variable on the y-axis and one on the x-axis. To interpret them, you first look at the left y-axis and x-axis to see what two variables are being compared. Next, on the right hand side of the graph, see which colors go with each y-axis response category. For example, 1 might be blue, 2 green, and 3 yellow. The left hand side of the y-axis goes from 0.00 to 1.00, so for each color you can read up the column to see what percentage of respondents chose that response. Each vertical bar shows the respondents that chose a certain x-axis response. As you read up the vertical column, each color block represents the percentage of people who chose a certain y-axis response and also chose the x-axis response that corresponds with the column.

Conservation of Open Space and Future Land-use

For this analysis, we compared how people rated the importance of conservation of open space against which future land-use model they favored. Model-A included low-density neighborhoods such as Jericho Hill in Hartford and the Hanover Center for Hanover. This A-Model is the traditional development patter exhibited in the two towns. Model-B was a low-density planned community development such as Quechee Lakes in Hartford and Northwest Hanover. Model-C was the high-density community developments such as Hemlock Ridge in Hartford and Velvet Spring in Hanover. Considering how many people chose “5” for the conservation of open space, it would make sense to favor the Model-C development, but this was not the case, as people tended to favor the more traditional development patterns, which conserve the least amount of open-space.

These two parameters were not associated, as the probability of the $\chi^2_{6,76}$ value was 0.1079. We understand that this lack of association could be due to the participants' lack of understanding of the different land-use models, not realizing that Model-C would conserve the most land.

Choosing to continue with traditional development patterns may be because of the inability of residents to picture what Hanover or Hartford will look like in the future. This highlights the importance of build-out analyses, such as the CommunityVIZ software used above to analyze how different development scenarios can affect core habitat, as well as how they affect the area of current agricultural use. Build-out analyses can show the citizens of Hanover and Hartford exactly how different development scenarios affect the future of the towns, thus enabling them to make more informed decisions about development now.



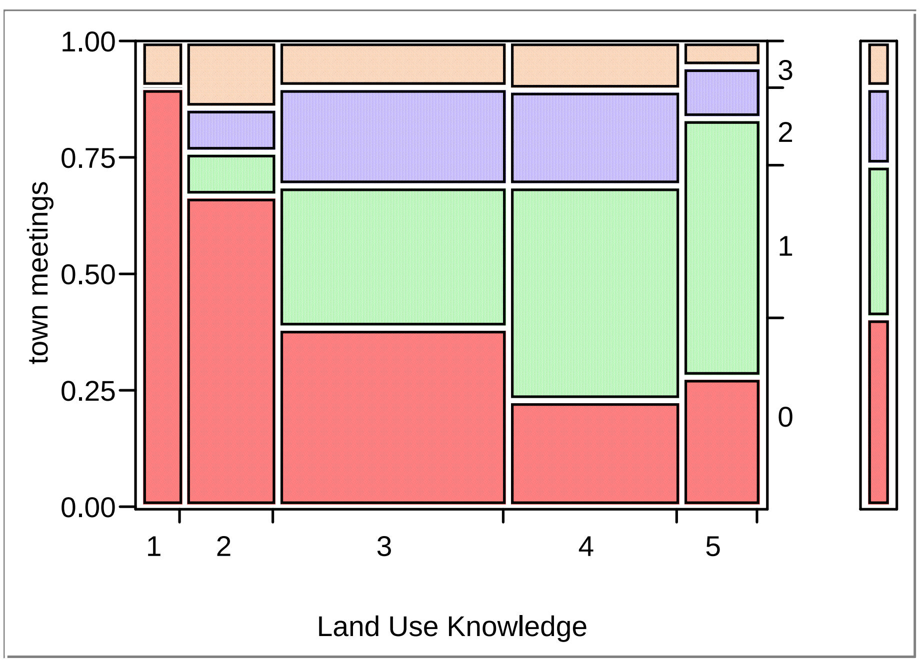
Legend: X-axis- A= unplanned, low density development; B= planned, low density development; C= planned, high density development
Y-axis- 1= little importance; 5= high importance

Figure 3.1 – Contingency Analysis of Conservation By Land-use Model

Environmental Knowledge and Town Meeting Attendance

For this analysis, we compared how people ranked their general knowledge regarding land-use issues against how often they attended their individual town meetings. The participants ranked their knowledge of land-use from 1 to 5, 1 being low knowledge and 5 being very knowledgeable. The choices for town meetings ranged from never to annually, with some extra choices in between.

We expected that the more often people went to town meetings, the higher their knowledge regarding land-use issues would be, and this was the case. An association does exist, with a $\chi^2_{12,125}$ P-value of 0.0008. The people who invested more time by attending their respective town meetings perceive themselves to be better informed and kept up to date on current important land issues. This high association shows the importance of public participation in town meetings.

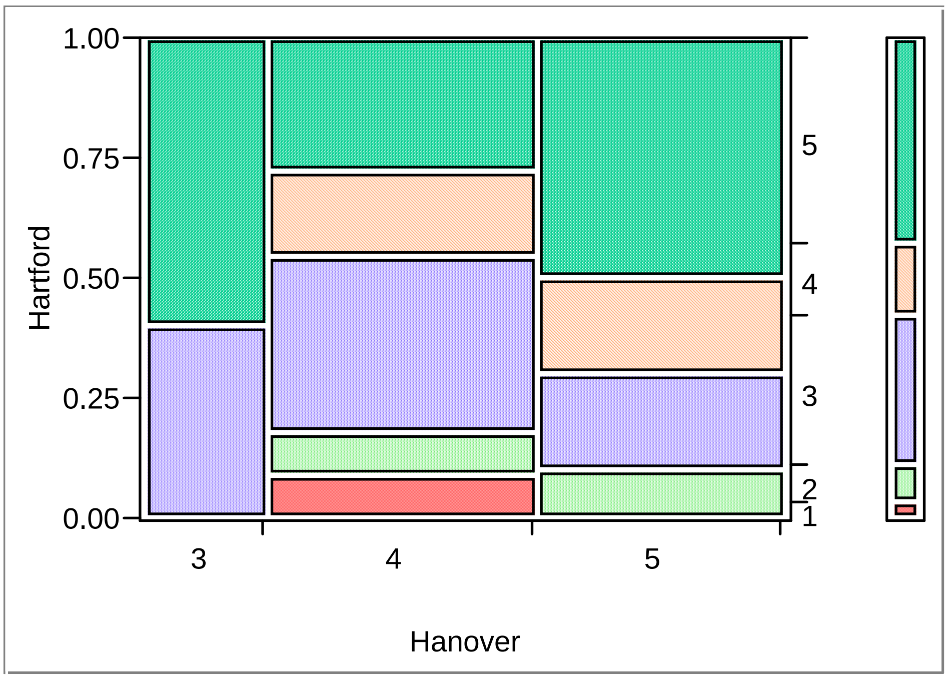


Legend: X-axis- 1= least amount of land-use knowledge; 5= very knowledgeable
Y-axis- 0= never attend Town Meeting; 1= attend annually; 2= attend every other year; 3= attend every third year

Figure 3.2 – Contingency Analysis of town meetings By Land-use Knowledge Mosaic Plot

Socioeconomic Diversity in Hartford and Hanover

For this analysis we wanted to compare how important people in Hartford thought socioeconomic diversity was compared to people in Hanover. Answers were ranked from 1 to 5, with one representing the least valuable, and 5 most valuable. The P-value associated with the $\chi^2_{8,14}$ for this analysis is 0.6369 showing that there is no relationship between whether people were Hanover or Hartford residents and how important they thought socioeconomic diversity is.



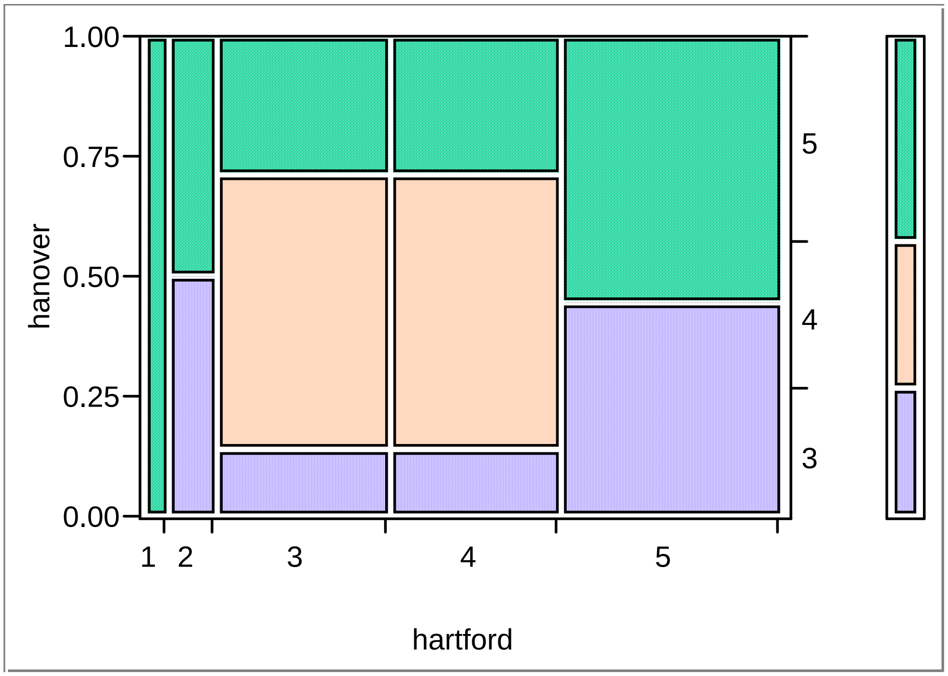
Legend: X-axis- 3= moderate importance; 5= high importance
Y-axis- 1= little importance; 5= high importance

Figure 3.3 – Contingency Analysis of Hartford By Hanover- Socioeconomic Diversity Mosaic Plot

Affordable Housing in Hartford and Hanover

We performed a contingency table analysis on affordable housing between Hartford and Hanover with the expectation that the relative scoring of the importance of affordable housing would be relevant to where the respondent lived and therefore have a significant association value. The needs for affordable housing are different in Hartford compared to Hanover mainly due to the influence of Dartmouth College, the differences in local town economies and the higher property values of Hanover. Therefore, we expected affordable housing to be a more pressing issue for Hartford residents. As can be seen in Figure 3.4, our results show that in Hanover there is a greater importance placed on affordable housing than in Hartford, although not by a substantial amount. Hanover respondents only scored affordable housing at the upper levels of importance, 3 to 5, while in the Hartford sample all levels of importance were represented.

The difference could be attributed to the recognized need for more middle income affordable housing in Hanover. Another reason for this difference can be attributed to the imbalance between the sample sizes, with half as many respondents from Hartford, which could have affected the association. Our results are also supported by the likelihood of the $\chi^2_{8,16}$ ratio, which shows that the probability that there would be a difference between the residency of the respondent and how they ranked the importance of affordable housing was 0.0753, which is almost significant. Therefore, it did not matter if the respondent lived in Hanover or Hartford based on what they thought of affordable housing.

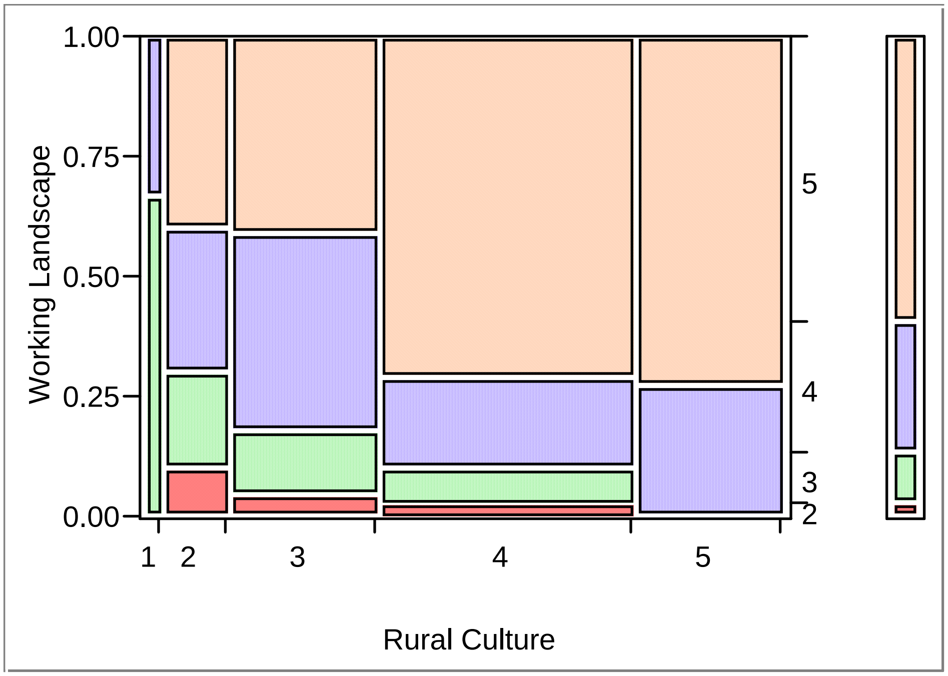


Legend: X-axis- 1= little importance; 5= high importance
Y-axis- 3= moderate importance; 5= high importance

Figure 3.4 – Contingency Analysis of Hanover By Hartford- Affordable Housing Mosaic Plot

The Working Landscape and Rural Culture

For this analysis we compared how important all respondents thought the working landscape was with how important they believed rural culture was. Again, 1 corresponded with not important and 5 corresponded with very important. We hypothesized that since the working landscape is a part of rural culture, those respondents that believed the working landscape was important would also believe that rural culture was important. The same should hold true for those who did not believe working landscape was important. The result was as we predicted. Respondents who chose 2, 3, 4, or 5 for working landscape tended to also choose the corresponding value for rural culture. However, a few people who do not value rural culture still value the working landscape. The $\chi^2_{12,80}$ P-value for this analysis was 0.0356 showing that these responses were not by chance. So, in the minds of residents of Hartford and Hanover the working landscape and rural culture are related.



Legend: X-axis- 1= little importance; 5= high importance
Y-axis- 2= little importance; 5= high importance

Figure 3.5 – Contingency Analysis of Working Landscape By Rural Culture Mosaic Plot

Socioeconomic Diversity and Rural Culture

For this analysis we compared socioeconomic diversity with rural culture. We believed that a higher ranking of socioeconomic diversity would also correspond with a high ranking of rural culture, because having a diverse array of jobs, including farming, is an important aspect of rural culture. Twenty-two out of the ninety-five respondents who believed that rural culture was highly important also believed that socioeconomic diversity was highly important. There were also many respondents who ranked both socioeconomic diversity and rural culture as a 4, and a number of people who ranked them both as a 3. There were, however, a few respondents who did not believe rural culture was important, but did believe that socioeconomic diversity is important. The $\chi^2_{16,75}$ P-value for this analysis was <0.0001 showing that this result was associated.

Legend: X-axis- 1= little importance; 5= high importance
Y-axis- 1= little importance; 5= high importance

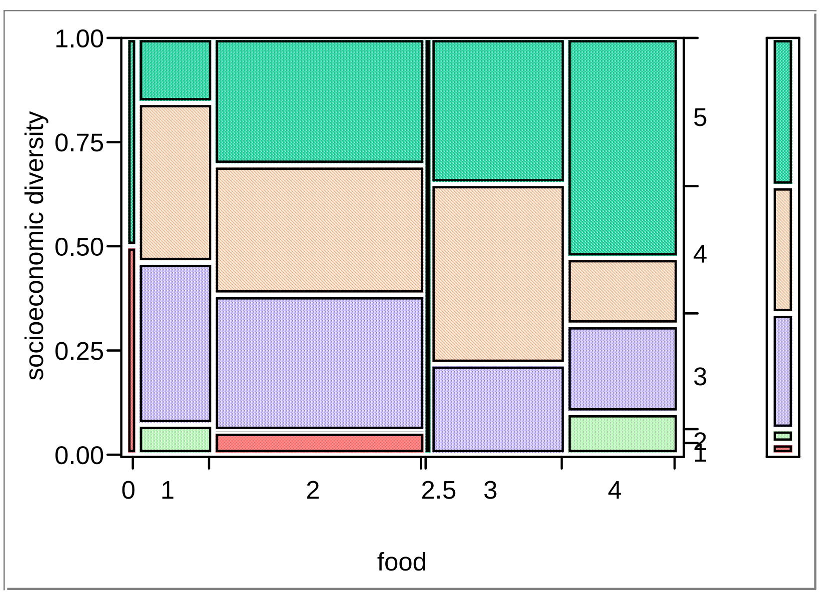
Figure 3.6 - Contingency Analysis of Socioeconomic Diversity By Rural Culture Mosaic Plot

Socioeconomic Diversity and the Willingness to Pay for Locally Produced Food

We analyzed socioeconomic diversity versus the extra amount residents would be willing to pay for locally grown food items. We were expecting that if the respondents valued socioeconomic diversity then they would be willing to pay more for locally grown food items to keep local farmers in business. We had this assumption because the presence of local farmers enhances the socioeconomic diversity of an area and assists in keeping the rural culture intact.

However, as our results show in figure 3.7, this was not the case, with a $\chi^2_{20,70}$ P-value of 0.1448, there is far from a significant association between the value that respondents placed on socioeconomic diversity and their willingness to spend more on locally grown food. The greatest percentage of respondents said they would be willing to pay a 5-10% increase for locally grown foods items and of that amount over half scored socioeconomic diversity at a level of importance of 4 or 5.

The respondents who stated they would pay over 15% for locally grown items also had the highest percentage of those who scored socioeconomic diversity to have the highest importance. Interestingly, for the small amount who would not pay more for locally grown goods, there was an equal divide in that amount between those who saw socioeconomic diversity to be of least and greatest importance. This inconsistency could be due to our small sampling population, which is even smaller for this analysis due to the fact that we were forced to change the order of the scoring options after our initial survey attempt (see the earlier discussion of survey problems) and were unable to use some of the responses for this question. Additionally, it is also possible that residents would encourage socioeconomic diversity in theory but not in practice nor make an effort to encourage changes.



Legend: X-axis- 0= 0%extra; 1= 1-5% extra; 2= 5-10% extra; 3= 10-15% extra; 4= greater than 15% extra
Y-axis- 1= little importance; 5= high importance

Figure 3.7 – Contingency Analysis of Socioeconomic Diversity By food

Comparing environmental knowledge, residential area, and preferred land-use model

This analysis yielded several interesting associations. First, there was a non-significant trend between residential area and perceived environmental knowledge. Rural residents scored their environmental knowledge an average of 0.23 more than urban residents. Suburban residents scored their environmental knowledge 0.35 less than urban residents. However, the $\chi^2_{8,100}$ was 10.09 and the P-value was 0.22, showing that this association between residential area and perceived environmental knowledge could be by chance.

Second, there was a strong association between perceived environmental knowledge and preferred land-use model. Those who preferred Model B, low density planned development, ranked their environmental knowledge 0.15 more than those who preferred Model C, high density planned development. There was a large gap between the perceived environmental knowledge of those who chose Model B and Model C, compared to Model A, more traditional unplanned low-density development. This is seen in the fact that those who chose Model A tended to rank their environmental knowledge 0.42 less than Model C. The $\chi^2_{8,117}$ was 19.52 and the P-value was 0.01, well below the 0.05 needed to prove an association. So, residents of Hanover and Hartford who think they know more about the environment are more likely to choose a form of planned development, whether it is low density or high density development. Residents who do not feel very informed about the environment want to see the continuation of traditional low-density development.

3.5 – Conclusion and Recommendations

Our survey results show that conserving land is very important to both communities. Furthermore, the conservation of land and the environment is more important to both Hanover and Hartford than affordable housing, socioeconomic diversity, and rural culture. However, these two towns are inevitably going to continue to grow because of Dartmouth College and DHMC. In order to preserve the environment and the open space, Hanover and Hartford need to address socioeconomic diversity and affordable housing.

We recommend that one way to conserve the working landscape and open space is through creating high density affordable housing in these two communities. This affordable housing would help to preserve the socioeconomic diversity in Hanover and Hartford. If it is high density it will lead to less roads and therefore lessening the impacts of fragmentation. As exhibited in our analysis it was not of significance whether a respondent lived in Hanover or Hartford when determining the importance value they placed on affordable housing.

Although the Hanover Affordable Housing Commission is in the process of addressing some of these needs, there must be action in order for there to be results in the long-term. Without action now, the lack of affordable housing will continue to be an issue. In order for these communities to have long term success and survival there needs to be a wide array of housing, which can help lead to an increase in socioeconomic diversity and maintain rural culture. If measures such as these are not implemented, potential residents will not be able or interested in coming to the towns for vital jobs. The town needs to provide incentives for developers to create affordable housing units.

In conclusion, Hanover and Hartford are interested and concerned about the preservation of open space and the working landscape. However, as is evident in our research there are still many steps for the towns to take before this preservation can be achieved. Community perspectives need to be considered when decisions concerning the working landscape and open space are made.

Recommendations:

- **We found that the residents of Hanover and Hartford placed a high emphasis on conserving open space and maintaining the working landscape as it applies to rural culture, and it is reflected in the current Master Plans. Future Master Plans should continue to place high importance on conservation of the rural zones and making the working landscape a priority.**
- **Hanover and Hartford should provide high density affordable housing.**
- **Hanover and Hartford need to do further research on where to place this affordable housing.**
- **We recommend that Hanover and Hartford hold focus groups to consider other ways to conserve the working landscape.**

CONCLUSION

The goal of this year's ENVS 50 class was to examine the intricate relationship between the environmental, social, and economic impacts of land use. Within this approach, our research emphasized the importance of open space and the working landscape, both of which play a role in maintaining the rural tradition in both Hanover and Hartford. Furthermore, beyond satisfying the intellectual aspect required of us by Dartmouth College, we hoped to provide Hartford and Hanover with useful tools that could be considered for future land-use decisions. However, due to the 10-week term at Dartmouth College, we were bound by time constraints. With this in mind, we would like to conclude our report with suggestions for future research.

There are a number of important issues that were beyond the scope of our class. These issues would provide feasible topics of research if undertaken by either of the towns. Second, a well-planned, serious approach to Master Plan revision is important. If the two towns want to mitigate the negative effects we have described throughout this report, then placing a high market value on open space and using the market to protect the working landscape is key. The protection of working landscape would be the result of each town identifying and protecting their respective rural zones. Also, each town should understand that socioeconomic diversity should be valued as it is closely related to traditional ways of living in this area and the rural character of the natural environment. If affordable housing is not considered in future development plans, many of the social and environmental aspects that make up the rural character will be lost.

In regards to the quality of the environment in Hanover and Hartford, the current situation is excellent. While development has impacted the area by causing loss of core habitat and slightly decreasing water quality in more developed watersheds, overall environmental quality is high. Indeed, the natural amenities are what attract residents and visitors to the Upper

Valley. Therefore, it is important to continue preserving those areas which have been least impacted by development. Clustering new development by reducing the minimum parcel size for zoning is one strategy that will help preserve contiguous tracts of the working landscape. However, this will not be without problems, as the results of our surveying show that current residents of the Upper Valley are resistant to the concept of cluster zoning as a way to help protect open areas and working landscapes. This signifies a need for education on the issues of development and building scenarios. Regardless, our GIS analysis of build-outs under different zoning scenarios shows that this is one of the best ways to save core habitat.

Beyond the various recommendations we have made, one of the clearest needs this report highlights is the power of GIS technology in evaluating the effects of sprawl. GIS was used to analyze the effect of various development scenarios on habitat fragmentation and agricultural resources, as well as to guide our water quality research. GIS applications underpin a number of the recommendations we make, making GIS one of the most powerful tools we used in our analysis of Hartford and Hanover sprawl.

Nevertheless, GIS remains largely unutilized by either Hanover or Hartford. Although Hartford, with the help of the Two Rivers-Ottauqueechee Regional Planning Commission (TRORC), recently completed a GIS build-out analysis, neither town has a central GIS database. Most of our data for both towns came from state or regional planning authorities. In fact, Hanover has almost no data available for the past seven years; data as critical as the distribution of structures throughout Hanover is nonexistent.

Master Plan review is a critical and regularly occurring process in both towns. GIS analysis would allow for simple but incisive evaluation of various strategies to implement planning goals. Hartford uses the TRORC databases when it needs GIS data; Hanover must follow Hartford's example, either by contracting with an outside organization for GIS data or establishing its own in-house GIS database. Both towns must work to ensure that these databases are regularly updated, and that the use of GIS data and models are integrated throughout the planning process.

Beyond the evaluation of planning decisions, GIS's educational and information sharing qualities could prove useful to both towns. GIS can be used both to educate townspeople on planning decisions and to allow for public input on those decisions. Also, GIS data could be integrated on a regional basis, in order to provide for a more cohesive regional effort to control exurban sprawl. All in all, GIS provides Hanover and Hartford with an effective planning and educational tool; the only precondition being that each town embraces its potential.

We hope that this report can provide a catalyst for future land-use research in Hanover and Hartford. Education and awareness about land-use issues are important to creating the most informed decisions about the future of the two towns. Our mission was to examine the effect that exurban sprawl has on open space and on the working landscape and to provide a reference for Hanover and Hartford. If Hanover and Hartford use this report as a tool for any future land-use recommendations, then we will have succeeded with our goal.

APPENDIX

1. The Economic Implications of Sprawl

Appendix 1A: Zoning Districts in the Hanover and Hartford Study Areas and Their Regulations

Hanover:

Industrial and Commercial Zoning:

- *"BM" Service Business and Limited Manufacturing:* The purpose of the Service Business and Limited Manufacturing District is to provide an area for office, research, and light manufacturing where public water and sewer are available. Other uses serving employees of adjacent businesses are allowed as supportive uses. Access to the Great Hollow area is via Etna and Greensboro Roads fronted by residential uses; consequently, uses resulting in negative traffic impacts on these neighborhoods are discouraged. Steep, rocky terrain, wetlands, and the Mink Brook corridor surround the district, and these characteristics limit expansion of it. The area fronting Route 120 is more amenable to higher volume traffic access and to public transportation.
- *"B" Retail Business:* The areas for the Retail Business District are designed to provide in selected locations throughout the community, but separate from the Downtown Districts, sites for retail sales and services that are needed to serve the community.
- *"OL" Office and Laboratory:* Based on existing land use demand and projected types of development in Hanover, this specialized district was designed primarily for professional offices and research laboratories. It should have readily available transportation access and be located so that it can be served by municipal services and utilities.

Residential Zoning:

- *"GR" General Residence:* Within any community that has a built-up area with organized community services such as fire and police protection and community water and sewer service, it is necessary to provide areas for high and moderate density residential dwellings in a range of dwelling units from single family to multi-family. The location of these units depends on the readily available community services and the existing or potential servicing of these areas by Public Water and sewer systems. Thus, these areas are found within or adjacent to the presently built-up area of the community. Four districts in the General Residence District are provided for. These districts have similar uses and Special Exceptions, with additional residential uses permitted in the GR-3 and GR-4 Districts. The GR districts have different lot and Planned Residential Development (PRD) regulations depending upon their accessibility, present density, and relationship to certain municipal services and facilities.
- *"SR" Single Residence:* The designation Single Residence is for a district to provide for one-family dwelling units as is typical in many New England villages. With adequate safeguards, certain other types of uses such as forestry, agricultural and governmental uses will be permitted. These types of uses not only complement the single-family homes, but serve these homes as well. Three districts are provided in the Single Residence designation. In each of the districts, similar uses are allowed, but there are varying lot regulations depending on the location of the district's present land development, and its relation to surrounding districts.
- *"RR" Rural Residence:* The Rural Residence district provides for the building of single-family homes outside of the built-up section of the community where public water and sewer service are not generally available. Along with the rural residential use, other

prime uses of the area are Forestry and Agriculture. As a Special Exception, certain other residential uses, special types of facilities, certain commercial establishments that are desirable in a rural area, and governmental facilities are provided for.

Natural or Traditional Use Zoning:

- *"F" Forestry and Recreation:* Much of Hanover, due to its steep slopes, remoteness, types of soils and similar limiting factors, should have a very low intensity of use in order not to permanently damage the land and not to cause undue burdens on the Town for providing municipal services. In these areas, the primary land use will be forestry with some agricultural operations. Another acceptable land use for such an area is recreation, mainly of the outdoor type. Residential use, because of the inaccessibility and remoteness of much of this land, is limited to seasonal dwellings and then only as a Special Exception. Certain other land uses in selected areas of the Forestry District will be allowed as special exceptions, including certain limited commercial, recreational pursuits, removal of earth and other limited governmental and commercial activities that will not be harmful to the area.
- *"NP" Natural Preserve:* Fragile and unique land areas should have the least intensity of use. They can support on a limited basis certain outdoor recreational activities and associated uses. Most of these areas have been acquired by the Town of Hanover for the purpose of preserving said areas in their natural state for recreation, conservation, education, and protection of scenery, woodlands, wetlands, ponds, stream banks, and steep slopes. Town owned lands are held and utilized consistent with the purposes of New Hampshire Revised Statutes Annotated (RSA) 36-A and shall be under the supervision of the Hanover Conservation Commission. Other land in this district has been

designated by the landowner for inclusion in such a district. Uses will be prohibited in this district that are inconsistent with the conservation of scenic characteristics and ecological processes.

Hartford

Exclusively Industrial and Commercial Zoning:

- *“I/C” Industrial/Commercial:* This district is designed to reserve locations for commercial and light industrial operations which require larger lots than are available in other commercial districts. The I-C Districts offer large, relatively level tracts of land with good highway access and sufficient distance to buffer existing residential neighborhoods.

Residential and Commercial Mixed-Use Zoning:

- *“RC-2” Residential-Commercial Two:* This district provides for continued mixed uses in areas which have public water and sewer systems and are located on major highways. New development should be consistent with the predominantly residential character of these areas.

Residential Zoning:

- *“R-3” Residential Three:* This district is designed to encourage predominantly residential development at lower densities in established neighborhoods more distant from village centers. While not all parts of these districts are now served by public water and sewer, such services can be extended relatively efficiently as development continues.

- *“VR-2” Village Residential Two:* This district maintains the residential character of established village neighborhoods where public water and sewer are not likely to be available in the foreseeable future.
- *“RL-1” Rural Lands One:* This district provides areas where residential development can occur in a rural setting. These lands, where moderate density is permitted, are near major roadways and could be served by public water and sewer some time in the future.
- *“RL-3” Rural Lands Three:* This district provides areas for expansion of existing rural-residential development at lower densities than RL-1.
- *“RL-5” Rural Lands Five:* This district attempts to limit developmental density in areas which are now largely in agricultural or forestry uses, where development may be difficult and/or undesirable and the public water and sewer services cannot be provided efficiently. Since the rural character of these lands depends on open space and natural areas, protection of these features should be considered when evaluating proposed conditional uses.

Appendix 1B: Data Parameters and Results for Build-Out Model Scenarios in Hanover and Hartford Study Areas

Hanover Study Area:

Build-Out Report - Current Zoning

Tuesday, May 15, 2007, 5:32 PM

Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	zone1_parzone
Attribute specifying land-use designation	ZONE
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
B-1		0.72 FAR	80
BM		0.49 FAR	80
F			100
GR-1	0.344 acre min. lot size		60
NP			100
OL		0.49 FAR	60
RR	10 acre min. lot size		76.3
SR-2	0.459 acre min. lot size		60

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
B-1	1	0	1
BM	1	0	1
F	1	0	1
GR-1	1	0	1
NP	1	0	1
OL	1	0	1
RR	1	0	1
SR-2	1	0	1

Constraints to Development

Constraint Layer	Can density be transferred?
zone1_nobuild_Dissolve	no

Spatial Build-Out Settings

Settings				
Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
B-1	15	Random		0
BM	25	Random		0
F	0	Random		0
GR-1	15	Random		0
NP	0	Random		0
OL	25	Random		0
RR	50	Random		0
SR-2	20	Random		0

Results

Dwelling Unit Quantities				
Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
B-1	0	0	0	0
BM	0	0	0	0
F	0	0	0	0
GR-1	259	258	1	0
NP	0	0	0	0
OL	0	0	0	0
RR	586	564	22	0
SR-2	285	282	3	0
Total	1130	1104	26	0

Commercial Floor Space				
Land-Use Designation	Numeric Build-Out Floor Area (sq. feet)	Spatial Build-Out Floor Area (sq. feet)	Difference	Existing Floor Area
B-1	20026.873	20026.873	0	0
BM	8492930.551	8492708.462	222.089	0
F	0	0	0	0
GR-1	0	0	0	0
NP	0	0	0	0
OL	828701.462	828303.79	397.673	0
RR	0	0	0	0
SR-2	0	0	0	0
Total	9341658.886	9341039.124	619.762	0

Building Quantities				
Land-Use	Numeric Build-Out	Spatial Build-Out	Difference	Existing

Designation	Units	Units		Buildings
B-1	1	1	0	0
BM	33	32	1	0
F	0	0	0	0
GR-1	259	258	1	0
NP	0	0	0	0
OL	12	11	1	0
RR	586	564	22	0
SR-2	285	282	3	0
Total	1176	1148	28	0

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
B-1	8213.353	3230.133	4983.22
BM	2478714.848	2012802.875	465911.973
F	8519847.812	4066450.103	4453397.709
GR-1	1093045.901	525728.157	567317.744
NP	560444.41	441770.933	118673.477
OL	333916.88	261866.843	72050.036
RR	25303244.591	17908310.697	7394933.893
SR-2	998113.223	728108.137	270005.086
Total	39295541.016	25948267.878	13347273.138

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commercial buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
B-1	0	0	0
BM	0	1	0
F	0	0	0
GR-1	1	1	0
NP	0	0	0
OL	0	1	0
RR	22	22	0
SR-2	3	3	0
Total	26	28	0

Build-Out Report - Lower Density Zoning

Tuesday, May 15, 2007, 7:05 PM

Numeric Build-Out Settings

Land Use Layer	
Layer containing land-use information	zone1_parzone
Attribute specifying land-use designation	ZONE
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
B-1		0.72 FAR	80
BM		0.49 FAR	80
F			100
GR-1	0.344 acre min. lot size		60
NP			100
OL		0.49 FAR	60
RR	28 acre min. lot size		76.3
SR-2	0.459 acre min. lot size		60

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
B-1	1	0	1
BM	1	0	1
F	1	0	1
GR-1	1	0	1
NP	1	0	1
OL	1	0	1
RR	1	0	1
SR-2	1	0	1

Constraints to Development

Constraint Layer	Can density be transferred?
zone1_nobuild_Dissolve	no

Spatial Build-Out Settings

Settings

Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
B-1	15	Random		0
BM	25	Random		0
F	0	Random		0
GR-1	15	Random		0

NP	0	Random		0
OL	25	Random		0
RR	50	Random		0
SR-2	20	Random		0

Results

Dwelling Unit Quantities

Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
B-1	0	0	0	0
BM	0	0	0	0
F	0	0	0	0
GR-1	259	258	1	0
NP	0	0	0	0
OL	0	0	0	0
RR	490	468	22	0
SR-2	285	282	3	0
Total	1034	1008	26	0

Commercial Floor Space

Land-Use Designation	Numeric Build-Out Floor Area (sq. feet)	Spatial Build-Out Floor Area (sq. feet)	Difference	Existing Floor Area
B-1	20026.873	20026.873	0	0
BM	8492930.551	8492708.462	222.089	0
F	0	0	0	0
GR-1	0	0	0	0
NP	0	0	0	0
OL	828701.462	828303.79	397.673	0
RR	0	0	0	0
SR-2	0	0	0	0
Total	9341658.886	9341039.124	619.762	0

Building Quantities

Land-Use Designation	Numeric Build-Out Units	Spatial Build-Out Units	Difference	Existing Buildings
B-1	1	1	0	0
BM	33	32	1	0
F	0	0	0	0
GR-1	259	258	1	0
NP	0	0	0	0
OL	12	11	1	0

RR	490	468	22	0
SR-2	285	282	3	0
Total	1080	1052	28	0

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
B-1	8213.353	3230.133	4983.22
BM	2478714.848	2012802.875	465911.973
F	8519847.812	4066450.103	4453397.709
GR-1	1093045.901	525728.157	567317.744
NP	560444.41	441770.933	118673.477
OL	333916.88	261866.843	72050.036
RR	25303244.591	17908310.697	7394933.893
SR-2	998113.223	728108.137	270005.086
Total	39295541.016	25948267.878	13347273.138

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commercial buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
B-1	0	0	0
BM	0	1	0
F	0	0	0
GR-1	1	1	0
NP	0	0	0
OL	0	1	0
RR	22	22	0
SR-2	3	3	0
Total	26	28	0

Build-Out Report - PRD Development

Tuesday, May 15, 2007, 11:45 PM

Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	zone1_prd_final
Attribute specifying land-use designation	ZONE_12
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
B-1		0.72 sq meters	80
BM		0.49 FAR	80
F			100
GR-1	0.344 acre min. lot size		60
GR-1PD	7.5 DU per acre		15
NP			100
OL		0.49 FAR	60
RR	10 acre min. lot size		76.3
RR1	0.333 DU per acre		22.5
SR-2	0.459 acre min. lot size		60
SR-2PD	4 DU per acre		35

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
B-1	1	0	1
BM	1	0	1
F	1	0	1
GR-1	1	0	1
GR-1PD	1	0	1
NP	1	0	1
OL	1	0	1
RR	1	0	1
RR1	1	0	1
SR-2	1	0	1
SR-2PD	1	0	1

Constraints to Development

Constraint Layer	Can density be transferred?
zone1_nobuild_Dissolve	no

Spatial Build-Out Settings

Settings

Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
B-1	15	Random		0
BM	25	Random		0
F	0	Random		0
GR-1	15	Random		0

GR-1PD	15	Random	zone1_roads_Merge	30
NP	0	Random		0
OL	25	Random		0
RR	50	Random		0
RR1	100	Follow Roads	zone1_roads_Merge	100
SR-2	20	Random		0
SR-2PD	10	Follow Roads	zone1_roads_Merge	20

Results

Dwelling Unit Quantities

Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
B-1	0	0	0	0
BM	0	0	0	0
F	0	0	0	0
GR-1	80	79	1	0
GR-1PD	123	123	0	0
NP	0	0	0	0
OL	0	0	0	0
RR	481	459	22	0
RR1	111	78	33	0
SR-2	244	241	3	0
SR-2PD	44	44	0	0
Total	1083	1024	59	0

Commercial Floor Space

Land-Use Designation	Numeric Build-Out Floor Area (sq. feet)	Spatial Build-Out Floor Area (sq. feet)	Difference	Existing Floor Area
B-1	6.2	6.2	0	0
BM	8492930.551	8492708.462	222.089	0
F	0	0	0	0
GR-1	0	0	0	0
GR-1PD	0	0	0	0
NP	0	0	0	0
OL	828701.462	828303.79	397.673	0
RR	0	0	0	0
RR1	0	0	0	0
SR-2	0	0	0	0
SR-2PD	0	0	0	0

Total	9321638.214	9321018.452	619.762	0

Building Quantities

Land-Use Designation	Numeric Build-Out Units	Spatial Build-Out Units	Difference	Existing Buildings
B-1	1	1	0	0
BM	33	32	1	0
F	0	0	0	0
GR-1	80	79	1	0
GR-1PD	123	123	0	0
NP	0	0	0	0
OL	12	11	1	0
RR	481	459	22	0
RR1	111	78	33	0
SR-2	244	241	3	0
SR-2PD	44	44	0	0
Total	1129	1068	61	0

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
B-1	8213.353	3230.133	4983.22
BM	2478714.848	2012802.875	465911.973
F	8519847.812	4066450.103	4453397.709
GR-1	667275.562	109913.621	557361.94
GR-1PD	455963.868	446008.065	9955.804
NP	88386.452	10967.322	77419.129
OL	333916.88	261866.843	72050.036
RR	15892147.196	11968863.716	3923283.48
RR1	9852961.824	6340057.063	3512904.761
SR-2	809411.831	597925.151	211486.68
SR-2PD	188701.393	130182.986	58518.406
Total	39295541.016	25948267.878	13347273.138

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commercial buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
B-1	0	0	0
BM	0	1	0

F	0	0	0
GR-1	1	1	0
GR-1PD	0	0	0
NP	0	0	0
OL	0	1	0
RR	22	22	0
RR1	33	33	0
SR-2	3	3	0
SR-2PD	0	0	0
Total	59	61	0

Hartford Study Area

Build-Out Report – Current Zoning Scenario
Tuesday, May 08, 2007, 8:39 PM
Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	zone3_parcel_zone
Attribute specifying land-use designation	SHORT
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
I-C		0.5 FAR	80
R-3	1 acre min. lot size		80
RC-2	0.344 acre min. lot size	0.45 FAR	80
RL-1	1 acre min. lot size		60
RL-3	3 acre min. lot size		65
RL-5	5 acre min. lot size		67.5
VR-2	0.459 acre min. lot size		80

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
I-C	1	0	1
R-3	1	0	1
RC-2	1	0	1

RL-1	1	0	1
RL-3	1	0	1
RL-5	1	0	1
VR-2	1	0	1

Constraints to Development

Constraint Layer	Can density be transferred?
zone3_nobuild_Dissolve	no

Existing Buildings

Layer containing existing buildings	Value or attribute specifying DU/bldg	Value or attribute specifying floor area (sq feet)
Zone 3 Existing Structures	1	0

Spatial Build-Out Settings

Settings

Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
I-C	20	Random	Zone 3 Roads	0
R-3	25	Random		0
RC-2	15	Follow Roads	Zone 3 Roads	50
RL-1	25	Random		0
RL-3	40	Random		0
RL-5	50	Random		0
VR-2	15	Follow Roads	Zone 3 Roads	25

Results

Dwelling Unit Quantities

Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
I-C	0	0	0	35
R-3	1	1	0	1
RC-2	14	11	3	21
RL-1	71	71	0	14
RL-3	78	78	0	68
RL-5	354	354	0	160
VR-2	30	10	20	16
Total	548	525	23	315

Commercial Floor Space

Land-Use	Numeric Build-Out Floor	Spatial Build-Out Floor	Difference	Existing

Designation	Area (sq. feet)	Area (sq. feet)		Floor Area
I-C	2468433.241	2468433.241	0	0
R-3	0	0	0	0
RC-2	92642.431	79014.316	13628.115	0
RL-1	0	0	0	0
RL-3	0	0	0	0
RL-5	0	0	0	0
VR-2	0	0	0	0
Total	2561075.672	2547447.557	13628.115	0

Building Quantities

Land-Use Designation	Numeric Build-Out Units	Spatial Build-Out Units	Difference	Existing Buildings
I-C	44	44	0	35
R-3	1	1	0	1
RC-2	38	32	6	21
RL-1	71	71	0	14
RL-3	78	78	0	68
RL-5	354	354	0	160
VR-2	30	10	20	16
Total	616	590	26	315

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
I-C	858410.149	573312.134	285098.015
R-3	16115.318	2583.73	13531.588
RC-2	178314.094	79692.22	98621.874
RL-1	734126.955	585409.539	148717.416
RL-3	3445100.586	2001291.586	1443809
RL-5	18411391.598	14779537.814	3631853.784
VR-2	217544.852	119750.858	97793.994
Total	23861003.553	18141577.88	5719425.673

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space	Number of commercial buildings that couldn't be placed because of space	Number of polygons where number of existing buildings

I-C	0	0	0
R-3	0	0	0
RC-2	3	6	0
RL-1	0	0	0
RL-3	0	0	0
RL-5	0	0	0
VR-2	20	20	0

Build-Out Report - Proposed Zoning
Wednesday, May 09, 2007, 8:43 PM
Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	zone3_zone_prop
Attribute specifying land-use designation	SHORT
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
I-C		0.5 FAR	80
R-3	1 acre min. lot size		80
RC-2	0.344 acre min. lot size	0.45 FAR	80
RL-1	1 acre min. lot size		60
RL10	10 acre min. lot size		76.3
RL-3	3 acre min. lot size		65
RL-5	5 acre min. lot size		67.5
VR-2	0.459 acre min. lot size		80

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
I-C	1	0	1
R-3	1	0	1
RC-2	1	0	1
RL-1	1	0	1
RL10	1	0	1
RL-3	1	0	1
RL-5	1	0	1
VR-2	1	0	1

Constraints to Development	
Constraint Layer	Can density be transferred?
zone3_nobuild_Dissolve	no

Existing Buildings		
Layer containing existing buildings	Value or attribute specifying DU/bldg	Value or attribute specifying floor area (sq feet)
Zone 3 Existing Structures	1	0

Spatial Build-Out Settings

Settings				
Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
I-C	20	Random		0
R-3	25	Random		0
RC-2	15	Follow Roads	Zone 3 Roads	50
RL-1	25	Random		0
RL10	50	Random		0
RL-3	40	Random		0
RL-5	50	Random		0
VR-2	15	Follow Roads	Zone 3 Roads	25

Results

Dwelling Unit Quantities				
Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units
I-C	0	0	0	35
R-3	1	1	0	1
RC-2	14	11	3	21
RL-1	71	71	0	14
RL10	198	198	0	160
RL-3	78	78	0	68
RL-5	0	0	0	0
VR-2	30	10	20	16
Total	392	369	23	315

Commercial Floor Space				
Land-Use Designation	Numeric Build-Out Floor Area (sq. feet)	Spatial Build-Out Floor Area (sq. feet)	Difference	Existing Floor Area
I-C	2468433.241	2468433.241	0	0
R-3	0	0	0	0

RC-2	92642.431	79014.316	13628.115	0
RL-1	0	0	0	0
RL10	0	0	0	0
RL-3	0	0	0	0
RL-5	0	0	0	0
VR-2	0	0	0	0
Total	2561075.671	2547447.557	13628.115	0

Building Quantities

Land-Use Designation	Numeric Build-Out Units	Spatial Build-Out Units	Difference	Existing Buildings
I-C	44	44	0	35
R-3	1	1	0	1
RC-2	38	32	6	21
RL-1	71	71	0	14
RL10	198	198	0	160
RL-3	78	78	0	68
RL-5	0	0	0	0
VR-2	30	10	20	16
Total	460	434	26	315

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
I-C	858410.148	573312.133	285098.015
R-3	16115.318	2583.73	13531.588
RC-2	178314.094	79692.22	98621.874
RL-1	734142.748	585409.538	148733.21
RL10	18379834.03	14779537.814	3600296.216
RL-3	3445100.586	2001291.586	1443808.999
RL-5	31560.661	0	31560.661
VR-2	217562.944	119750.858	97812.086
Total	23861040.528	18141577.88	5719462.649

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space	Number of commercial buildings that couldn't be placed because of space	Number of polygons where number of existing buildings exceeds build-

I-C	0	0	0
R-3	0	0	0
RC-2	3	6	0
RL-1	0	0	0
RL10	0	0	0
RL-3	0	0	0
RL-5	0	0	0
VR-2	20	20	0

Build-Out Report – Clustered Development

Monday, May 14, 2007, 10:32 PM

Numeric Build-Out Settings

Land Use Layer

Layer containing land-use information	zone3_rl4_rl11_parcels
Attribute specifying land-use designation	SHORT
Attribute specifying unique identifier of each land-use area	FID

Density Rules

Land-Use Designation	Dwelling Units	Floor Area	Efficiency Factor (%)
I-C		0.5 FAR	80
R-3	1 acre min. lot size		80
RC-2	0.344 acre min. lot size	0.45 FAR	80
RL-1	1 DU per acre		60
RL10	0.1 DU per acre		80
RL11	0.1 DU per acre		76.3
RL-3	0.333 DU per acre		80
RL-4	0.333 DU per acre		67.5
RL-5	0.2 DU per acre		80
VR-2	0.459 acre min. lot size		80

Building Information

Land-Use Designation	DU per Building	Area (sq feet)	Floors
I-C	1	0	1
R-3	1	0	1

RC-2	1	0	1
RL-1	1	0	1
RL10	1	0	1
RL11	1	0	1
RL-3	1	0	1
RL-4	1	0	1
RL-5	1	0	1
VR-2	1	0	1

Constraints to Development

Constraint Layer	Can density be transferred?
zone3_nobuild_Dissolve	no

Existing Buildings

Layer containing existing buildings	Value or attribute specifying DU/bldg	Value or attribute specifying floor area (sq feet)
Zone 3 Existing Structures	1	0

Spatial Build-Out Settings

Settings

Land-Use Designation	Minimum Separation Distance (feet)	Layout Pattern	Road or Line Layer	Setback (feet)
I-C	20	Random		0
R-3	25	Random		0
RC-2	15	Follow Roads	Zone 3 Roads	50
RL-1	25	Random		0
RL10	25	Follow Roads	Zone 3 Roads	50
RL11	25	Random		0
RL-3	25	Follow Roads	Zone 3 Roads	50
RL-4	20	Random		0
RL-5	20	Follow Roads	Zone 3 Roads	50
VR-2	15	Follow Roads	Zone 3 Roads	25

Results

Dwelling Unit Quantities

Land-Use Designation	Numeric Build-Out	Spatial Build-Out	Difference	Existing Dwelling Units

I-C	0	0	0	35
R-3	1	1	0	1
RC-2	14	11	3	21
RL-1	71	71	0	14
RL10	162	158	4	158
RL11	43	43	0	2
RL-3	61	59	2	68
RL-4	27	27	0	0
RL-5	0	0	0	0
VR-2	30	10	20	16
Total	409	380	29	315

Commercial Floor Space

Land-Use Designation	Numeric Build-Out Floor Area (sq. feet)	Spatial Build-Out Floor Area (sq. feet)	Difference	Existing Floor Area
I-C	2468433.241	2468433.241	0	0
R-3	0	0	0	0
RC-2	92642.431	79014.316	13628.115	0
RL-1	0	0	0	0
RL10	0	0	0	0
RL11	0	0	0	0
RL-3	0	0	0	0
RL-4	0	0	0	0
RL-5	0	0	0	0
VR-2	0	0	0	0
Total	2561075.671	2547447.557	13628.115	0

Building Quantities

Land-Use Designation	Numeric Build-Out Units	Spatial Build-Out Units	Difference	Existing Buildings
I-C	44	44	0	35
R-3	1	1	0	1
RC-2	38	32	6	21
RL-1	71	71	0	14
RL10	162	158	4	158
RL11	43	43	0	2
RL-3	61	59	2	68
RL-4	27	27	0	0
RL-5	0	0	0	0

Total	477	445	32	315

Buildable Area

Land-Use Designation	Gross Area (sq meters)	Net Buildable Area (sq meters)	Difference (sq meters)
I-C	858410.148	573312.133	285098.015
R-3	16115.318	2583.73	13531.588
RC-2	178314.094	79692.22	98621.874
RL-1	734126.954	585409.538	148717.416
RL10	16602090.832	13001797.106	3600293.727
RL11	1777740.708	1777740.708	0
RL-3	2997106.881	1553297.882	1443808.999
RL-4	447993.704	447993.704	0
RL-5	31560.058	0	31560.058
VR-2	217544.852	119750.858	97793.994
Total	23861003.551	18141577.88	5719425.671

Exceptions

Land-Use Designation	Number of dwelling units that couldn't be placed because of space constraints	Number of commercial buildings that couldn't be placed because of space constraints	Number of polygons where number of existing buildings exceeds build-out limit
I-C	0	0	0
R-3	0	0	0
RC-2	3	6	0
RL-1	0	0	0
RL10	4	4	0
RL11	0	0	0
RL-3	2	2	0
RL-4	0	0	0
RL-5	0	0	0
VR-2	20	20	0
Total	29	32	0

Appendix 1C: Interview Questions

1. How many acres of farmland do you own?
2. How many acres do you farm?
3. What do you produce?
4. What do you think are you major challenges in turning a profit?

Appendix 1D: Detailed Model Assumptions and Calculations for the Cooperative Forestry Analysis, Hartford VT

With VFF Acre Size and Sugar Maple Mill Price

Assumptions		Calculations	
Total Forest Area (acres)	3,159	Trips	78
Number of Loggers	2	Annual Harvested Land (acres)	163
Logger Wage ($/year)	24,000	Annual Average Stumpage Price ($/acre)	105
Average Trip Length (mi.)	30		
Cost Mileage ($/mile)	$2	Costs	
Truck Capacity (board feet)	8000	Mileage Costs	$4,680.00
Annual Harvest (%total Forest/year)	5%	Logger Costs	$48,000.00
Average Yield (cords/acre)	3	Total Annual Average Stumpage	$17,115.46
Average Stumpage ($/cord)	35 (5 yr average)	Total Operation Cost	$69,795.46
Average Harvest Volume (cords)	750		
Harvest Volume: Board Feet (1 cord = 417 board feet)	312750		
		Revenue	
		Average Mill Price	$399.50
		Harvest Volume x Unit Price	$65,120.26
		Net Profit	($4,675.20)

Appendix 1E: Price Chart for Vermont Timber

Average[1] Values Price Report for: **January 1 - December 31, 2005**
Recent prices offered or paid for standing timber in Vermont. Prices are in dollars per thousand feet (Int. 1/4 inch rule) except where other units are specified.

Vermont Region	Number Of Responses[2]	Range[3]	**Sugar Maple**	**Yellow Birch**	**Ash**	**Red Oak**	**White Birch**	**White Pine**	**Spruce Fir**	**Hemlock**	**Red Pine**
North	PWP=5/22	Low	225	97.5	110		100	65	90	25	
	CF=0/0	Medium	341	186.25	162.5	3.33	135.75	119.5	109.5	7.38	18.75

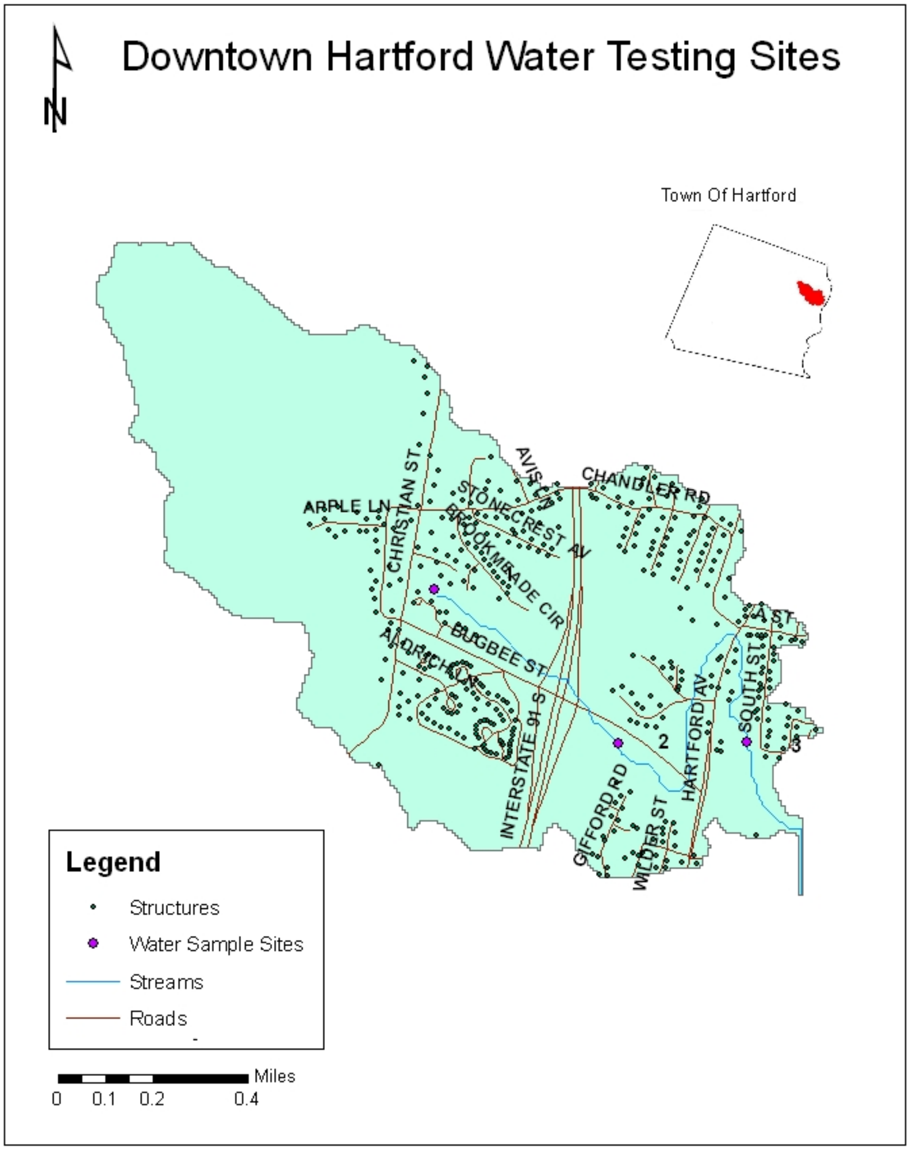
	PCF=4/67	High	580	360	260		250	167.5	180	50	
Central	PWP=7/47	Low	181.5	71.67	100		80	56.25	65	20	15
	CF=0/0	Medium	399.5	149.5	178.75	305.63	76.25	118.75	92.5	36.88	34.38
	PCF=3/39	High	668.75	300	202.5		100	155	123.75	50	75
South	PWP=2/6	Low	200	85	100	200	45	86.67	60	20	25
	CF=0/0	Medium	44.5	57.75	38.75	70.75	36.25	86.5	53.125	42	39.17
	PCF=2/11	High	925	400	275	600	125	174.33	175	45	85

http://stumpage.uvm.edu/stumpage.php

[1] Averaged over four financial quarters.
[2] Price estimates from Primary Wood Processors (PWP), County Foresters (CF) and Private Consulting Foresters (PCF)

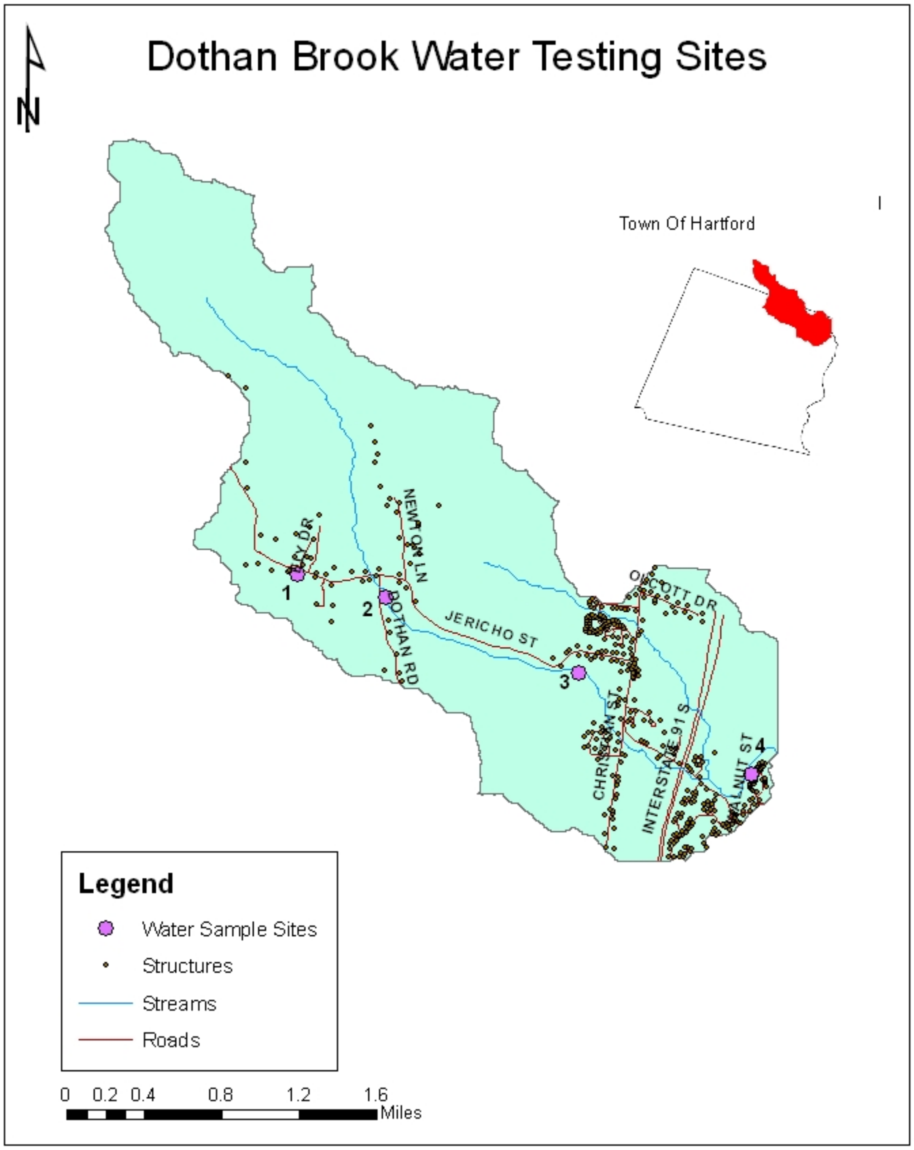
2. Environmental Issues of Exurban Sprawl in Hanover and Hartford

Appendix 2A: Water Quality Testing Sites



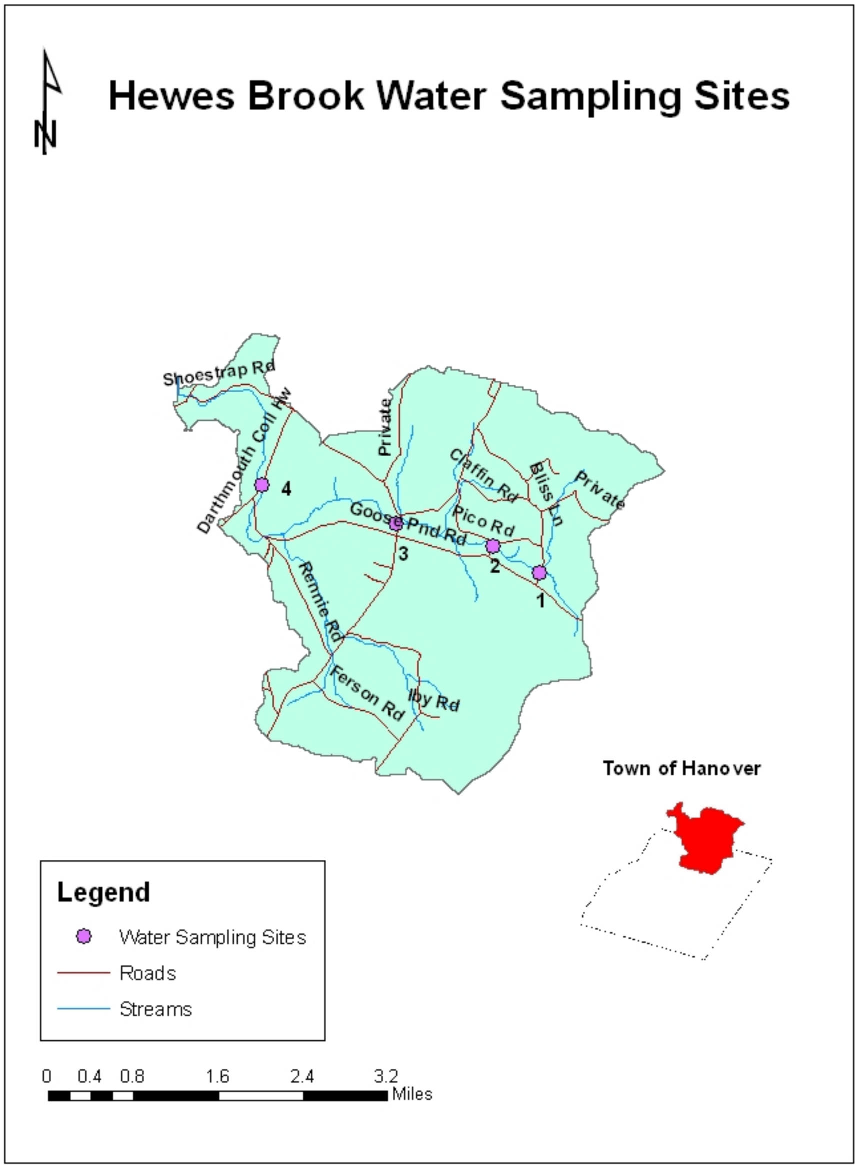
Site	Conductivity (µS)
1	269
2	482
3	477

Table 1A.1. – Conductivity at Cemetary



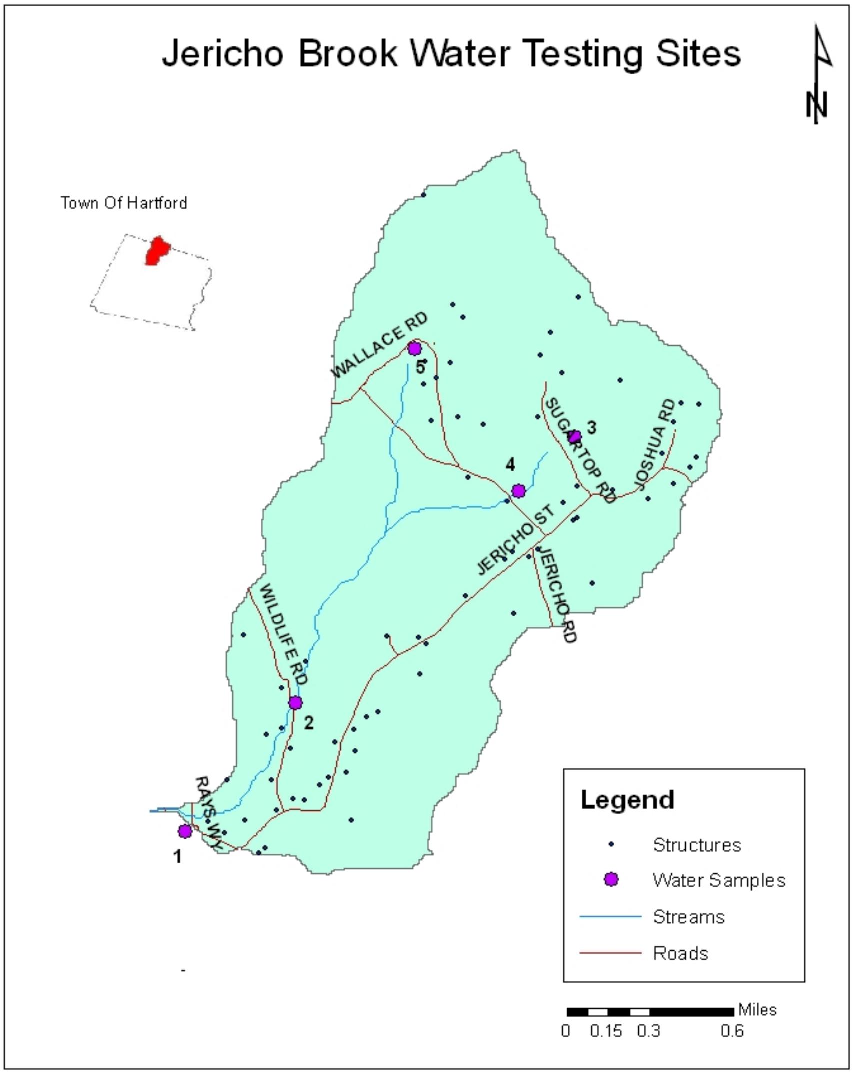
Site	Conductivity (µS)
1	170
2	107
3	131
4	225

Table 1A.2. – Conductivity at Dothan Brook



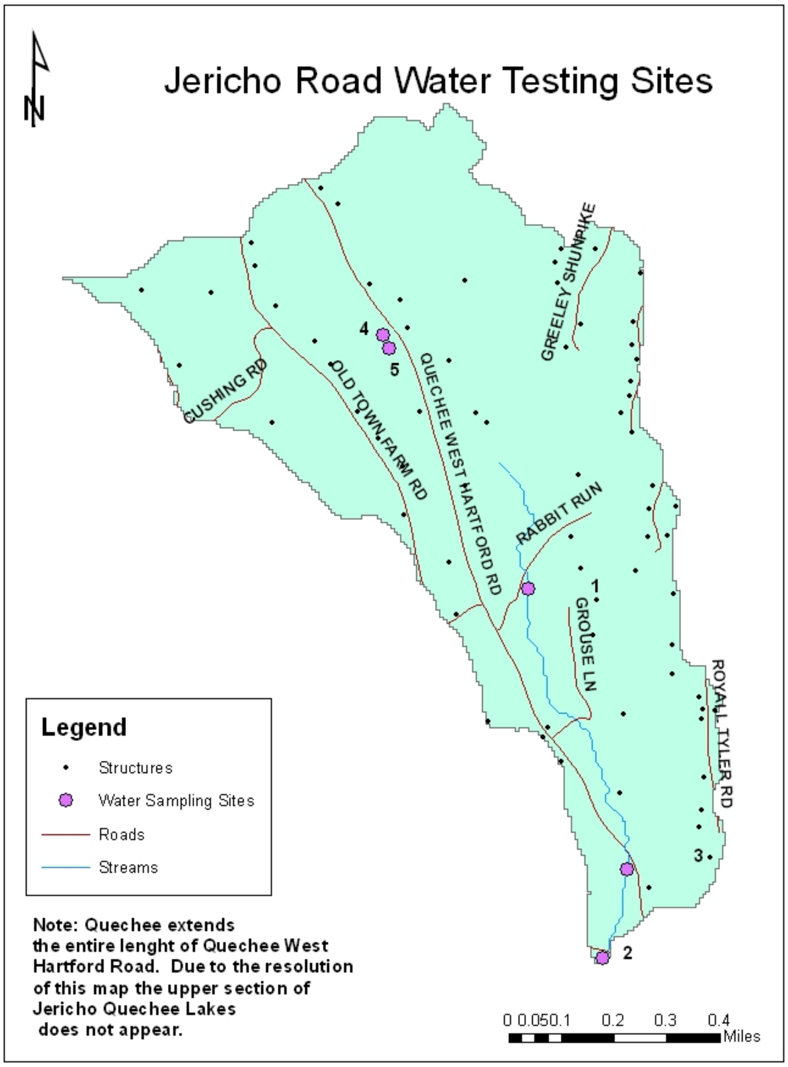
Site	Conductivity (µS)
1	42
2	56
3	65
4	78

Table 1A.3. – Conductivity at Hewes Brook



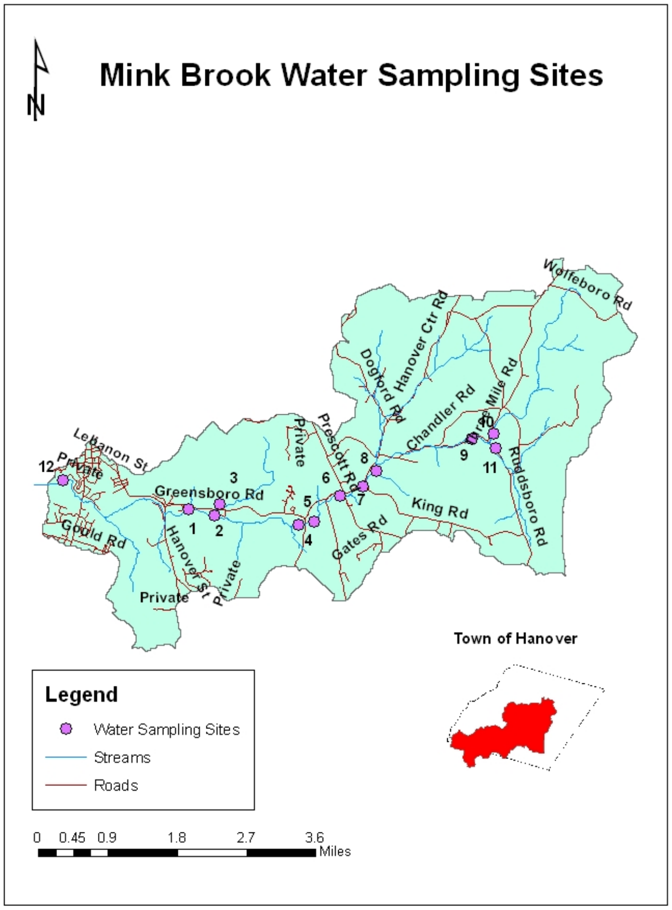
Site	Conductivity (µS)
1	127
2	103
3	96
4	107
5	66

Table 1A.4. – Conductivity at Jericho Brook



Site	Conductivity (µS)
1	242
2	192
3	104
4	164
5	198
6	201
7	200

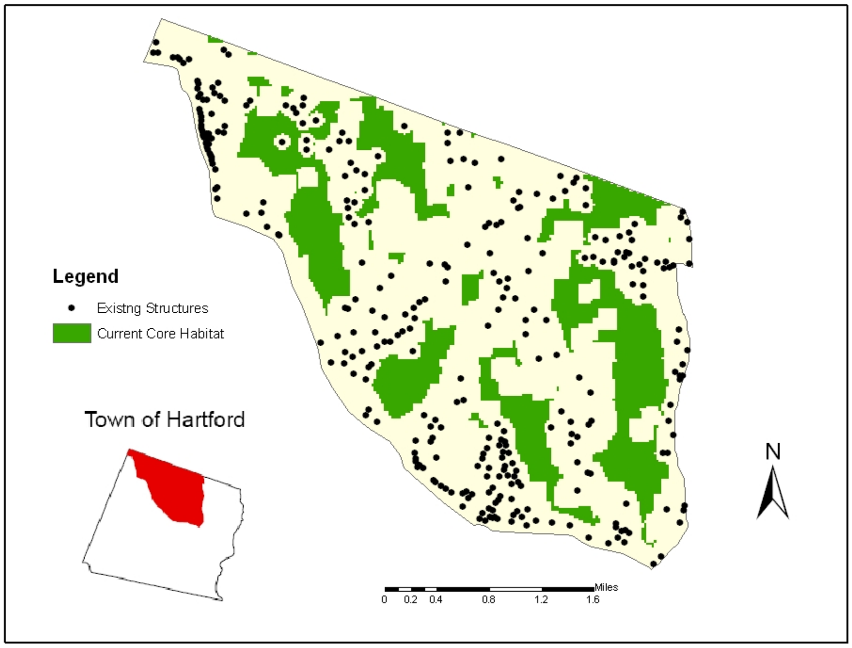
Table 1A.5. – Conductivity at Jericho Road

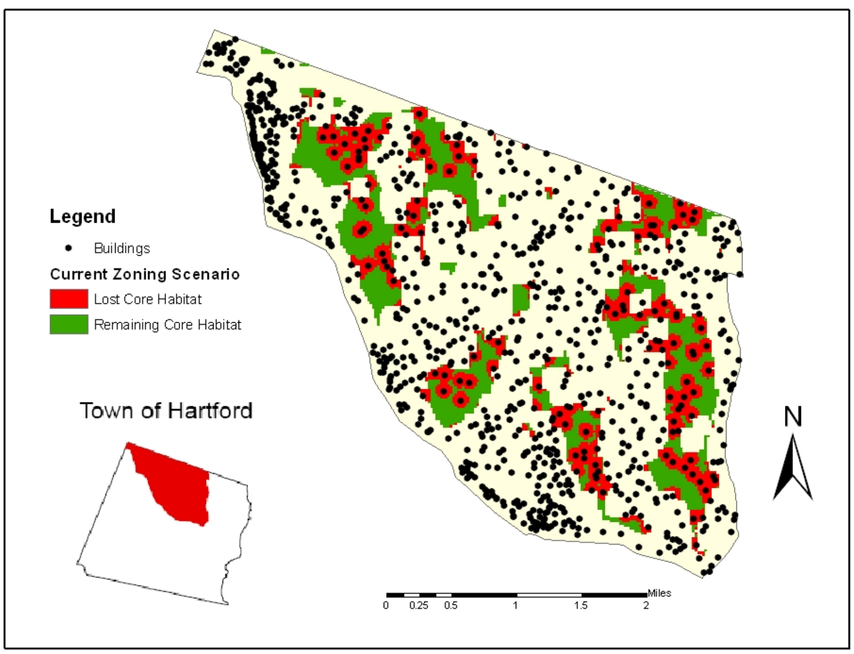


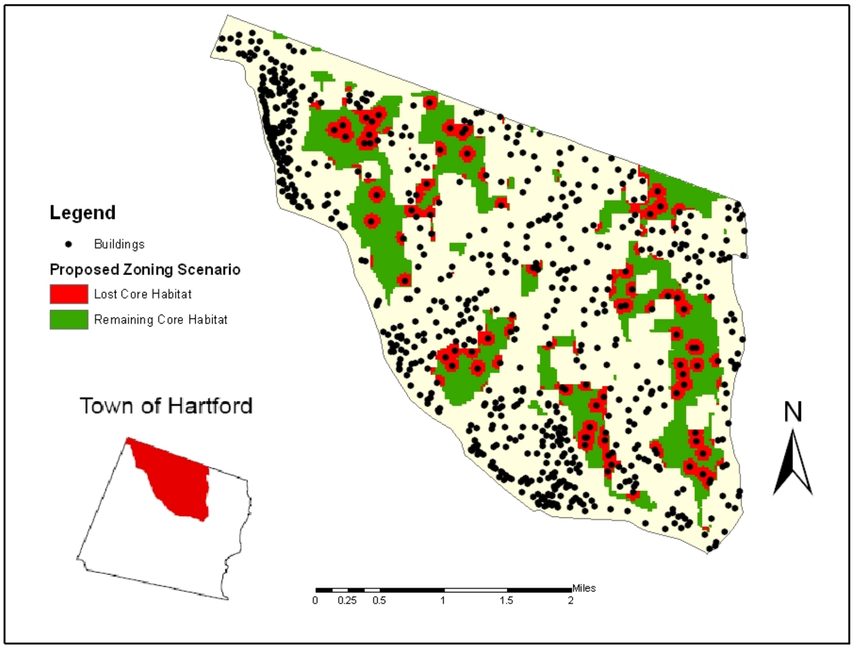
Site	Conductivity (µS)
1	111
2	91
3	92
4	85
5	83
6	68
7	67
8	60
9	58
10	41
11	63
12	160

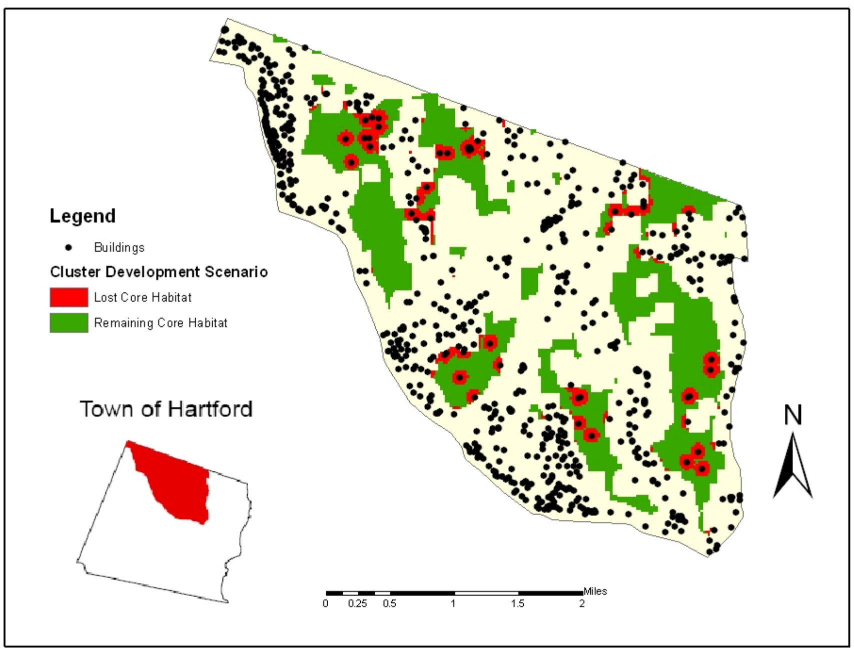
Table 1A.6. – Conductivity at Mink Brook

Appendix 2B – Ovenbird Core Habitat Maps

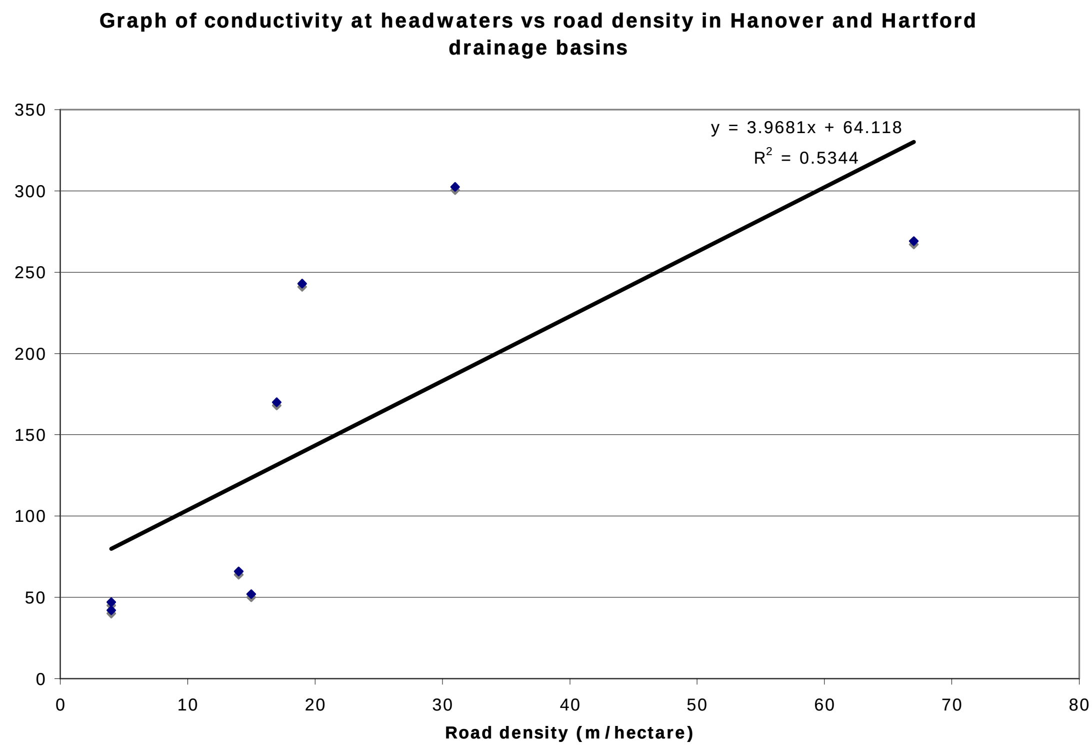


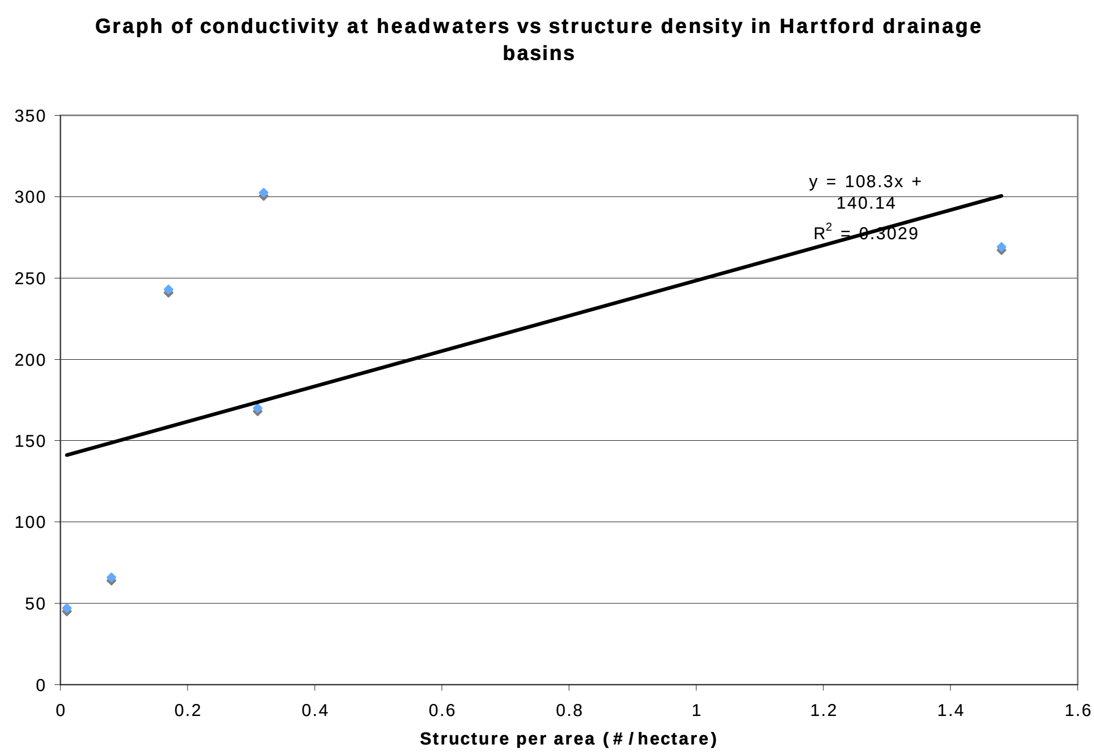



Legend
Buildings
Proposed Zoning Scenario
Lost Core Habitat
Remaining Core Habitat
Town of Hartford
N
0 0.25 0.5 1 1.5 2
Miles

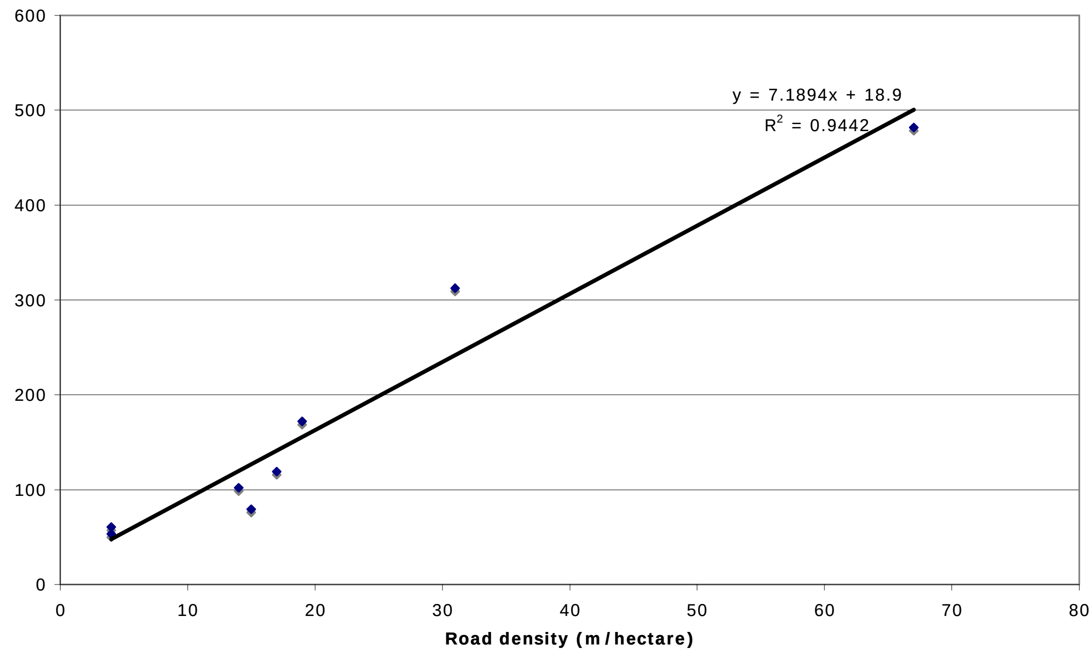

Legend
Buildings
Cluster Development Scenario
Lost Core Habitat
Remaining Core Habitat
Town of Hartford
N
0 0.25 0.5 1 1.5 2
Miles

Appendix 2C: Water Quality Graphs

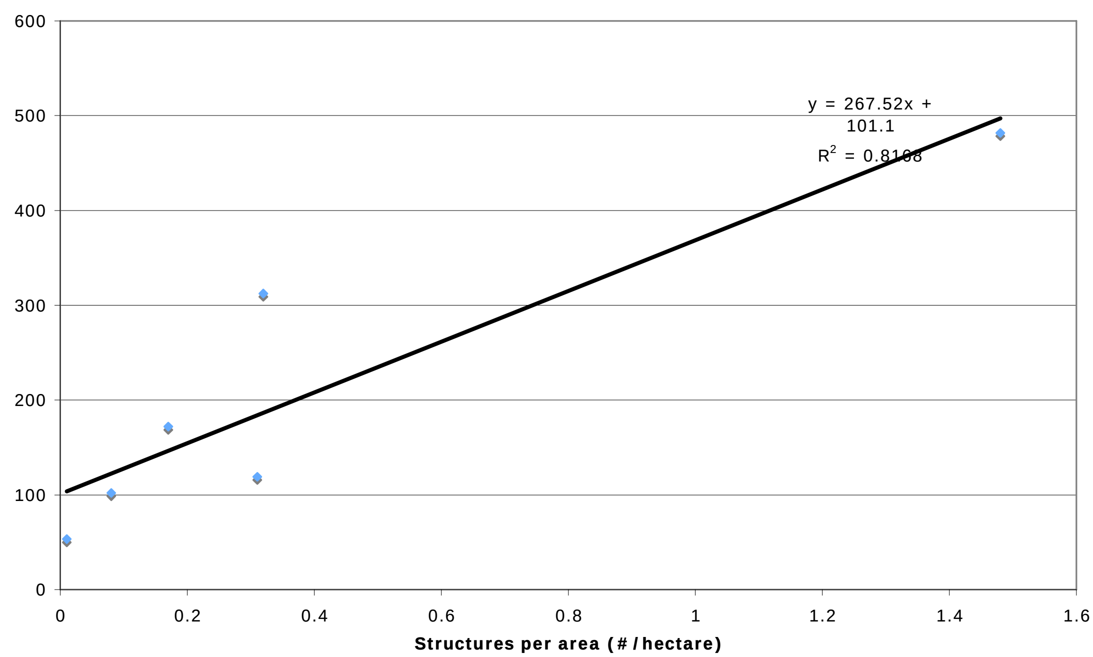




Graph of average conductivity of midstreams vs road density in Hanover and Hartford drainage basins



Graph of average conductivity of midstreams vs structure density in Hartford drainage basins



3. The Social Impacts of Land Use

Appendix 3A: Land Use Questionnaire

HANOVER RESIDENTS

PROJECT INFORMATION SHEET

This project is being conducted by an Environmental Studies undergraduate student group with supervision by a faculty advisor from **Dartmouth College**, Hanover, NH, USA. It is a study regarding land use in Hartford and Hanover.

Your participation is voluntary. Participation involves a 3-5 minute survey. You may choose to not answer any or all questions.

The information collected will be maintained confidential and anonymous.

Thank you for your time! We appreciate it.
- Inga, Hayley, Katherine, and Shane

Faculty advisor: Douglas Bolger, (603)-646-1866, doug.bolger@dartmouth.edu

Age (Please circle.) 18-25 25-35 35-50 50-65 65+

Residence (Please circle.) Urban Hanover Suburban Hanover Rural Zone

How many years have you been a resident in the Upper Valley? ______________

Are you a landowner? (Please circle.) YES NO

If yes, how many acres do you own? (Please circle.)

<1 1-5 5-10 10-50 50+

How often do you attend Hanover's Town Meeting?

Annually **Every Other Year** **Every Third Year** **Never**

Please Turn Over

On a scale of 1-5 how would you rank your knowledge of the environmental impacts of land use in Hanover? (Please circle.)

1 2 3 4 5
(no knowledge) **(very knowledgeable)**

On a scale of 1-5 how important is the working landscape (farms and productive forests) to preserving the culture of Hanover? (Please circle.)

1 2 3 4 5
(no concern) (great importance)

What type of neighborhood do you see as the best model for future rural growth in Hanover? (Please circle.)

A. Low density neighborhoods (e.g. Hanover Center)?
B. Low density community developments (e.g. Trescott Road development or Northwest Hanover)?
C. High density community developments (e.g. Velvet Rocks development)?

How much extra would you be willing to pay for locally grown items? (Please circle.)

Food	0%	1- 5%	5-10%	10-15%	>15%
Lumber/Firewood	0%	1-5%	5-10%	10-15%	>15%

Please rank each of the following from least important (1) to most important (5):

Conservation of Rural Open Space	1	2	3	4	5
Water Quality	1	2	3	4	5
Outdoor Recreation	1	2	3	4	5
Affordable Housing	1	2	3	4	5
Job Availability	1	2	3	4	5
Socioeconomic Diversity	1	2	3	4	5
Rural Culture	1	2	3	4	5
	(least important)			(most important)	

What is your greatest concern about the future of land use in Hanover?

HARTFORD RESIDENTS

PROJECT INFORMATION SHEET

This project is being conducted by an Environmental Studies undergraduate student group with supervision by a faculty advisor from **Dartmouth College**, Hanover, NH, USA. It is a study regarding land use in Hartford and Hanover.

Your participation is voluntary. Participation involves a 3-5 minute survey. You may choose to not answer any or all questions.

The information collected will be maintained confidential and anonymous.

Thank you for your time! We appreciate it.
- Inga, Hayley, Katherine, and Shane

Faculty advisor: Douglas Bolger, (603)-646-1866, doug.bolger@dartmouth.edu

Age (Please circle.) 18-25 25-35 35-50 50-65 65+
Which village do you live in? (Please circle.) Hartford Quechee W. Hartford

Wilder White River Junction

Which area do you live in? (Please circle.) Urban Suburban Rural

How many years have you been a resident of the Upper Valley? ______________

Are you a landowner? (Please circle.) YES NO

If yes, how many acres do you own? (Please circle.)

<1 1-5 5-10 10-50 50+

How often do you attend Hartford's Town Meeting?

Annually Every Other Year Every Third Year Never

Please Turn Over

On a scale of 1-5 how would you rank your knowledge of the environmental impacts of land use in Hartford? (Please circle.)

1 2 3 4 5
(no knowledge) (very knowledgeable)

On a scale of 1-5 how important is the working landscape (farms and productive forests) to preserving the culture of Hartford? (Please circle.)

1 2 3 4 5
(no concern) (great importance)

What type of neighborhood do you see as the best model for future rural growth in Hartford? (Please circle.)

A. Low density neighborhoods (e.g. Jericho Hill)?
B. Low density community developments (e.g. Quechee Lakes)?
C. High density community developments (e.g. Hemlock Ridge or Sterling Springs)?

How much extra would you be willing to pay for locally grown items? (Please circle.)

Food	0%	1- 5%	5-10%	10-15%	>15%
Lumber/Firewood	0%	1-5%	5-10%	10-15%	>15%

Please rank each of the following from least important (1) to most important (5):

Conservation of Rural Open Space	1	2	3	4	5
Water Quality	1	2	3	4	5
Outdoor Recreation	1	2	3	4	5
Affordable Housing	1	2	3	4	5
Job Availability	1	2	3	4	5
Socioeconomic Diversity	1	2	3	4	5
Rural Culture	1	2	3	4	5

What is your greatest concern about the future of land use in Hartford?

Appendix 3B: Open Response Questions and Responses

What is your greatest concern about the future of land use in Hartford?

No open space and no public transportation

Overdevelopment and loss of habitat

Setting aside so much land or zoning in such a way that necessary infrastructure cannot be maintained or developed to provide the services required to support population growth which is expected to take place over the next few decades (transportation facilities, utilities, job development, medical facilities, affordable housing etc.) Otherwise reasonable growth will be stifled.

Needs to be balanced

I understand that they are trying to conserve the big lands as much as possible, but I wish they put the landowners' land on modification in future (in case we are unable to work or something maybe when the time comes we will sell the property…)

That it is used wisely

Hartford town leaders seem to place great value on bringing in more and more development to the town, emphasizing growth, not infrastructure

My concern is that Quechee Lakes seems to be able to do whatever they want by paying for it.

Development

State and Town deciding on how and what should be built
Too much building of non-low cost housing

Current attempts to "fill in density" in villages will leave little green space for "in town" residents. Not worth sacrificing that to prevent development in outlying areas.

Uncontrolled development and an increase in out of town summer homes.

Red tape, boring meetings, lack of knowledge for general public will mean developers can get away with anything!

Pollution, No open space (rec)

Farm preservation, athletic fields/ facilities

Will lose big open spaces

My greatest concern is that 2nd home owners will buy up the open land and build enormous houses to be used only on an occasional basis. This is a waste of both natural resources and open space. I also worry that they will all build in the middle of usable crop land which will render that land useless. I am also concerned that the land is going to cost too much for native Vermonters who will have to move out into more rural areas such as Tunbridge/Chelsea which will cause them to commute further. This will add to the burden of using additional gasoline and causing increased emissions into the environment of pollutants.

Local politics do not favor intelligent land use (or much else).

Only that it is thoughtful and democratically decided. I don’t want and half-baked ideas making it through, but I want concerns of the whole town, not my own, to be the deciding factor.

Ugly, overpriced condos

That it will contain more Quechee-like developments for wealthy flatlander retirees instead of affordable housing for the region's middle-class workers who want to live in Hartford.

It won’t be done wisely.

The preservation of what I see at first glance!

My greatest concern is that the rural lands will become totally suburbanized because the income that people earn from maintaining a productive land-base is not great enough for them to afford to buy and own the land necessary to support their livelihood. This has already happened to a great extent but the parcelization and fragmentation has not happened to the same degree. At some point, unless attitudes and economic patterns radically change, property owners will change and the psychic connection to the land as it has been will not have the same immediacy and the land will be developed without respect to the forestlands and agricultural lands. A glum prospect especially when combined with other homogenization of the culture.

Population overgrowth

The creation of "10 acre slums" and ridgetop building. We must maintain local means of production for dairy, lumber and food to whatever extent is practical.

What is your greatest concern about the future of land use in Hanover

That so many great folks won’t be able to live here…Too much pushing out = Greenwich (not why we live here).

I would hate to see Hanover become too built up and metropolitan. As much as a lot of the commercial development that has been going on has been a good thing, it is sad to drive down route 120 and all the forested area completely gone.

Large developments, too rapid growth, destruction of habitat, wetlands, slopes

While I appreciate the consideration given to development, I feel it is being too restrictive.

Overpopulation

Any affordable housing will be totally blocked.

10 acre minimum in rural areas will adversely affect development.

Too much development

Lack of affordable housing despite increased development in “RR” zones.

Low density neighborhoods

Etna and Hanover Center (over represented on the Selectboard) make huge gains in terms of water-fire, yet they also get more tax abatement year after year. Rural lobby has too much influence.

Growth

That people will build 1 house on lots that are too spread out from one another.

Absentee landlords allowing homes to fall into disrepair

Continued growth and upward sprawl in Center of Town

Smart Growth

Sprawl

Too much development away from town facilities or sprawl

Enough water, habitat

Exclusivity in rural Hanover

I wish the number of Mansions would decrease

That residences are spread out too much and we lose our open land. We should have high density settlements and not allow sub-divisions or large rural spaces.

Big brother.

Proper planning by residents.

Avoiding the “West Lebanonization” of the town. A corrolary coaxing development into relatively dense areas.

Rural zoning needs to be put in place before unexpected development happens.

There must be consideration given to allowing much higher density on all town water and sewer lines in order to make downtown Hanover more vibrant and preserve open space in the rural areas. People must be allowed to build on steep slopes.

Continued rural sprawl- ill planned developments that carve up the rural landscape with no cohesive plan re: infrastructure efficiencies, social interaction, etc.

Too much growth

Loss of public land available for hunting/fishing/biking etc.

Overdevelopment

Replication of the “boom town” overdevelopment scenario seen elsewhere in the U.S. Loss of our cultural tradition (people and landscape).

That it be done slowly and deliberately rather than rushing or overbuilding

I would like to see more opportunities to get around town walking and/or biking (more trails) and more public transport to reduce traffic.

Too many cars, not enough bike trails

Concerned about too many people and not enough jobs to support them.

Concerned about being too spread out and affecting wildlife.

We need to make careful decisions about future land-use- not quick, knee jerk decisions that may be disastrous. Long-term impacts in terms of the importance of balancing growth needs with conservation desires.

Not enough open space and places for recreation

Too much development

Too much building. Where will the open spaces where our children can play be? Keep green and open space!

Continued irresponsible growth.

I am nervous about the way the town's zoning administrator is pushing for community centers.

That it is responsible and well considered.

Too many restrictions.

Too much growth- lack of awareness of impacts of growth on the rural sector

Balancing environmental needs with affordable housing, economic diversity, etc.

That it will get paved over!

Keeping is pristine. Not developing.

Need to preserve open space.

No more Velvet Rocks.

That it be developed in concert with the natural assets of the land i.e. not putting large apt. buildings on wetlands. Work with the land, design with nature, not crush it…

I believe VT landowners and their increased property tax is misrepresented when considering Hanover's growth. (harsh perhaps)

Over commercialization

Unplanned high density community sprawl

That everything, water, environmental, people use, be balanced equitably

Crowded roads

Loss of open space

Future use needs to preserve wild and farmlands for beauty, animal habitats and common recreational enjoyment
Sprawl development, strip malls

Over-development

Cost factor. I don't think my children will ever be able to afford to live here!

Sprawl

Preserve large open spaces/ unbroken forests

Uncontrolled development, unregulated development

Loss of open space/ rural feel
Availability of open land for recreation/ conservation

McMansions!

The houses respect their surroundings in scale and not built on the ridges (so the rest of us have to see them!)

Low density housing

Planning policies, overdevelopment at expense of historical rural areas, traffic.

Increasingly homogeneous population- need greater socioeconomic diversity and more affordable housing

Appendix 3C - Contingency Tables

Table 3.2- Land Use Model By Conservation

Count Total % Col % Row %	1	2	3	4	5	
A	0 0.00 0.00 0.00	0 0.00 . 0.00	4 4.71 44.44 10.81	7 8.24 28.00 18.92	26 30.59 55.32 70.27	37 43.53
B	2 2.35 50.00 7.41	0 0.00 . 0.00	3 3.53 33.33 11.11	9 10.59 36.00 33.33	13 15.29 27.66 48.15	27 31.76
C	2 2.35 50.00 9.52	0 0.00 . 0.00	2 2.35 22.22 9.52	9 10.59 36.00 42.86	8 9.41 17.02 38.10	21 24.71
	4 4.71	0 0.00	9 10.59	25 29.41	47 55.29	85

Tests

Source	DF	-LogLike	RSquare (U)
Model	6	5.211491	0.0573
Error	76	85.664835	
C. Total	82	90.876325	
N	85		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	10.423	0.1079
Pearson	8.917	0.1783

Table 3.3- Land Use Knowledge By Town Meetings

Count Total % Col % Row %	0	1	2	3	
1	9 6.43 15.79 90.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.71 7.14 10.00	10 7.14
2	14 10.00 24.56 66.67	2 1.43 4.35 9.52	2 1.43 8.70 9.52	3 2.14 21.43 14.29	21 15.00
3	20 14.29 35.09 38.46	16 11.43 34.78 30.77	11 7.86 47.83 21.15	5 3.57 35.71 9.62	52 37.14
4	9 6.43 15.79 23.08	18 12.86 39.13 20.51	8 5.71 34.78 20.51	4 2.86 28.57 10.26	39 27.86

5	5 3.57 8.77 27.78	10 7.14 21.74 55.56	2 1.43 8.70 11.11	1 0.71 7.14 5.56	18 12.86
	57 40.71	46 32.86	23 16.43	14 10.00	140

Tests

Source	DF	-LogLike	RSquare (U)
Model	12	16.79636	0.0953
Error	125	159.39898	
C. Total	137	176.19534	
N	140		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	33.593	0.0008
Pearson	29.396	0.0034

Table 3.4- Hanover By Hartford Socioeconomic Diversity

Count Total % Col % Row %	1	2	3	4	5	
1	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00
2	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00
3	0 0.00 0.00 0.00	0 0.00 0.00 0.00	2 7.69 25.00 40.00	0 0.00 0.00 0.00	3 11.54 27.27 60.00	5 19.23
4	1 3.85 100.00 9.09	1 3.85 50.00 9.09	4 15.38 50.00 36.36	2 7.69 50.00 18.18	3 11.54 27.27 27.27	11 42.31
5	0 0.00 0.00 0.00	1 3.85 50.00 10.00	2 7.69 25.00 20.00	2 7.69 50.00 20.00	5 19.23 45.45 50.00	10 38.46
	1 3.85	2 7.69	8 30.77	4 15.38	11 42.31	26

Tests

Source	DF	-LogLike	RSquare (U)
Model	8	3.045988	0.0876
Error	14	31.720670	
C. Total	22	34.766658	
N	26		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	6.092	0.6369
Pearson	4.534	0.8060

Table 3.5 - Hartford By Hanover Affordable Housing

Count Total % Col % Row %	1	2	3	4	5	
1	0 0.00 . 0.00	0 0.00 . 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 3.85 9.09 100.00	1 3.85
2	0 0.00 . 0.00	0 0.00 . 0.00	1 3.85 14.29 50.00	0 0.00 0.00 0.00	1 3.85 9.09 50.00	2 7.69
3	0 0.00 . 0.00	0 0.00 . 0.00	1 3.85 14.29 14.29	4 15.38 50.00 57.14	2 7.69 18.18 28.57	7 26.92
4	0 0.00 . 0.00	0 0.00 . 0.00	1 3.85 14.29 14.29	4 15.38 50.00 57.14	2 7.69 18.18 28.57	7 26.92
5	0 0.00 . 0.00	0 0.00 . 0.00	4 15.38 57.14 44.44	0 0.00 0.00 0.00	5 19.23 45.45 55.56	9 34.62
	0 0.00	0 0.00	7 26.92	8 30.77	11 42.31	26

Tests

Source	DF	-LogLike	RSquare (U)
Model	8	7.128012	0.2539
Error	16	20.948747	
C. Total	24	28.076759	
N	26		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	14.256	0.0753
Pearson	11.191	0.1911

Table 3.6- Rural Culture By Working Landscape

Count Total % Col % Row %	2	3	4	5	
1	0 0.00 0.00 0.00	2 2.11 20.00 66.67	1 1.05 3.85 33.33	0 0.00 0.00 0.00	3 3.16
2	1 1.05 33.33	2 2.11 20.00	3 3.16 11.54	4 4.21 7.14	10 10.53

	10.00	20.00	30.00	40.00	
3	1 1.05 33.33 4.55	3 3.16 30.00 13.64	9 9.47 34.62 40.91	9 9.47 16.07 40.91	22 23.16
4	1 1.05 33.33 2.63	3 3.16 30.00 7.89	7 7.37 26.92 18.42	27 28.42 48.21 71.05	38 40.00
5	0 0.00 0.00 0.00	0 0.00 0.00 0.00	6 6.32 23.08 27.27	16 16.84 28.57 72.73	22 23.16
	3 3.16	10 10.53	26 27.37	56 58.95	95

Tests

Source	DF	-LogLike	RSquare (U)
Model	12	11.086844	0.1153
Error	80	85.079568	
C. Total	92	96.166412	
N	95		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	22.174	0.0356
Pearson	22.937	0.0283

Table 3.7- Rural Culture By Socioeconomic Diversity

1	2	3	4	5	
2 2.11 66.67 50.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 1.05 3.45 25.00	1 1.05 2.94 25.00	4 4.21
1 1.05 33.33 9.09	2 2.11 66.67 18.18	5 5.26 19.23 45.45	2 2.11 6.90 18.18	1 1.05 2.94 9.09	11 11.58
0 0.00 0.00 0.00	0 0.00 0.00 0.00	16 16.84 61.54 61.54	6 6.32 20.69 23.08	4 4.21 11.76 15.38	26 27.37
0 0.00 0.00 0.00	1 1.05 33.33 3.45	3 3.16 11.54 10.34	19 20.00 65.52 65.52	6 6.32 17.65 20.69	29 30.53
0 0.00 0.00 0.00	0 0.00 0.00 0.00	2 2.11 7.69 8.00	1 1.05 3.45 4.00	22 23.16 64.71 88.00	25 26.32
3 3.16	3 3.16	26 27.37	29 30.53	34 35.79	95

Tests

Source	DF	-LogLike	RSquare (U)

Source	DF	-LogLike	RSquare (U)
Model	16	41.25546	0.3333
Error	75	82.51282	
C. Total	91	123.76828	
N	95		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	82.511	<.0001
Pearson	105.842	<.0001

Table 3.8- Food By Socioeconomic Diversity

Count Total % Col % Row %	1	2	3	4	5	
0	1 1.06 33.33 50.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 1.06 3.03 50.00	2 2.13
1	0 0.00 0.00 0.00	1 1.06 33.33 7.69	5 5.32 19.23 38.46	5 5.32 17.24 38.46	2 2.13 6.06 15.38	13 13.83
2	2 2.13 66.67 5.56	0 0.00 0.00 0.00	12 12.77 46.15 33.33	11 11.70 37.93 30.56	11 11.70 33.33 30.56	36 38.30
2.5	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 1.06 3.03 100.00	1 1.06
3	0 0.00 0.00 0.00	0 0.00 0.00 0.00	5 5.32 19.23 21.74	10 10.64 34.48 43.48	8 8.51 24.24 34.78	23 24.47
4	0 0.00 0.00 0.00	2 2.13 66.67 10.53	4 4.26 15.38 21.05	3 3.19 10.34 15.79	10 10.64 30.30 52.63	19 20.21
	3 3.19	3 3.19	26 27.66	29 30.85	33 35.11	94

Tests

Source	DF	-LogLike	RSquare (U)
Model	20	13.33445	0.1086
Error	70	109.39675	
C. Total	90	122.73120	
N	94		

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	26.669	0.1448
Pearson	32.941	0.0342

Table 3.9- Response Environmental Knowledge Whole Model

Summary of Fit

RSquare	0.104682
RSquare Adj	0.075328
Root Mean Square Error	1.05419
Mean of Response	3.244094
Observations (or Sum Wgts)	127

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	15.85235	3.96309	3.5661
Error	122	135.58072	1.11132	Prob > F
C. Total	126	151.43307		0.0087

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	4	7.62008	1.90502	1.7567
Pure Error	118	127.96064	1.08441	Prob > F
Total Error	122	135.58072		0.1422
				Max RSq
				0.1550

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.3170685	0.100196	33.11	<.0001
residential area[R]	0.2345822	0.143801	1.63	0.1054
residential area[S]	-0.347108	0.140889	-2.46	0.0151
land use model[A]	-0.4203	0.132879	-3.16	0.0020
land use model[B]	0.152522	0.14045	1.09	0.2796

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
residential area	2	2	6.799502	3.0592	0.0505
land use model	2	2	11.135094	5.0099	0.0081

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