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Prediction of Suburban Encroachment on the Ethan Allen Firing Range and Camp Johnson, Chittenden County, Vermont

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PREDICTION OF SUBURBAN ENCROACHMENT ON THE ETHAN ALLEN FIRING RANGE AND CAMP JOHNSON CHITTENDEN COUNTY, VERMONT

by

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ABSTRACT

Prediction of Suburban Encroachment on the Ethan Allen Firing Range and Camp Johnson, Chittenden County, Vermont

by

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Suburban encroachment is a growing concern for many National Guard training installations. The Ethan Allen Firing Range and Camp Johnson, Vermont, are either experiencing or are completely enclosed by urban encroachment. The objective of this study was to analyze the trends of suburban growth within Chittenden County, Vermont, to evaluate growth and explore future training site viability of the Ethan Allen Firing Range and Camp Johnson.

This study focused on historical data, recent real estate transactions, population projections, and county plans for growth. Using historical and contemporary data,

I developed a predictive model of suburban encroachment on Camp Johnson and the Ethan Allen Firing Range facilities by residential and commercial development. This model may assist land managers make decisions and illustrate the viability of these installations as National Guard training sites. This model may also be applied to other installations with similar concerns.

(95 pages)

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John D. Calandrelli

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INTRODUCTION

The objective of this study was to develop a viability assessment for the Ethan Allen Firing Range (EAFR) and Camp Johnson in Vermont (Figure 1). This was done by estimating future encroachment on National Guard facilities through land use trends from Burlington growth as well as pressure from real estate speculation. The purpose of this assessment was to show the direction or pattern of growth within Chittenden County to assist the National Guard in ascertaining the viability of these training sites and assist in long-term planning through the year 2015. The final map shows where residential or commercial development will likely occur given certain guiding parameters.

This assessment evaluated the population growth of Burlington and surrounding areas by showing the direction and rate of change using historical land use data and existing county master plans. This will help determine land use history of the Burlington area and where they plan to grow.

Camp Johnson and the EAFR are completely enclosed by Chittenden County, and changes in land use/land cover originate from many physical, social, economic, and political issues.

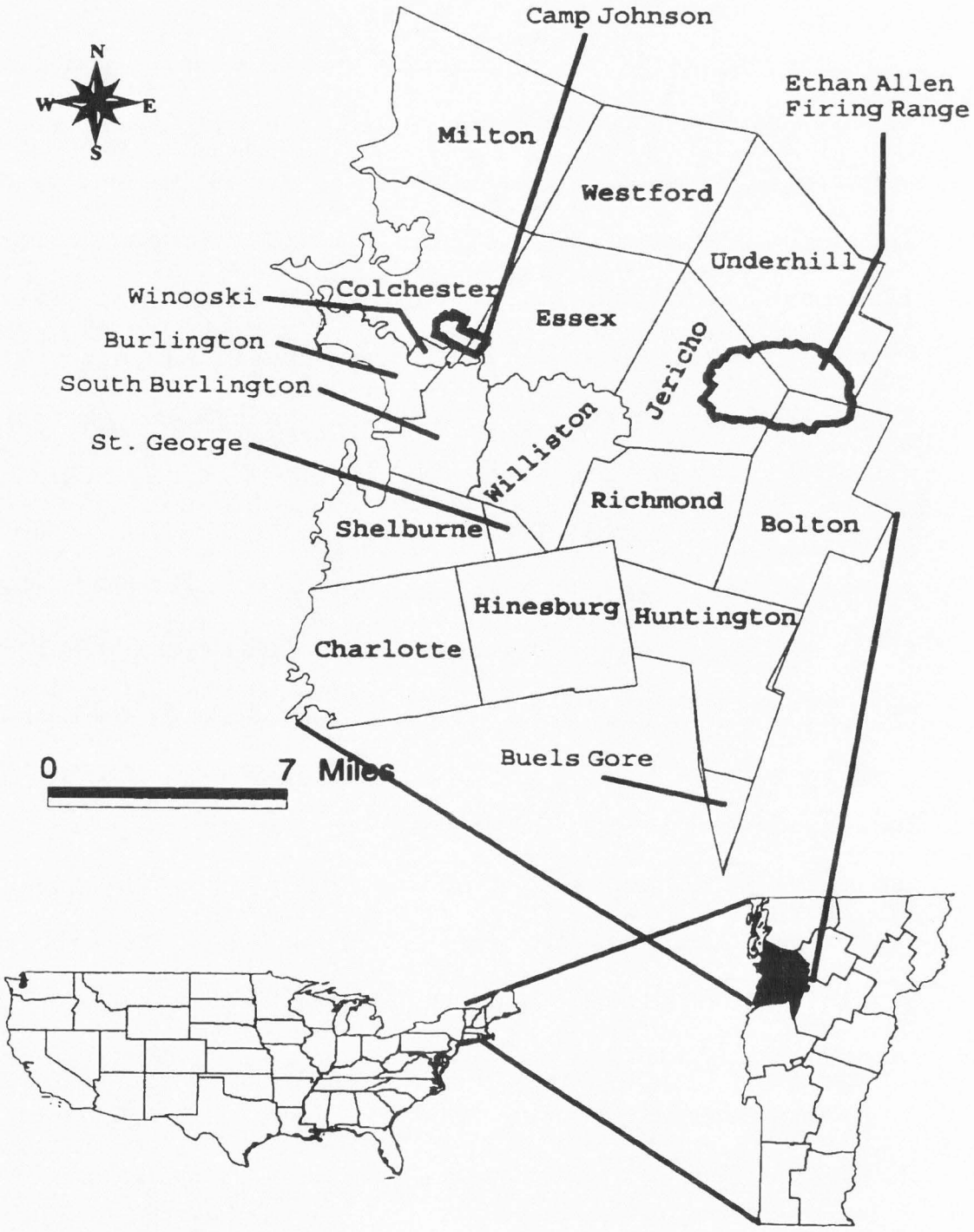

Figure 1. Camp Johnson and the Ethan Allen Firing Range in Chittenden County, Vermont.

The EAFR may not be in immediate danger from development pressure but the training activities may be the first aspect of the property to be altered if suburbia continues to spread. Identifying growth rates and direction, as well as identifying prime areas for future development would be of great value to Camp Johnson and the EAFR. Land around the firing range is rural and somewhat mountainous. However, there is current construction around the perimeter of the range and a large percentage of soils around the firing range is suitable for septic systems.

Only a small portion of the EAFR is currently used for live fire. The majority of the property is conserved so it can be a long-term reusable training resource. Bivouac training and rappelling have little impact on the site and live fire exercises require a safety buffer. If the current live fire training site were no longer viable, the remaining portion of the property could be developed. This can also be said for Camp Johnson. This fact points to another pressure: as suburbia grows, EAFR land values will increase. Given suburban growth and increases in property values coupled with increasing restrictions on training activities, federal or state governments may be forced to consider alternative uses for this installation.

Some of the questions that can be raised from the results of this work are: Will the installation be able to continue current practices with a growing suburban population? Will Camp Johnson and Ethan Allen have to adopt new procedures to remain a viable training site? This database and assessment may be used by the National Guard to help determine how long training activities can continue at these facilities in the near future.

The population of Chittenden County will continue to grow. The rate of this growth and its fluctuations are impossible to predict, though I have included individual town projections (see study area section p. 41). The political landscape and economic conditions will be the major factors in population growth. As the number of second homes and bedroom communities continue to grow, the restrictions on training at the EAFR may also grow. However, as population increases and suburbia spreads, the EAFR may become a valuable "buffer" of open space to surrounding towns. This project can assist the National Guard to better understand its future management options.

The outcome of this assessment may indicate alternative land management at Camp Johnson/Ethan Allen and other National Guard facilities in order to deal with

increases in population pressures. Noise or environmental contamination will most likely be the major factors affecting training activities. The usefulness of these installations may have to be weighed against the cost of leasing the land if reduced training activities become a reality. It is uncertain how far reductions in training activities have to go before significant changes in existing uses are necessary.

The EAFR is the only National Guard training facility in this vicinity. This may be a factor siding with the EAFR. In general, given sufficient space, this type of National Guard training need is more mobile than other activities requiring a more permanent entity like an airport. A similar site, Bog Brook training area (Maine), is 100 miles east but does not have the size or facilities required for live fire practice. Fort Drum (New York) has sufficient space but is approximately 150 miles west. Training at the next closest installation may be the first alternative since available lands of this size and configuration are rare in the northeastern United States.

This study was completed to help answer the question: will growing county population increase pressure, political or regulatory, on National Guard activities at the EAFR

facility in the next twenty years? If the answer is yes, this will probably decrease the value of this facility as a training site. However, the area around the EAFR is so rural that even increased population (expected 82% in Underhill by the year 2010) will have little effect on the type of activities currently allowed at this facility.

Study Limitations

When attempting to predict the future pattern of land use within Chittenden County, some assumptions will be necessary. The accuracy and precision of available data must be assessed. The historical data may have some inaccuracies impossible to confirm or correct. Another large assumption with this type of past-to-future extrapolation is the belief that land use will continue on its present course. Land use attitudes may change, planning and zoning measures may change due to political pressure, large paper companies may sell off land holdings to developers, etc. What I can show is a particular trend, which may be used to illustrate current decision patterns for development within Chittenden County. Population change, technological change, relative affluence/poverty, the political/economic structure, and the beliefs and

attitudes of the community are all factors which cannot consistantly be accounted for.

Historical and Regional Context

In the late 1960s there was a spurt of growth that created the need for Act 250 (Figure 2). Act 250 contains development regulations on lot size, slope, configuration, soils, water proximity, and suitability for public services. Growth with conservation was a large part of Act 250's intent. The permit review process of Act 250 is meant to minimize the impact on environmental concerns and public services from any development. Vermont has had detailed development regulations since Act 250 was established in 1970. Landowners are given incentives to conserve the land and penalties for lack of conservation to preserve the character of the county. Penalties are described in section 6003 of Act 250. The permit process has limited effects on the placement of development and its density (Danials 1989). A major drawback within Act 250 is the case-by-case nature of its regulation. Act 250 does not take into account the regional effects of its decisions. The Vermont Scenic Landscape Study (Courtney 1991) attempted to address this deficiency in Act 250. This study used its definition of scenic landscape and the scenic criteria set forth in the

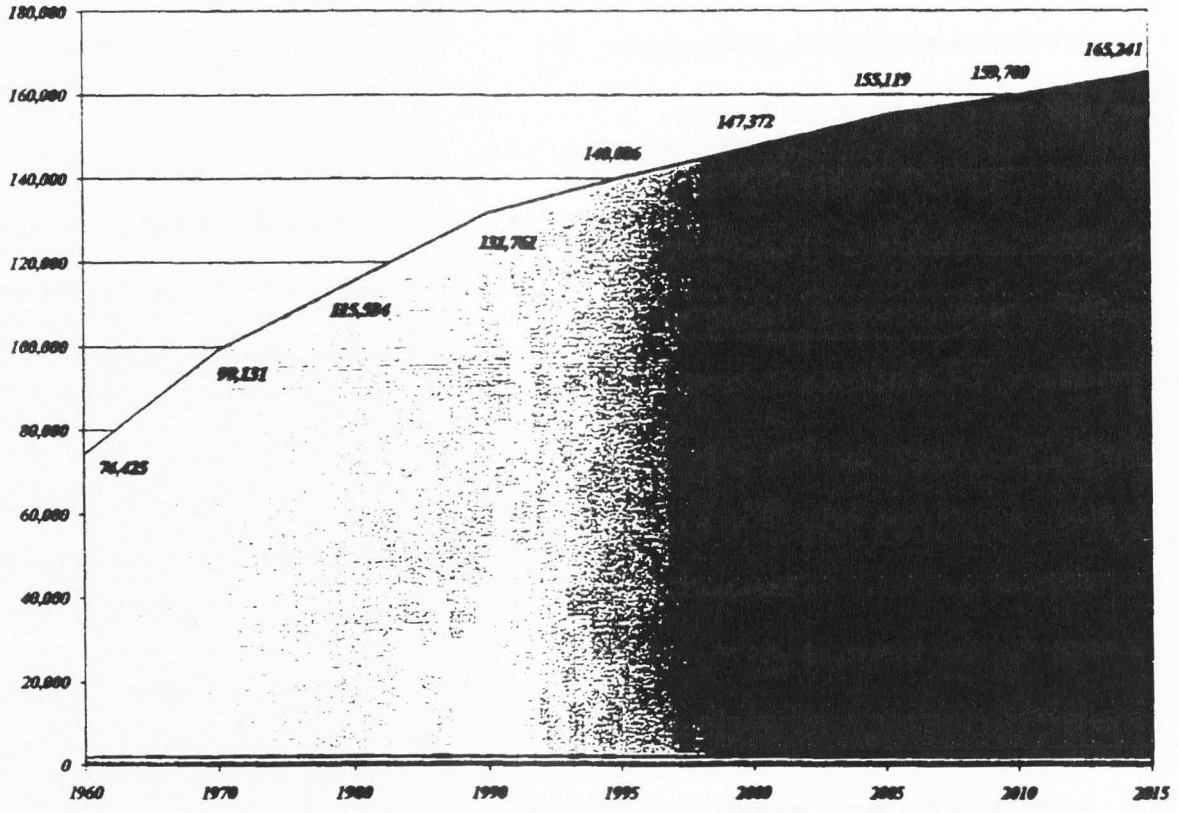

Figure 2. Chittenden County Population Projections.

Source: Vt. Health Care Authority, Center For Rural Studies, 1993; GBIC Greater Burlington Industrial Corp. 1970; GBIC Greater Burlington Industrial Corp. 1983

Growth Management Act of 1988 to outline a strategy for saving Vermont's rural character. Since tourism is still Vermont's second largest industry, the implementation of the Vermont Scenic Landscape Study and the goals of towns such as Richmond could be what extend the current use of the EAFR. However, since 1996 the individual towns within

the county have been creating their own plans for growth giving rise to a multi-center look to the county.

The definition of "sprawl" is "unlimited outward expansion, low-density residential and commercial settlements, leapfrog development, fragmentation of political power over land use among many small localities, dominance of transportation by private auto, no centralized planning or control of land uses, widespread strip commercial development, great fiscal disparities among localities, segregation of types of land uses in different zones, and reliance mainly on trickle-down or filtering process to provide housing to low-income households" (Downs 1998, np.).

In a recent poll of 2,300 Vermonters, the Vermont Forum on Sprawl (Ewing, Humstone, and Farley 1999) found the characteristics listed below to be evidence of sprawl to the majority of respondents (Ewing, Humstone, and Farley 1999):

Commercial development strung out along a highway	88%
Increased roads, paved areas and parking	72%
Single-family homes spread out on former farm fields	72%
Widely spaced development with a scattered appearance	58%
Development that requires an automobile	56%

The Caledonian Record (McClaughry 1998) cited a earlier work that claimed there are three precepts of

public growth management (development). The first is simply, "when money talks, zoning regulations walk." It was suggested in this article there are no zoning regulations, only deals. The second precept indicates the only guarantee growth will go the way the public wants it to is for the public to acquire and own the land. The purchase of shoreline acreage in the Northern Forest Lands by the state of Vermont is an example of this.

The highest priority lands slated for protection (which may or may not involve acquisition) are undeveloped lake or river shores, large tracts of forest land (to maintain continuity of central forested corridor of Green Mountains), and threatened natural communities (examples: lowland boreal forest, limy conifer swamps, old growth woodlands, high diversity limy hardwood forests).

There are two reasons why any tract of land is given high priority for protection. Either the tract is high value land, which is immediately threatened or the tract of land is available now and may not be in the future. In many cases the Vermont Agency of Natural Resources is the only organization in the state interested in or capable of making these acquisitions (Table 1). There may be other

Table 1. Approximate State Conservation Land Acquisition Rates by Decade

Decade	Acres per Year
1910	1449
1920	1710
1930	2339
1940	1078
1950	6781
1960	4769
1970	4678
1980	1859

Source: Jenkins, Benjamin and Thompson 1991, 20

ways to protect land without outright purchase. Cooperation between organizations can develop ways to ensure public access and protection. (The EAFR is considered public conservation lands and lands held by the Vermont Agency of Natural Resources bound it on the east.)

The Regional Plan also includes policies that are intended to provide for the maintenance or improvement of the environment. Policy 13 states, "Growth in the region should be managed to maintain or improve the quality of air, water, land resources and wildlife." One of the goals of this policy is the accounting of the natural resources consumed by human activities every two years. Policy 16 is an identification of recreation areas, aquifers, historic

sites, scenic areas, and rare irreplaceable areas. These two policies (along with others) may bode well for the EAFR. As mentioned previously, if the EAFR is kept reasonably intact, it could serve as a "buffer" to more development and, therefore, be of value to the surrounding communities.

The third precept of public growth management is the fact that the government still has control over the building, maintenance, and expansion of public utilities. Therefore, the government can guide to some extent where expansion will feasibly take place. The town of Richmond gives an example of this when it decided to delay expansion of the sewer lines up to exit 11 on route 89 until an environmental assessment could be conducted. The town of Richmond also feared losing their rural character if more sewer lines were put in place. The expansion of the sewer lines would have made residential expansion inevitable (Jenkins, Benjamin, and Thompson 1991).

On the other end of the scale (and county) is Colchester (approx. pop. 17,000). A proposal for a bond measure to fund increasing the sanitary sewer system along the lakefront was submitted in June 1999. This was done

because of environmental concerns due to the increasing population along the waterfront.

There are many other aspects of suburban sprawl, one of which is increases in vehicle use. As the Vermont Forum poll results indicated, a majority of respondents (56%) believed development that required the use of the automobile was a major indicator of sprawl. The spread of population as well as the increase in population reveals itself in two ways: the increase in miles traveled per commute and the number of vehicles per household. While Vermont's population has increased by 32% since 1970, vehicle traffic has more than doubled over the same period. Between 1981 and 1996 annual miles driven by each Vermonter has increased by an average of 43% (Ewing, Humstone, and Farley 1999). There was an increase in the number of vehicles per household between 1980 and 1990 (Table 2). This can be attributed to an increase in population (and, therefore, an increase in jobs per household) or an increase in affluence.

In 1995 public transit accounted for less than 1% of all travel in Chittenden County. There is some question as to whether sprawl encourages personal transportation or if the type of transportation produce sprawl. The reliance on

Table 2. Vehicles per Household 1980 - 1990

# of Vehicles	1980	1990
0	10.7%	8.5%
1	**41.9%**	32.4%
2	34.1%	**43.4%**
3	13.3%	15.7%

Source: Chittenden County Regional Planning Organizations 1995

private automobiles for transportation seems to stem from public policies, which sometimes attempt to solve traffic problems by building new roads (Moe 1999).

Attempting to focus on public transportation and reduce reliance on private transportation is a highlight of the Chittenden County Regional Plan (CCRP). A growth center is an area within a community, which provides a concentration of housing, employment opportunities, government facilities, and commercial services. According to the Regional Plan, growth centers should: include clearly identified boundaries, allow mixed uses, allow a higher density of uses than the surrounding area, provide basic infrastructure to support development, and take into

account the historic and present development concentrations (Chittenden County Regional Planning Commission [CCRPC] 1996).

Growth centers are broken down into three levels: regional, subregional, and local. The town of Burlington is an example of a regional growth center. It provides services for the entire region. Subregional growth centers generally serve adjoining communities. The five-corner center in Essex Junction is an example of a sub-regional growth center. The local growth center is a town center, like Underhill Center, which services the municipality. One of the goals of the Regional Plan is to distribute growth in the following ratio: 20% in the regional growth center, 60% in the subregional growth center, and 20% in the local growth centers. This is because resource use is also a focus of the 1996 Regional Plan.

The implementation of the growth center scenario is hoped to have a positive effect on slowing the increase in energy use as the population rises. Conservation on the consumer side of energy use is one way the Region can slow the rate of increased energy use. It is believed the rise of the growth centers can encourage an increase in public transit use, which can mean fewer miles in the private

auto. It would also condense the essential services needed by concentrating people, jobs, and services. Whether any of this can be truly implemented remains to be seen. Politics and funding may be the reigns that hold back some of the recommendations of the Regional Plan.

If the implementation of growth centers is to become a reality, transportation systems need to be as efficient as possible. The transportation system for Chittenden County includes the finances to maintain and operate the roads, railways, airport, and public transit. Since the financial resources are finite, alternative modes of transportation between and within these growth centers are recommended by the 1996 Regional Plan.

There are many factors in the pattern of growth and the transportation needs of that growth. The circumferential highway project is an example of politics and funding complicating the implementation of a Regional Plan. In 1965, the Vermont Department of Highways (1966) proposed a Burlington beltway for approximately 26 million dollars. Sections of the highway were completed in the following decade. In a Vermont Agency of Transportation study (1979), the highway was expected to divert 220,000 vehicle miles from existing regional highways by 1998. The

circumferential highway was recommended in this study because it would save the $836,000 (1977 prices) needed to make improvements in existing roads, although this would not totally solve the traffic problem by 1998.

In 1998, the extensions of the highway are still being debated. Some towns fear the miles of new road would mean more traffic and pollution to their area. Businesses in the urban center believe it would take away business by allowing easy detour of the downtown area. The circumferencial highway has yet to be completed.

Utility management is another way suburban sprawl can be managed. The towns have control over the placement of services. One of these services is the sewer system. Private residences can, and often do use a septic system on their property but any large development will usually choose to hook up to the existing sewer system. In a survey conducted by the CCRPC, inadequate sewer and water services were said to be a "somewhat" to "very serious" problem countywide.

In the Regional Plan there is a recommendation for sewer line extensions to accommodate the regional, sub-regional, and local growth centers. If it is deemed necessary to extend sewer and water lines between growth

centers to handle the needed capacity, a "no new, or limited tap-ins" policy is suggested.

Housing is another planning concern and according to the 1996 Regional Plan, affordable housing is still in short supply in Chittenden County. This was made clear in a citing of the 1990 CCRPC Housing Report, "In spite of the increase in the supply of housing for low and moderate income households, the number has not kept pace with the growth in the number of such households" (CCRPC 1996, 45). Affordable housing is defined as costing no more than 30% of the gross income of the household. The 30% costs involve rent and utilities for renters and principal, interest, taxes, and insurance for homeowners. In 1995, Richmond, Underhill, and Jericho rated 25th, 26th, and 27th, respectively, in new home prices out of 100 towns ranked in the state. They are very affordable by East Coast standards ($126,477 to $125,605). The mixed use recommended in the growth center scenario would assist in creating affordable housing. If quality-of-life issues are not addressed in a growth center plan, it may be difficult to draw people away from the dream house in the country, thus promoting sprawl.

The dream of building one's own place in the country is not the only reason for the expansion of private ownership around the EAFR. The farther from Lake Champlain, the lower the land prices. If a person has employment in the Burlington area it may be more cost effective to commute. Open land in the Burlington area is also at a greater premium than it is fifteen miles east around the EAFR. Whether one is building a home to commute to Burlington or for use as a second home near the ski resorts, the land around the EAFR would probably be more attractive.

The Regional Plan includes thresholds for developments of various types. The threshold for residential development would probably be the most immediate concern for the EAFR. Census totals for households from 1990 were used for the thresholds. The number of proposed units would exceed the threshold if it were 1% of the municipality's total housing units in a municipality of > 10,000 (Burlington). The threshold is 2% for municipalities of 1,800 to 10,000 housing units (Colchester, Winooski, Essex, Essex Junction) and 3% for < 1,800 units (Bolton, Jericho, Richmond, and Underhill).

If any of these thresholds were exceeded, the Regional Plan would be used in state regulatory proceedings.

The 1996 Regional Plan included projections up to the year 2000. It included population projections and more importantly, broke the county down into three sections: the urban center, the inner ring, and the outer ring (Figure 3). The Urban center consisted of Burlington and Winooski. The inner ring was comprised of South Burlington, Colchester, Essex Center, Essex Junction, Milton, St. George, Shelbourne, and Williston. The outer ring included the rest of the county, Bolton, Hinesburg, Charlotte, Huntinton, Jericho, Richmond, Underhill, and Westford. Camp Johnson falls in the inner ring and the outer ring contains the EAFR.

The population data showed the greatest increase occurring within the inner ring and the outer ring coming in second. Between 1970 and 1980 the population growth was 75.61% in the inner ring and 36.05% in the outer ring. The population of the urban center actually decreased 11.66% during the same time period. Between 1980 and 1984 the urban center grew 5.1% but was again outpaced by the inner ring (+68.05%) and the outer ring (+26.84%) (CCRPC 1986).

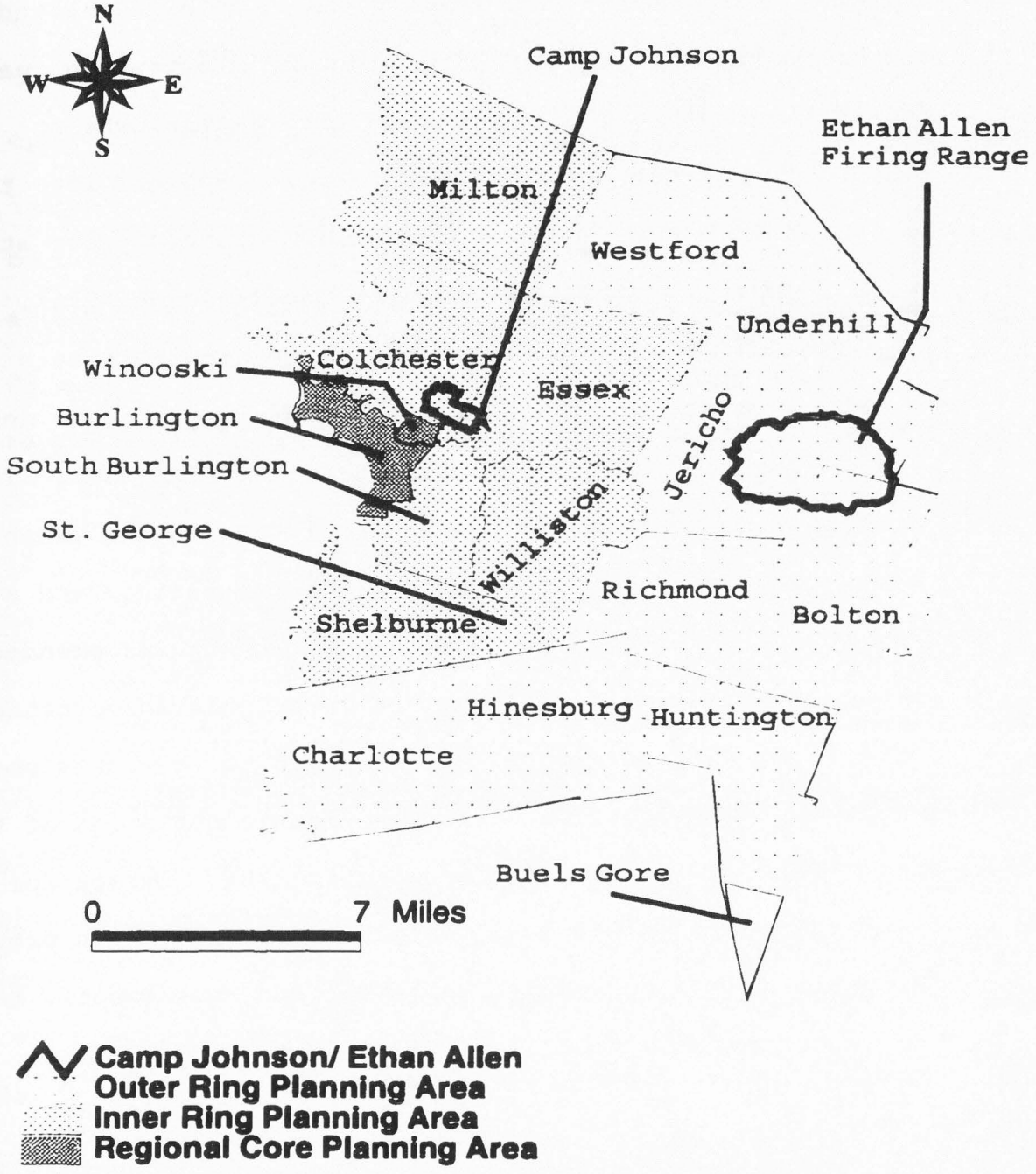

Figure 3. Planning Areas of Chittenden County, Vermont. The County Has Been Classified into Three Sections. In an Attempt to Control Growth, Different Development Thresholds Apply to Each Planning Area.

An indication of the type of growth within Chittenden County is the demographic group with the greatest increase. The 35 - 54 year old age group was the fastest growing between 1980 and 1990 at 45.8%. Between 1990 and 1994 they continued to be the fastest growing demographic group at 20.2% (Vermont. Dept. of Employment and Training 1996).

The 20/60/20 ratio of growth in the growth centers concept is also recommended for the urban center, the inner ring, and the outer ring planning areas (CCRPC 1996). This ratio represents a 20% growth in population in the urban center, a 60% population growth in the inner ring, and a 20% growth in the outer ring. This ratio was recommended to facilitate the efficient use of existing transportation, and utility infrastructure. It was also thought this would be the best distribution to protect scenic qualities of the area. This was planned and adopted in 1986. Except for a few large entities moving into the inner ring in the past few years (e.g., Toys-R-Us, Wal-Mart, and Home Depot), this growth pattern has come to pass (CCRPC 1996).

In 1972 there were three alternatives of growth spelled out in the proposed open space plan (Sargent 1972). The first was unlimited quick economic and population expansion. The second alternative was a controlled

economic expansion to provide jobs for the county's youth as they approach working age. The final alternative was a stabilization of the county population. The author of the open space plan believed the first alternative came with too much baggage. Environmental damage and a cost-to-benefit ratio would be questionable at best. The third alternative was difficult to achieve in a reasonable span of time in a democratic society. Attitudes and fertility rates change slowly. The second alternative seemed the obvious choice. Although, over the years since this report (Sargent 1972), implementation of the second alternative has had limited success due to the cyclical nature of the local economy (Sargent 1972).

One of the main catalysts of suburban sprawl in Chittenden County is the ten-acre loophole. Act 250 states lots over ten acres are exempt from review and approval of the same environmental standards and regulations of smaller lots. The study stated, "over the decade in which these regulatory mechanisms have been implemented, the rate of formation of ten acre lots has increased significantly, more so than for the five to ten acre lots." Development by conventional zoning regulations usually encourages sprawl. Instead of preserving open spaces and rural

character, the ten-acre loophole often covers every available acre with suburbia. For example, between 1937 and 1990, Upper Dublin Township in Montgomery County, Pennsylvania, has gone from rural farmland to completely carpeted with subdivisions (Arendt 1994). Even two-acre zoning has completely filled in Darien, Connecticut. Similar regulations in New York and Maine also encourage larger lot subdivisions (Munsun 1982).

According to a 1978 study entitled "Lands in Transition: Lake Champlain Shoreland Changes: 1960 - 1990," "The 'ten-acre loophole' in Vermont's Act 250 should be closed in order to minimize wasteful large lot subdivisions, which contribute to scattered growth and the decline of resource management lands" (Humstone 1978, ii). The connectors (circumferential highway.) should be completed to "minimize opportunities for strip development in fringe areas..." (Humstone 1978, ii). "Both the Plattsburgh and Burlington areas will expand their economic bases in the future due to growth of existing firms, introduction of new national firms to the area, and openings of branch operations of Canadian businesses .. ..Industrial parks will be developed in Clinton, Chittenden, and Franklin Counties to accommodate industrial

growth" (Humstone 1978, iv). These predictions have come to pass. Examples of these predictions are Home Depot in Williston and Husky Manufacturing in Milton. Commercial development along interstate interchanges was expected to continue although "major regional shopping malls in fringe areas may not be a part of the commercial development pattern in Vermont…" (Humstone 1978, v).

Other projections in this report included the following: "Projected urbanization patterns in Chittenden County will cause issues of growth control, housing opportunities, preservation of open space, and adequate provision of public utilities, and services to be raised.… Ten acre parcels will be a prevalent rural density in Vermont due to their exemption from Act 250 review" (Humstone, 1978, vi). It was also predicted in this report shoreline development in New York and Vermont will increase by 28.9% by 1990.

The economic and political situation in Canada will also have an effect on Chittenden county growth and can not be predicted with any accuracy. Efforts were made as early as the 1970s to change development patterns in and around Burlington. These include clustered housing and shops, pedestrian malls, and adaptation of historic buildings for

new uses. However, to this day the central city still loses some of its economic vitality to the fringe shopping centers. Proposed zoning changes in the 1970s indicate a parcel by parcel pattern in response to development pressure. This has come to pass in many areas.

Current zoning regulations seem to be the driving force of suburban sprawl and the farmland is the main land use type taken for residential use. While population grew by 9.8% between 1982 and 1992, developed land increased by 25.3%. Forty percent of this development had been on cropland or pasture (Ewing, Humstone, and Farley 1999).

With growth and the increased cost of land, the total amount of tax also increases. There are four ways farmers have dealt with increasing tax rates. Farmers can buy more land adjacent to their own to increase income and make the farm viable under the new taxes, or the farmer could sell everything to a larger farm. If farmers wanted to keep farming on a small scale, they could sell the land parcel by parcel every year to keep up with the increase in taxes. The fourth alternative is to sell the entire farm to a developer for subdivision. The developer would have to deal with slope, shallow soils, wet or unstable soils or zoning regulations in order to make the farmland feasible

for subdivision (Vermont Institute of Natural Science and the Ottauquechee Regional Planning Commission 1974).

Along with transportation policies, growth centers, and farmland loss there are a few other policies within Act 250 that could be of concern for the EAFR.

"Development" in Act 250 is defined as "construction of improvements on a tract or tracts of land, owned or controlled by a person, involving more than ten acres of land within a radius of five miles of any point on any involved land, for commercial or industrial purposes" (Vermont 1997, 4). This definition is more of a concern for Camp Johnson in Colchester than for the EAFR. This is because the land around the EAFR is generally zoned for residential land uses and not commercial or industrial.

There is a 2,500-foot dividing line in the development stipulations. "Development shall not include construction for farming, logging or forestry purposes below the elevation of 2,500 feet" (Vermont 1997, 5). Most of the land around the EAFR is below 2,500 feet. The activities of farming, logging or forestry would be more accepting of noise than residential land uses.

"Development shall also mean the construction of improvements for commercial, industrial or residential use

above the elevation of 2,500 feet" (Vermont 1997, 5). This definition would probably not impact the EAFR. Again, according to the Digital Elevation Models (DEMs) for the county, there are not that many areas above 2,500 feet.

Act 250 stipulates an adoption of a capability and development plan, which not only promotes "the health, safety, order, convenience, prosperity and welfare of the inhabitants" but also "reduces the waste of financial and human resources which results from either excessive congestion or excessive scattering of population" (Vermont 1997, 22). If this stipulation were adhered to it would promote the growth center scenario and probably help the EAFR by keeping scattered development at bay. However, current development patterns indicate this is not the case.

Act 250 also states, "Strip development along highways and scattered residential development not related to community centers cause increase cost of government, congestion of highways, the loss of prime agricultural lands, over taxing of town roads and services and economic or social decline in the traditional community center" (Vermont 1997, 23). A good argument can be made for most or all of this happening in Chittenden County.

Summary

Chittenden County will continue to grow but the rate of this growth and its direction depend on many factors. These factors will affect the prediction of development this study produces. Qualitative and quantitative changes in politics and economics will probably have the most influence on growth.

The rate and direction of growth in Chittenden County may soon be a major agent of change for Camp Johnson and the Ethan Allen Firing Range. This county has recently shown many of the standard symptoms of unrestrained growth. It is uncertain whether the political will or economic necessity needed to change this pattern of growth will occur before significant changes are needed at Camp Johnson and the Ethan Allen Firing Range.

LITERATURE REVIEW

Based on the literature review, suburban sprawl is a relatively new area of study. The idea of suburbia itself is primarily a western phenomenon. The rise of the automobile gave our idea of suburbia its start in the 1920s. After World War II several other factors combined to accelerate the spread of suburbia. The GI Bill, the Federal Housing Administration (FHA), affordable building techniques, tax breaks for homeowners, and funding for national highways all contributed to the growth of the suburbs in America (Fargis, Miller, and Faux 1997).

Although it is difficult to see when it started, in the 1990s, suburban sprawl is as clear as hindsight. This study is concerned with two of the four interpretations of land use data as described by Riebsame and Meyer (1994). The study will show *descriptions* (what uses are being made of the land) and *predictions* (what is expected to be done with the land). What *should be done* with the land and *why the land is used* the way it is cannot be covered in this thesis. I believe the latter two interpretations would require separate studies in geomorphology, economics, and sociology, which are beyond the scope of this study.

Guiding Factors of Land Use Change

Riebsame and Meyer (1994) suggest land use usually moves towards the most economically efficient use unless constrained by political jurisdiction, environmental laws, etc. Land use models should include (or in some way be linked to) ecological and social models. According to Riebsame, population and consumption are the major "social driving forces" behind land transformation.

The socioeconomic and ecological trends in Chittenden County, Vermont are too complex to include in this study; however, Dr. David Capen from the University of Vermont is currently in the process of compiling socioeconomic data on a town-by-town basis for the state of Vermont. Dr. Capen's work will be linked to land use trends for the last three decades (Personal correspondence).

In Chittenden County, as in many other counties, land-use decisions are controlled at the local level (Erickson 1995). As in a Michigan study by Erickson (1995), political boundaries will be used in this study because the towns and villages control planning and policy implementation. However, land use change can be caused by many factors that spread beyond boundaries, which is one

reason Erickson recommends a more regional approach to land use planning authority.

A powerful use of geographic information systems (GIS) is to show changing areas of land use/cover over space and time providing some cohesion and context to local land use changes. This geographic view of the landscape can also show how changes in land use for one location can affect land use in another. Rowntree (1984) used land use maps to predict where substantial forest canopy could be established in four eastern cities. Ten different land cover classes were weighted depending on the areal extent. Polygons of various land use classifications were planimetered by hand over aerial photos. Depending on polygon size, land use category, and physical landscape factors, Rowntree was able to estimate the amount of forest canopy possible in his study area. In my study, physical factors were used in a similar fashion to predict development in Chittenden County. This type of spatial analysis could be used in other areas of the country to show possible direction of urban land use.

Gilmour (1996, 20) noted, "Development is irreversible, preservation is not .... It would behoove the analysts and decision makers to err on the side of

caution." In Chittenden County, as in other areas, values of the county and individual town planners cannot be adequately evaluated without substantial work. However, as one might expect, there seem to be conflicting interests at work within the Chittenden County. According to some officials and residents, a rural character is desired (see Study Area section). Yet according to a local construction firm, where there is funding and proper design, development can occur anywhere without much resistance.

To illustrate the conservation of rural character side of this "conflict," the town administrator for Richmond, Vermont, was recently interviewed about the issue of sprawl and the town's planning strategy. The 1997 Town Plan of Richmond, Vermont, mentions thirteen objectives, listed below, to address sprawl and the effects it will have on the town.

- Conserve the town's rural character.
- Respect the character of the neighborhood when considering conversions in village neighborhoods.
- Development is planned so as not to impact natural resources negatively.
- The Town may support national and state policies to encourage preservation of natural resources.
- Establish maximum traffic flow capacities for all town roads.
- The Town should actively participate at the regional level on transportation issues, including mass transit, including coordination with neighboring towns.

- The Town may determine a desired growth rate in the context of a regional growth rate and in accord with the ability of the Town to meet the demands of growth.
- Facility, utility and service allocation should be consistent with planning objectives.
- Extension of facilities, utilities and services to areas designated for agriculture should be discouraged.
- Specific high density growth areas should be identified in the context of land use policies of the Town and currently available facilities, utilities and services.
- Promote development patterns which concentrate growth in central areas and locate residential growth near work and shopping areas, thereby reducing automobile travel.
- The Town will encourage the continued availability of agricultural land by supporting and encouraging farming as a viable economic enterprise.
- The Town will encourage the preservation of its overall rural character by designating a high density area in which higher densities are permitted. (Vermont Forum on Sprawl 1999, np)

The town of Richmond (southwest of the EAFR) has implemented goals that will help achieve these objectives. These goals are attain development rights on local farms to protect farm land adjacent to high growth areas, and delay water and sewer extensions up to exit 11 on Route 89 to study the effects of a growth spurt in this area.

Types of Suburban Sprawl

Suburban sprawl can take many forms. A recent study titled "Alternative Futures for the Region of Camp Pendleton, California" (Steinitz 1997) listed five different types of suburban spread: 1) uncontrolled spread, 2) spread now and conserve later, 3) private conservation,

4) multi-centers, or 5) the "new city" approach, which entails concentrated growth within a planned area. Chittenden County has used a combination of numbers two, three, and four. Towns such as Milton and Williston have shown growth spurts along road corridors in the last five years. Essex Junction is an example of the multi-center approach, where the center of town has grown around its single major intersection, a surrounding residential section and a space of rural land before the next town. Private conservation has started in some towns such as Underhill with easements to protect open space.

Land use changes on a watershed or county scale usually take time to show a trend. Erickson's Michigan study (1995) suggests twenty years is the average time span to use in this type of land use trend analysis. My study of Chittenden County covers approximately forty-two years (1973 - 2015) reflecting the time span of the historical data available, the growth plans for the towns within Chittenden County, and the population projections. The main focus of Erickson's study was to test the hypothesis: as urbanized areas increase, agricultural and forested areas will decrease. Erickson found that forestland increased while farmland decreased even though there was an

increase in urban use. The main focus of my study is to show where development will likely take place using particular land use types and capabilities as catalysts.

There are other growth models used to show suburban spread. For example, Clarke, Gaydos, and Hoppen (1996) developed an urban growth model based on "cellular automata." It uses parameters of slope, roads, existing urban centers, and random nearest neighbor cells to predict where urban centers will appear. The model concerns itself with four types of growth: spontaneous, diffusive, organic, and road-influenced. *Spontaneous growth* is indicated if a random cell meets slope suitability or has at least one urban "neighbor" cell. *Diffusive growth* will urbanize a cell if it meets slope criteria even if it is not near an urbanized cell. *Organic growth* is the expansion of established urban centers. *Road influenced growth* is represented by the "attraction" of an urban center expansion towards the established transportation network. Used first on data from the San Francisco Bay area, it was used to show a historical pattern of growth and then to show probable growth through the year 2100.[1]

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[1] This model requires specific data and software to run and can be downloaded from the Internet (http://geo.arc.nasa.gov/usgs/clarke/ftp.html)

Pond and Yeates (1993) worked on rural-to-urban conversion in Canada that helped them forecast and identify prime areas for future growth. Pond and Yeates identified direct and indirect impacts on the rural landscape. The direct impacts were easy to see. This happens when rural land, either open or actively farmed, is taken over by development which expands from an existing urban center. The rural/urban land conversion study by Pond and Yeates first used a simple formula to calculate the amount of land converted to urban use.

$$LCA_{t1-t2} = DLA_{t2} - DLA_{t1} / t2 - t1.$$

- LCA_{t1-t2} is the land converted in area between time (year) 1 and time 2.
- DLA is the area of land allocated to direct urban uses.

This can be done for Chittenden County by comparison of land use maps over time. Pond and Yeates (1993) also mentioned a land absorption coefficient (LAC). The LAC is a simple calculation of land converted to urban use over the change in population for the same time period.

Indirect urban impacts occur when rural land is usurped for uses that support urban life. These can be in the form of waste disposal, recreation facilities,

communications (radio towers, etc.), industrial parks, car pool lots, energy facilities (transmission lines, power station, etc.), and the isolated factory (Pond and Yeates 1993). I have concentrated on the more direct aspects of land use change and those areas that are planned for expansion because of easy access or soil suitability for septic systems.

Pond and Yeates (1993) also pointed to a characteristic of land that is usually a good indicator of land in transition. Parcels between one and eleven acres, owned by a corporation (individual or group) that also own other parcels, most of which are out of active use, are prime candidates for development. Farmland owned by absentee owners is a prime example.

Transition to shorter term agricultural use or idleness of farmland is another indicator of development pressure. If farmers perceive urban pressure, they will switch to a type of farming that demands a smaller capital investment and shorter turn around time. They will not invest in a type of farming, like dairy, that may require twenty years to show a return on investment. In the Northeast United States, as much as one acre of farmland is

idled for every acre converted to urban use (Berry and Plaut 1978).

Pond and Yeates (1993) mentioned five stages of urban development: 1) agricultural, 2) early urban influence, 3) small town growth and exurbanization, 4) suburbanization, and 5) urbanization. Towns such as Milton, in northern Chittenden County, seem to be entering stage 3 during the 1990s. Urban/suburban land uses, such as McDonalds' and subdivisions, are starting to encroach upon farming and pastures. Smaller towns in Chittenden County like Underhill and Richmond are already planning for expansion along existing road corridors.

At the moment, one of the largest concerns for the EAFR and the surrounding area is noise regulation and abatement. Noise was the main argument behind the opposition of a National Guard training facility in Minnesota and the ban of missile testing in Utah (Kelson and Lilieholm 1999). Both cases involved proximity to wilderness areas but similar opposition could come from encroaching suburbia. The growing suburban population of Chittenden County may consider the EAFR open space but resent the limited access to that open space. The open space buffer the EAFR could provide might not be the type

of buffer the surrounding towns desire. However, according to Danials (1989, 157), "state plans must consider the national interest in siting developments of greater than local impacts, such as electricity generating stations, national defense installations, harbors and ports…". However, zoning changes and other regulations could be made on a political basis. It is not known whether the towns surrounding the Ethan Allen Firing Range will create buffers to keep suburban encroachment out or will suburban encroachment demand accessible open space.

Summary

The use of GIS in the study of suburban sprawl has been limited. When the suburban sprawl concept came into focus, GIS technology was not available. Only recently has the technology in any form been used to study suburban sprawl. There appears to be a great potential for this technology as a tool in the study of suburban sprawl. However, GIS technology is limited because of the human factors involved with suburban sprawl that cannot easily be integrated into the analysis.

STUDY AREA

Ethan Allen Firing Range and Camp Johnson

The Ethan Allen Firing Range consists of 11,217 acres approximately 15 miles east of Burlington, Vermont. There is a 2,365-acre impact area in the center of the facility. There is a 775-acre government owned contractor operated (GOCO) test facility within the firing range boundary. The land for the Ethan Allen Firing Range is federally owned and licensed to the Vermont National Guard. The facilities consist of barracks (for 120), a 600-person dining facility, field training sites, rifle and grenade ranges, and three tactical landing zones (helicopters, etc.).

Camp Johnson is located in Colchester, Vermont, three miles from Burlington. This part of the National Guard installation consists of 729 acres. Federal land, licensed to the Vermont National Guard, consists of 669 acres while the other 60 acres is state owned. The terrain is relatively flat with 50% open and 50% wooded. Part of Camp Johnson contains the pitch pine sand flats, an endangered habitat under study by the University of Vermont. Non-live fire exercises can be accommodated at Camp Johnson. There are buildings for 30 officers and 260 enlisted personnel.

The remainder of Camp Johnson contains mess facilities, vehicle storage, administrative buildings, barracks, ammunition storage, and a dispensary. Camp Johnson runs on municipal water and sewage systems and is bordered by residential and commercial areas.

The "Future Land Uses" (Figure 4) section of the 1996 Regional Plan includes this statement: "The Colchester sub-regional growth center site includes Camp Johnson. While there are no immediate plans for terminating the present use of this facility, its key location justifies planning for future uses of this site" (CCRPC 1996, 28). The 1996 Regional Plan is intended as a policy guide for the region over the next twenty years. Revisions, amendments, and updates are considered every five years or annually if needed. As of June 1999, the town of Colchester submitted a proposal to "downzone" Camp Johnson from its GD-1 (General Development) status. It is hoped this change will make it easier to keep the open spaces of Camp Johnson intact.

Chittenden County

Chittenden County is in the heart of the state of Vermont (Figure 1) and is the population, employment, and

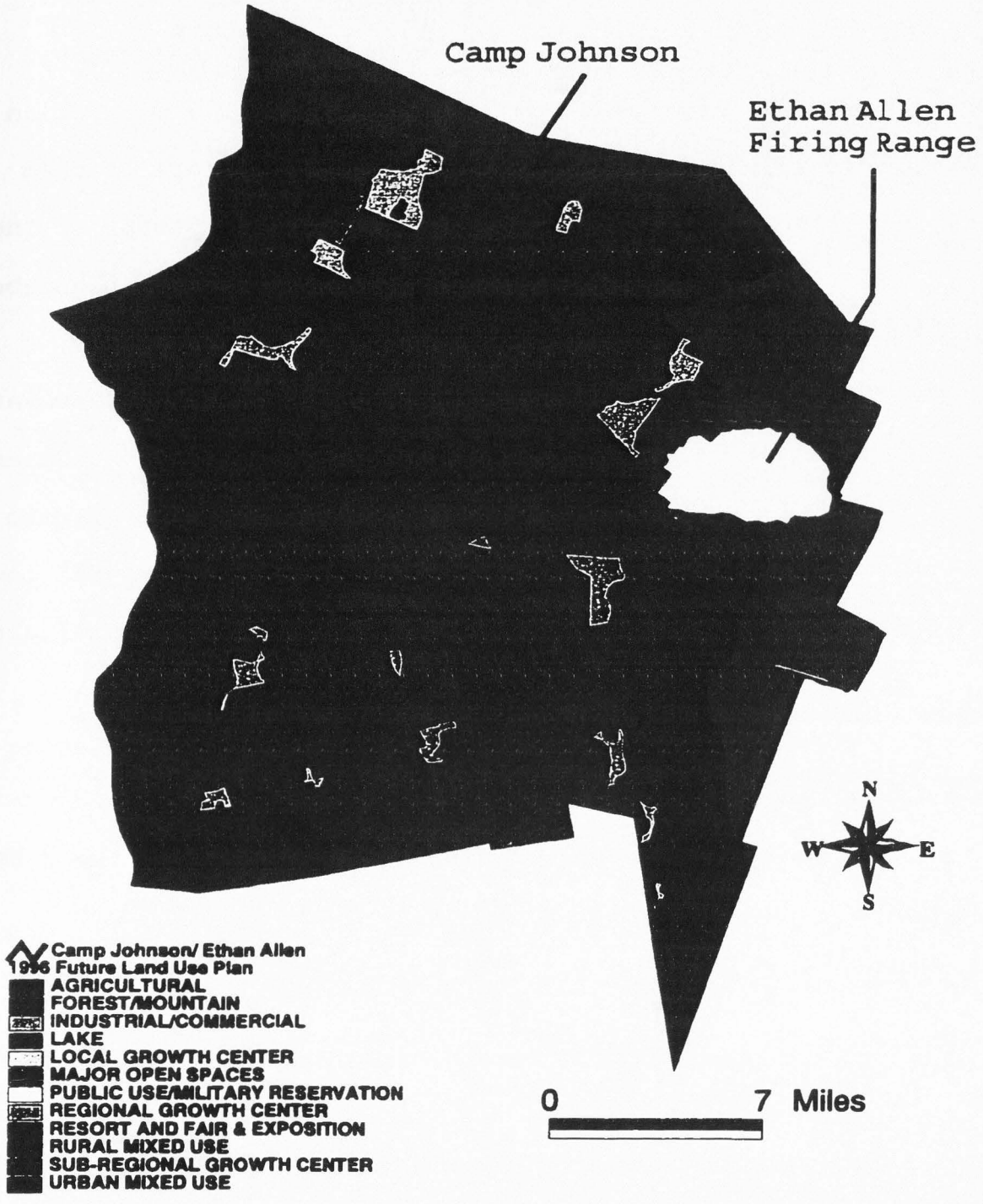

Figure 4. The 1996 Future Land Use Plan for Chittenden County, Vermont

cultural center. The population density of Chittenden County is nearly three times that of any other county. There are only seven towns in Vermont with a population above 10,000 and Chittenden County claims four of them (Burlington, S. Burlington, Essex, and Colchester). The population growth rate of Chittenden County has been above the state average from 1980 to 1994.

According to the Chittenden County Profile (Vermont Department of Employment and Training 1996, 3), "Chittenden County is expected to continue growing at a faster rate than the state over the next decade. The more rural towns such as Bolton, Hinesburg, Huntington, and Underhill are expected to have the highest rate of growth while Burlington and Winooski are expected to lose population by the year 2010" (Table 1).

The towns listed in bold on Table 3 border the EAFR.

Table 3. Chittenden County Population Projections

	Base Population 1990 (1)	Projection 2010 (2)	Change to 2010	%Change to 2010
Vermont	562,758	633,800	71,042	12.60%
Chittenden Count	131,761	159,118	27,357	20.80%
Bolton	971	1,775	804	**82.80%**
Burlington City	39,127	35,663	-3,464	-8.90%
Charlotte	3,148	4,528	1,380	43.80%
Colchester	14,731	19,870	5,139	34.90%
Essex	16,498	20,533	4,035	24.50%
Hinesburg	3,780	6,817	3,037	80.30%
Huntington	1,609	2,886	1,277	79.40%
Jericho	4,302	6,286	1,984	**46.10%**
Milton	8,404	12,623	4,219	50.20%
Richmond	3,729	5,035	1,306	35%
Shelburne	5,871	7,650	1,779	30.30%
So.Burlington Ci	12,809	15,139	2,330	18.20%
St. George	705	809	104	14.80%
Underhill	2,799	5,030	2,231	**79.70%**
Westford	1,740	2,514	774	44.50%
Williston	4,887	6,719	1,832	37.50%
Winooski City	6,649	5,241	-1,408	-21.20%

Sources: (1) U.S. Department of Commerce, Bureau of the Census
(2) Vermont Health Care Authority, 1993

Table compiled from: "Vermont County Series: An Economic - Demographic Profile of Northwestern Vermont, June 1996", Vermont Dept. of Employment and Training (1996).

METHODOLOGY

Data Collection

I used digital data supplied by the Vermont Center for Geographic Information (VCGI), the Regional County Planning Commission, the University of Vermont Spatial Analysis Lab, U. S. Geological Survey, private consulting firms, and the National Guard Installation (Camp Johnson). Additional data layers were created on site, either through the use of Trimble GPS equipment or on-screen digitizing using digital orthophoto quads and ArcView software.

I created a "picture" of the present land use/land cover conditions within the confines of Chittenden County, Vermont. Population data and projections from 1950 through 1990 collected from various agencies. Zoning maps of Jericho, Richmond, Bolton, Underhill, and Colchester were also included. Digital maps of Chittenden County land use for 1973 and 1995 were collected from the Chittenden County Regional Planning Commission.

Paper data were collected from each installation, Regional County Planning Commission, the Act 250 office, and the regional law library in Montpelier, Vermont. Orthophoto quads and digital raster graphics from the U.S. Geological Survey were incorporated into the database.

County Regulations from Act 250 has been included as well as the County's five-year plan for development within the county. Environmental, infrastructure, and military training data layers are also included. A complete list of data layers appears in the Appendix.

Data Processing

All digital data had to be compatible in their format and metadata in order to be compared. Conversion of most of the data collected entailed reprojection into a UTM (zone 18) coordinate system with NAD83 datum. Most data acquired were created in Stateplane (5526) projection and NAD27 datum. Most of the county data were in a scale of 1:2,000,000 (statewide) or 1:100,000 (U.S.G.S.). Hydrology data were made from 1:100,000 U.S.G.S. digital line graph data and "clipped" to county boundaries. Slope data were created from thirty-meter resolution digital elevation data. The soil septic suitability data were provided by the Chittenden County Regional Planning Commission (CCRPC) and was originally created from the 1:15,840 scale orthophoto quadrangles of the Natural Resource Conservation Service (NRCS). Some of the data collected were in ArcView shapefile format and converted into ArcINFO coverages. Most of the zoning data were converted from AutoCAD format.

This made the data, whether collected digitally or digitized from hardcopy, compatible and usable in either ArcINFO or ArcView.

After reviewing compatibility of each data layer, it was necessary to look for compatibility in the attribute information. Generally, the older the data, the fewer land use categories there are. Hard copy maps from earlier years are sometimes more coarse in scale. This was the case with the 1969 map of Chittenden County land use. This is one of the main reasons I concentrated on the expansion of the urban/suburban land use category, since this has been fairly consistent in its definition over the years.

Data Analysis

In order to properly compare land use categories from different periods, I separated different types of land use in the 1973 and 1995 data layers in ArcEdit by using their land use codes. Fortunately, land use codes and their definitions were the same in the digital data of different periods. I concentrated on a few major land use types because of their effects on other types of land uses. In general, urban land use requires more land for support services (i.e. landfills, gravel pits, etc.) than farming land use. Also, urban and residential land uses may be far

less tolerant of National Guard training activities than farming or logging land uses.

The land use types I concentrated on were Residential (Land Use code 1100), Crop/Pasture (2100), Industrial (1300), Commercial Services and Institutional (1200), Urban and Built-up (1700), Mixed Use (1600), and Industrial and Commercial Complexes (1500). The land use codes and definitions of these codes have not changed between 1973 and 1995. *Residential land use* consists of multi-family low, medium, and high rise apartments, condominiums, townhouses, single family, duplexes, mobile home parks, group, and transient quarters. *Cropland and pasture land use* consists of row crops, hay/rotation/permanent pasture, and grains. *Industrial land use* consists of primary metal production, petrochemicals, wood processing, etc. *Commercial services and institutional land use* contain retail and wholesale, banking and personal services, lodging, government, educational, hospitals, religious, and indoor cultural/public assembly. *Urban and built-up* contains outdoor cultural (zoos, etc.), outdoor public assembly (stadiums, racetracks, etc.), outdoor recreation, and cemeteries. *Industrial/Commercial* complexes are defined as industrial parks, office parks, and shopping

malls. In order to make the land use comparison less dependent on the definition of a particular land use type, the Industrial, Commercial/Service, Industrial Complexes, Urban and Built-up, and Mixed Use land uses were combined.

Prediction Methodology

In the modeling phase of this project I concentrated on basic criteria which would steer growth in the future (Figure 5). These criteria help illustrate where most residential and commercial development are most likely to occur. Criteria for future development include slope, proximity to roads, river and stream buffer, soil septic suitability, and proximity to growth centers. Those areas already developed for commercial or residential use were subtracted from the final prediction map.

Slope percent was derived from thirty-meter digital elevation models (DEM). This was used to show areas where slope would not be a prohibitive factor in construction. The greater the slope the more prohibitive the construction costs. According to personal interviews with local contractors, slope is not a significant factor in building residential developments. According to these interviews, anything under 10% slope is easy to build on. Design of the structure and soils are more limiting criteria.

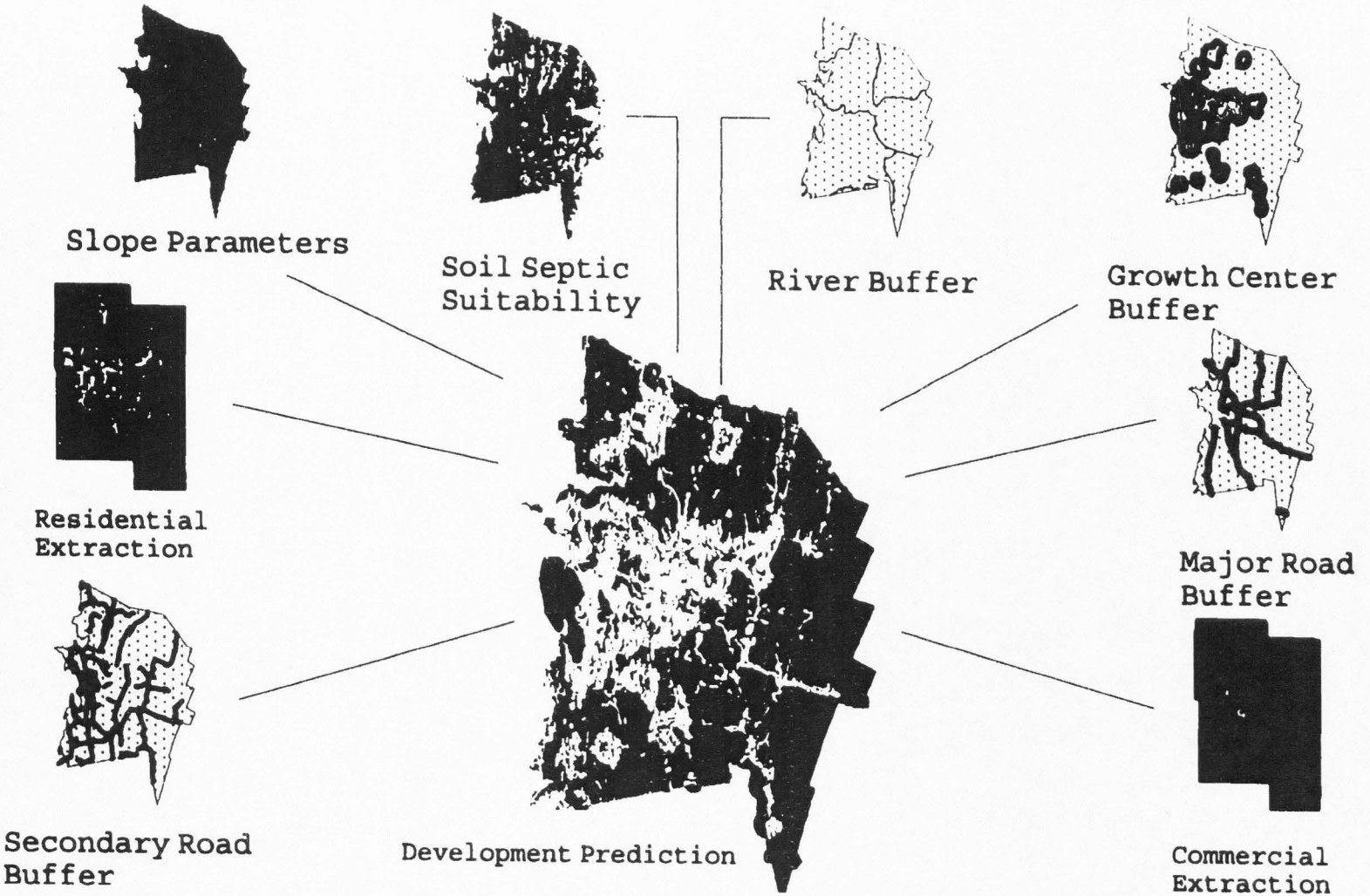

Figure 5. Composite Elements for the Predictive Development Map of Chittenden County, Vermont.

Site characteristics such as depth to bedrock and water table height are other factors affecting construction costs.

Each data layer used in the model was attributed depending on the suitability for development. An integer coding scheme was developed where a value of 0 was given to map categories that could not support development. Higher values (1, 2, 3, etc.) were given to map categories which were increasingly agreeable to development.

The slope map was divided into three categories. The 0 to 22 percent range was given the highest value of 3. The 23 to 33 percent slope category was given the value of 2 and the >33 percent slope was given the value of 1.

For proximity to roads a buffer of one quarter mile for secondary roads and one half mile on major roads was used. The area inside the buffer was given a value of 1 and the area outside the buffer was given a value of 0 (zero). Construction closer to existing infrastructure like roads (and sanitary sewer in some cases) is usually more desirable. This analysis does not account for the development of new roads, which is a function of permits, zoning, and available funds.

Proximity to growth centers was also evaluated with a buffer. Concentric buffers based on distance from the growth centers were created in ArcView. The growth centers were extracted from the future land use maps provided by the Chittenden County Regional Planning office. The concentric rings show various distances from the growth center depending on the size of the growth center. The closest buffer was given the highest value (3). This was done with the assumption that most development would want to be relatively close to urban centers. Individual developments that desire a more solitary or rural surrounding cannot be accurately predicted.

Septic soil suitability (Figure 6) was chosen as a criterion for growth because most of the towns outside of Burlington and Colchester do not have complete coverage by sanitary sewer systems. The town of Richmond went so far as to halt expansion of their sewer system to complete an environmental impact assessment. It was thought that expansion of the sanitary sewer system would encourage too much growth, or at the very least, growth that would come too fast. It is most likely that the towns that comprise the outer ring will continue to rely on individual septic systems. The Regional Planning Commission provided a soil

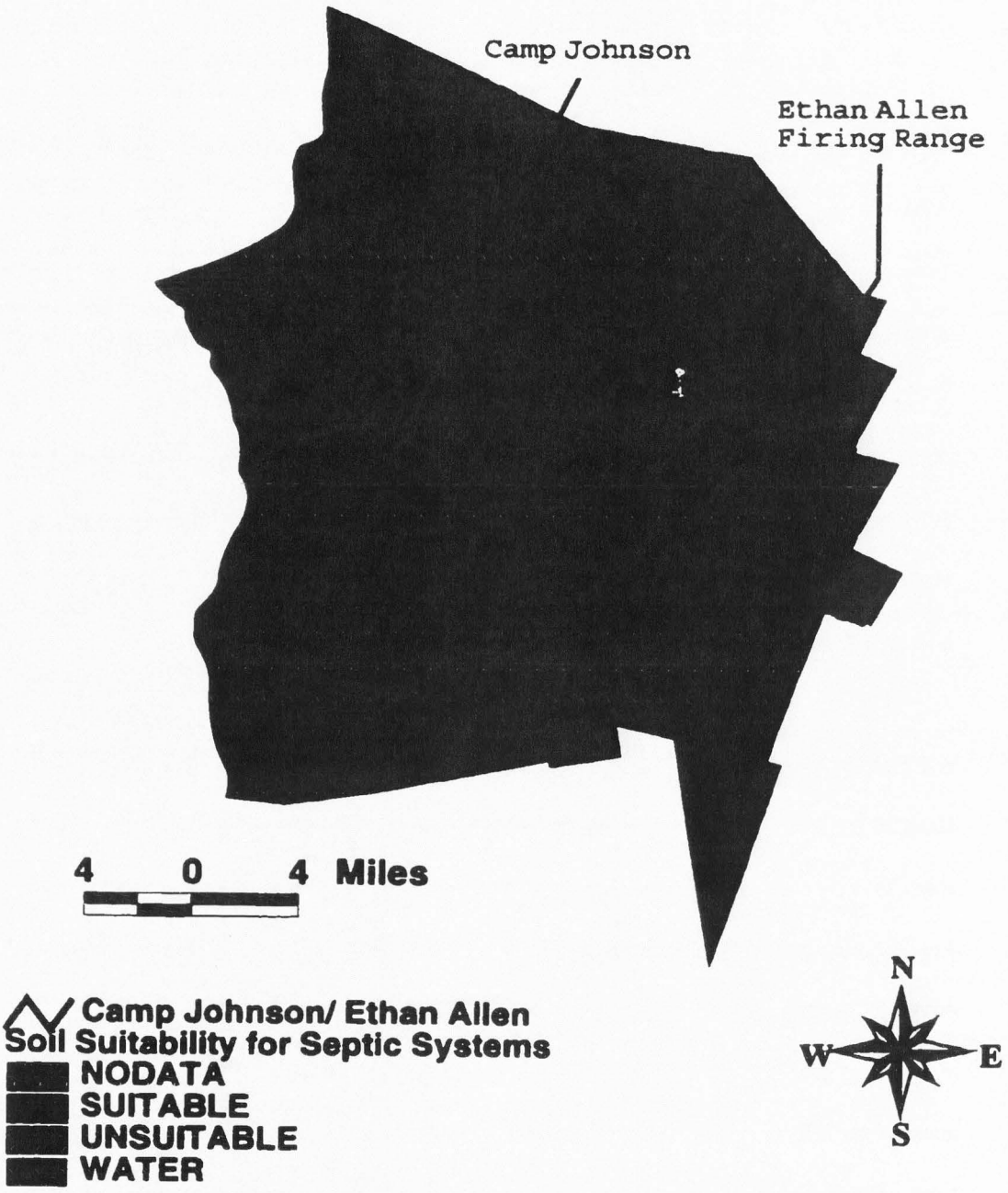

Figure 6. Soil Suitability for Septic Systems. This Map Illustrates Soil Suitability for Septic Systems in Chittenden County, Vermont. The Land Around Camp Johnson Is Served by Sanitary Sewer Systems. The Land Around the Ethan Allen Firing Range Is Mainly Septic Systems.

suitability map. I gave a value of 1 to the suitable soil polygons and separated them from the unsuitable soil polygons, water, and "no data" polygons in order to simplify the map for merging with other grids.

River and stream coverages were buffered forty meters. This was done to show areas where development might stay away from due to safety and environmental concerns such as bank destabilization and non-point source pollution. The interior of the buffer was given a null value to indicate an area were development would not be allowed. This buffer of rivers and streams was included because of the author's experience in other parts of New England. Historically, commercial areas have built structures adjacent to and even overhanging riverbanks. Originally, the reason for the commercial structure proximity to the river was to harness waterpower. Many residential areas have structures or at least lawns on the riverbank for aesthetic reasons.

The slope map, road buffer, growth center buffer, soil suitability, and river buffer were each converted into grids and reclassed into their integer values described below (Table 4) based on preference of development.

Table 4. Classification of Development Criteria

Criterion	Code 0	1	2	3
Slope		>33%	23-33%	<22%
Road Buffer	outside	inside		
River Buffer	outside			
Soil Suit.	water/no data unsuitable	suitable		
Proximity to urban centers	outside of buffer	farthest	middle	closest

All five grids were summed on a pixel-by-pixel basis. The land already developed was given a null value and added to the five grid total. The resulting totals reflect the susceptibility of a given piece of land to be developed. This composite map will show where development is more likely to take place given these parameters and unrestrained growth.

Politics and the economy were two major criteria which could not be included in this study because they were too variable to predict with any accuracy. Politics both locally and at the statewide level may change, causing possible changes on zoning and building codes, and effects on the economy. Economic change has a decided impact on

rates of growth. A boom economy would probably cause an increase in the local population through immigration. This was seen in the state of Vermont in the 1960s when ski resorts grew in number.

The nonquantitative or personal values of the population of individual towns are another growth inhibitor or catalyst. Anecdotal evidence suggests most rural towns on the east side of the county are anti-development. However, if there is enough capital, development usually will occur.

RESULTS

The trends of growth in Chittenden County are quite clear when analyzing the data from 1973 through 1995, and the pattern has not seemed to change in the past four years. Residential land use is the fastest growing and farmland is the fastest declining land use (Table 5, Figure 7 & Figure 8).

Residential land use growth has, in most cases, followed existing road systems. Residential areas for 1973 seem to be more clustered than the areas for 1995. If this pattern continues, the areas of residential use for 1995 will become more clustered in appearance and more areas

Table 5. Acreage of Selected Land Use Types 1973 - 1995

Land Use Type	Code	1973	1995	% Change
Residential	1100	16,525.54	34,624.68	+109.0
Crop/Pasture	2100	132,268.87	76,026.80	-43.0
Urban Buildout	1700(a)	1,255.44	343.75	
Industrial	1300(b)	1,042.02	1,139.90	
Industrial Complex	1500(c)	118.24	325.61	
Commercial/Service	1200(d)	4,032.68	3,738.40	
Mix Use	1600(e)	218.12	544.37	
	Sum a - e	6,666.46	6,092.03	-9.0

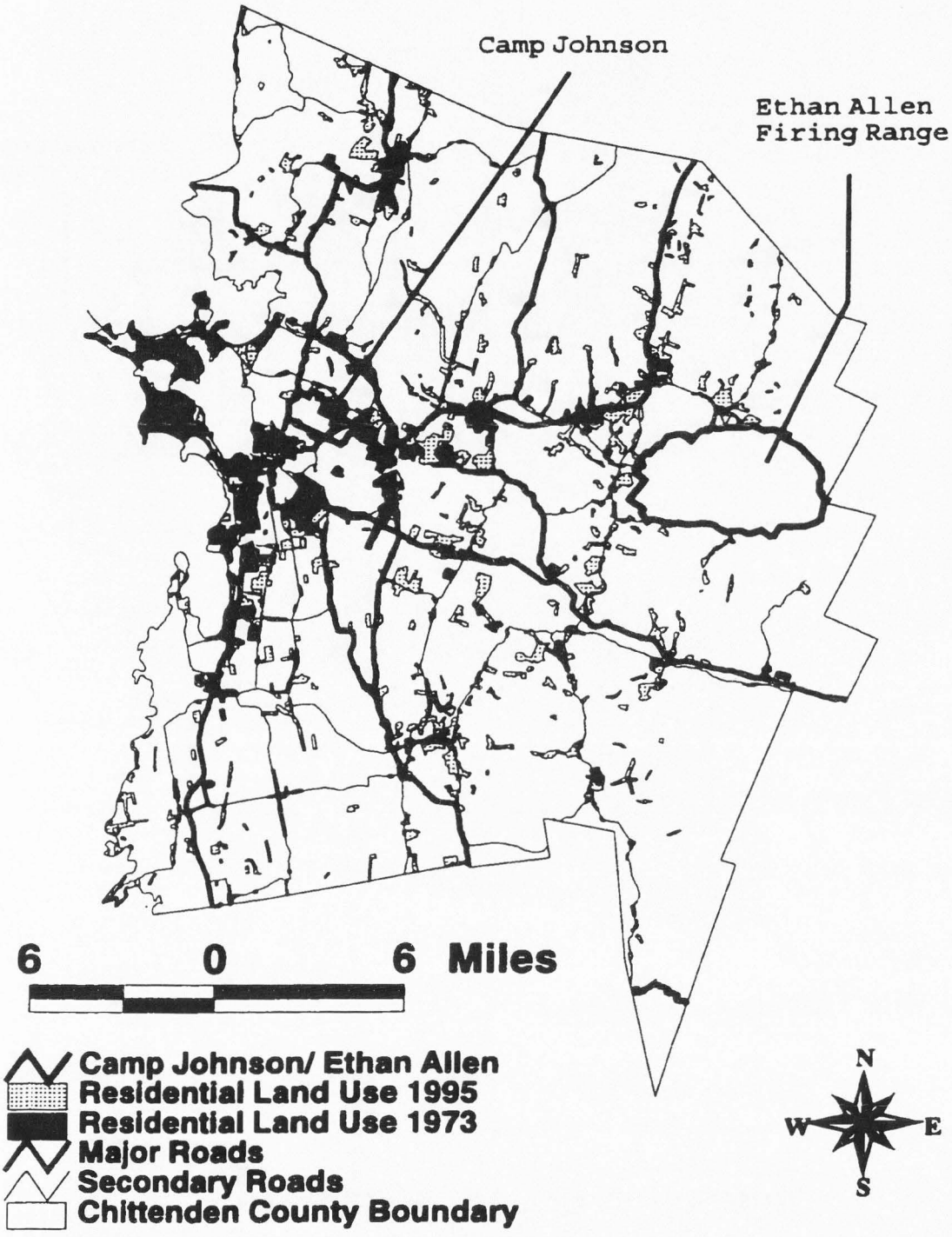

Figure 7. Residential Land Use Growth in Chittenden County, Vermont Between 1973 and 1995.

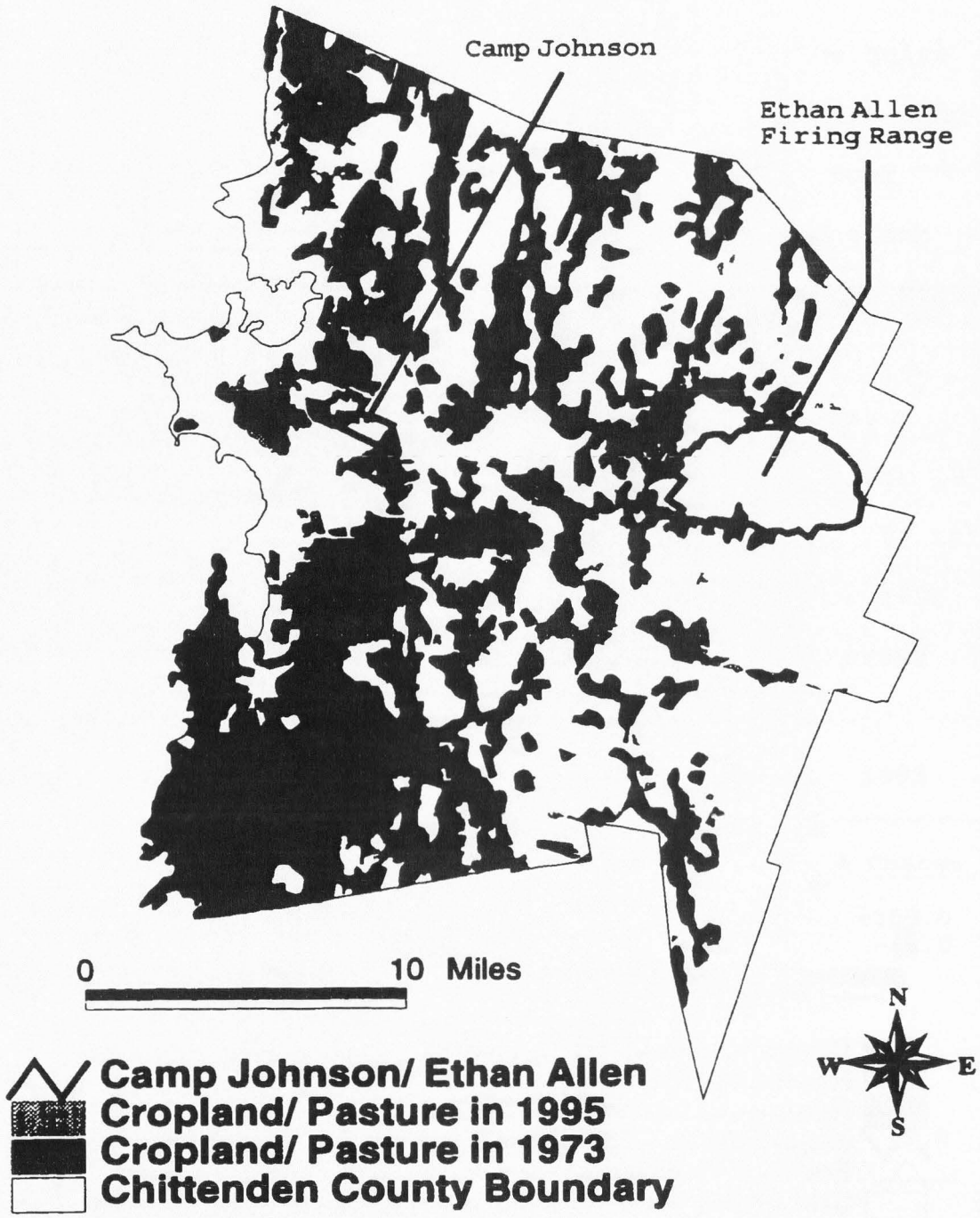

Figure 8. The Change in Cropland/Pasture Land Use in Chittenden County, Vermont Between 1973 and 1995.

of residential development will scatter outward. The pattern of growth in residential areas also seems to correlate with the change in land use pattern of crop land/pasture land. Most of the growth in residential areas is clustered to the east and north of the regional core (Burlington) with a corresponding loss of crop land and pasture land is in the same area.

Farm land seems to be the most easily converted because it is already cleared, it is relatively flat, it is usually unprotected, and the cost to developers is low compared to property closer to the urban center. Although farm land is usually the first to be converted it is not the only land to be converted. Forest land and vacant land (i.e. meadow) were also converted. Recent land sales indicate two distinct clusters, one in the Colchester area and another northwest of the EAFR. This could be indicative of two types of residential land sales. According to the town planner of Colchester, there are some developments purchasing adjacent lots to expand the number of units (Laidman 1999, personal interview). Residential land sales northwest of the EAFR appears to be transactions of individual homebuyers and not developers.

As mentioned in the methodology section, the development prediction is based on slope, soil, proximity to major and secondary roads, and proximity to growth centers. The development prediction map (Figure 9) indicates the most likely places for development given these parameters. The brighter the colors (and greater the number) the more likely the development possibility. Recent land sales (Figure 10), however, indicate a variance to this premise. Most of the land sales northwest of the EAFR are in pixels with relatively low development value. Comparing recent land sales to the prediction map shows pixel values of 3 - 4 of the possible 12, showing that the development parameters I used in the prediction map may not be the only factors involved.

There are other possible reasons for the pattern in recent land sales. Land may be more affordable and available in the eastern portion of the county versus the western (i.e. lakefront) portion where the more developable land exists (values 10 - 12). The attributes I included in the land sales database show land as high as $220,000 per acre on the lakefront and as low as $601 per acre in northeast Underhill (north of the EAFR).

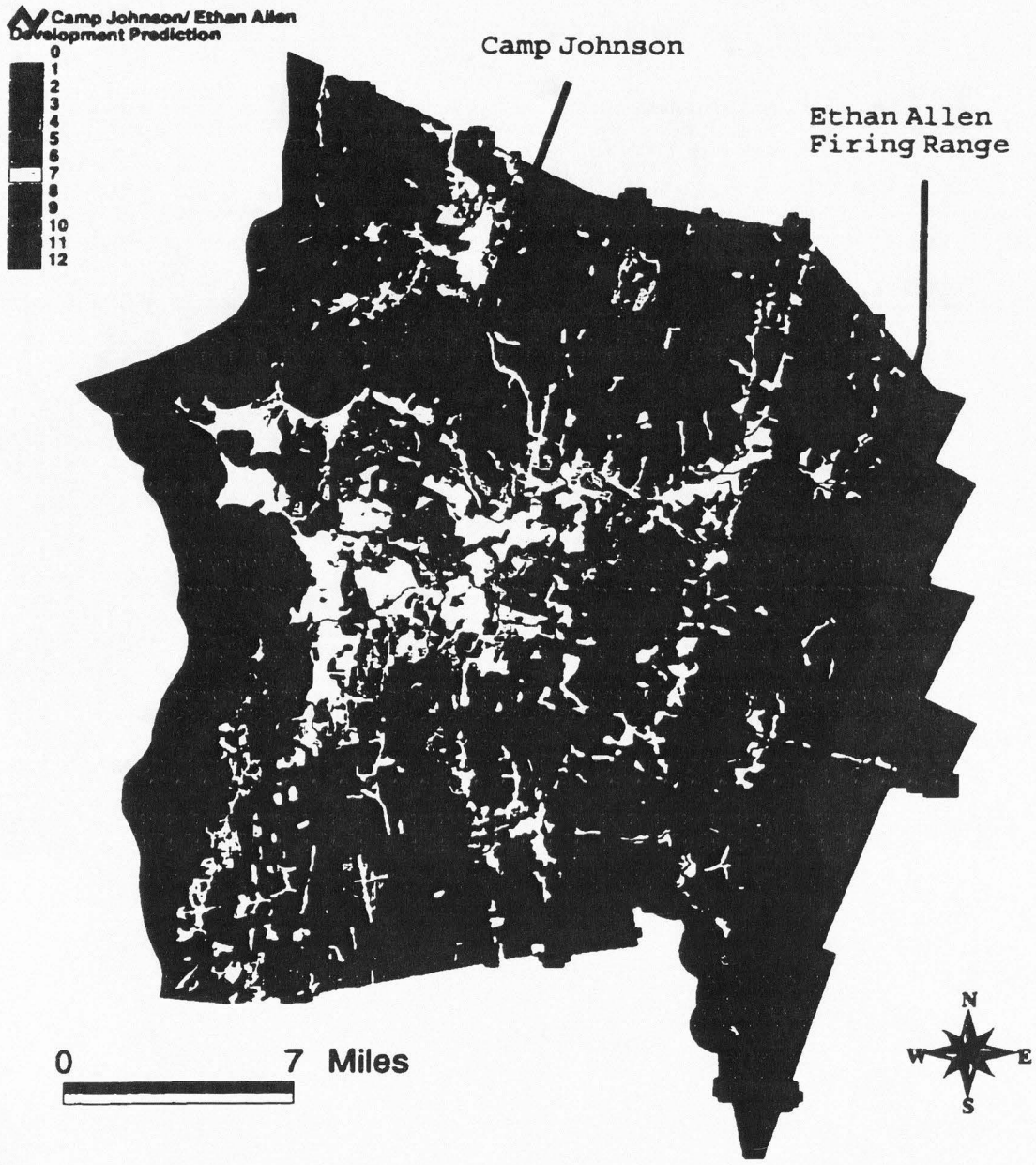

Figure 9. The Development Prediction Map for Chittenden County, Vermont. The Greater the Value of Any Particular Pixel, the More Likely Development Would Occur in That Area. The White Areas (0) Currently Have Commercial or Residential Development. The Camp Johnson Area Is Almost Completely Developed and the Ethan Allen Firing Range Area Is More Rural.

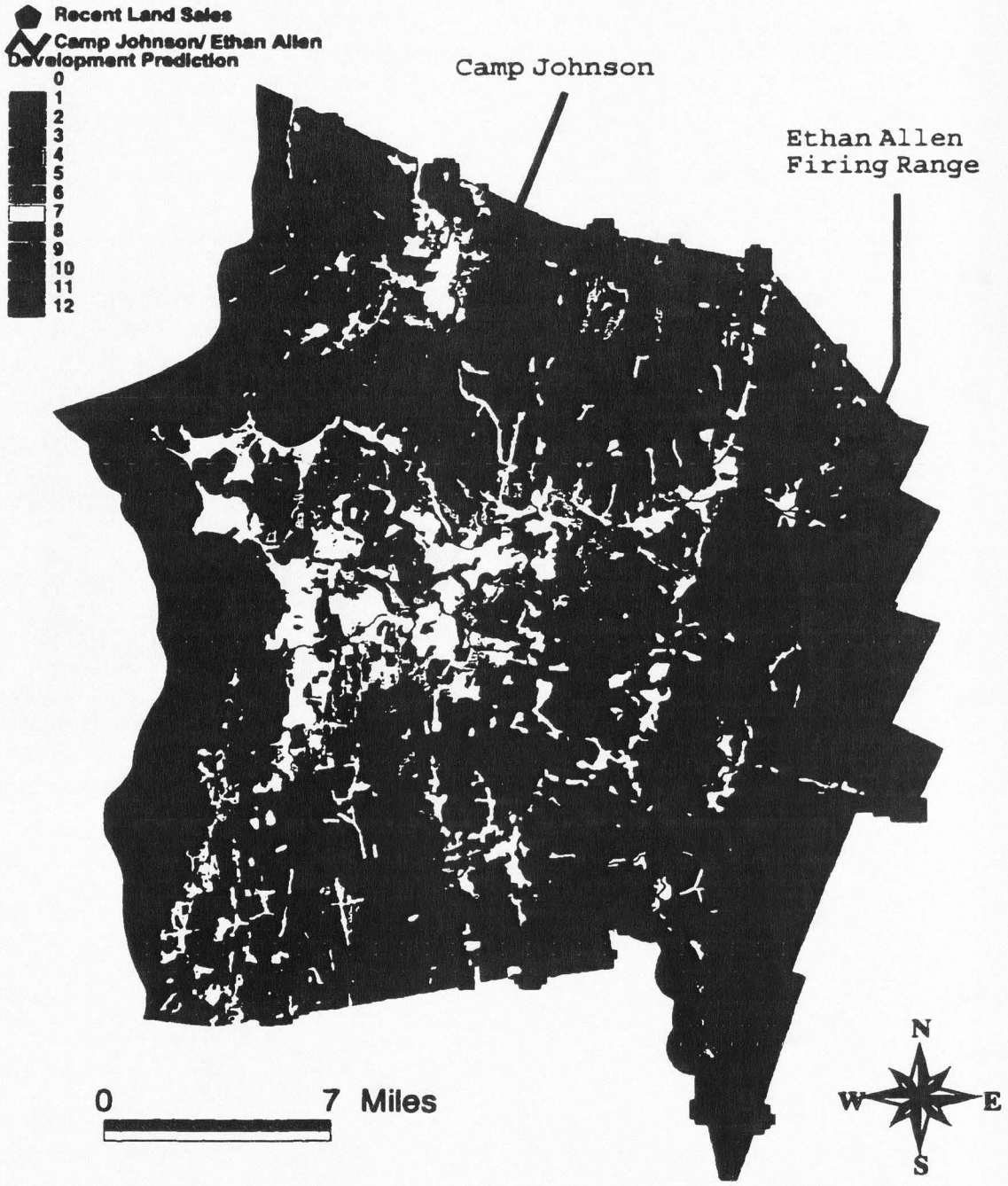

Figure 10. The Development Prediction Map for Chittenden County, Vermont with Recent Land Sales. Indicated Real Estate Sales Are Unimproved Land Zoned for Residential Development.

Also, Figure 11 shows that the frequency distribution of developable pixels in Chittenden County peaks along the same range as the recent land sales, showing that land purchases may be a function of availability. Another reason for the pattern of recent land sales could be the fact that the lots will be intended for second (i.e., vacation) homes. The land sales on the west side of the county

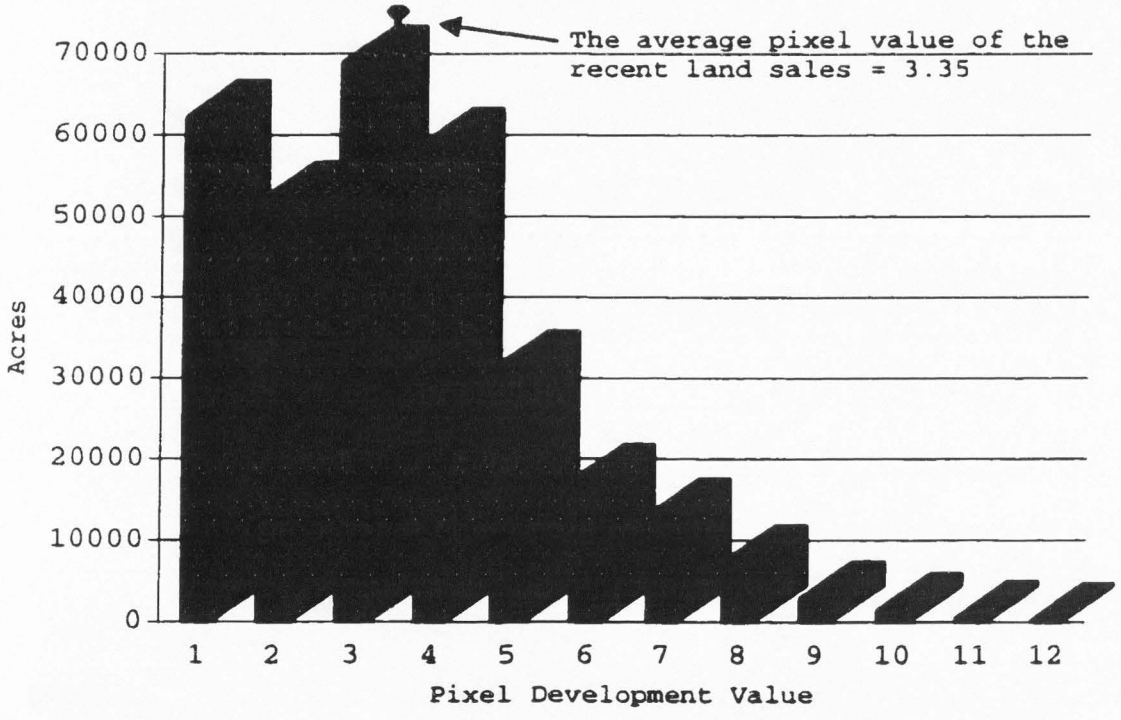

Figure 11. Pixel Development Values. This Chart Illustrates the Number of Pixels in Each Development Value. The Dashed Line Represents the Average Pixel Value of Recent Residential Land Sales.

are on or near the waterfront. The land sales around the Ethan Allen Firing Range are not only more secluded but also fairly close to ski resorts.

Figure 12 shows residential land use to have doubled in size and farmland dropped by almost 43%. Commercial, industrial, and "urban" areas have remained relatively stable over this period (see also Figure 13). This is probably due to the fact that as some major commercial developments have been created (e.g., Williston commercial areas), others were relocated, transformed, or rehabilitated to other companies.

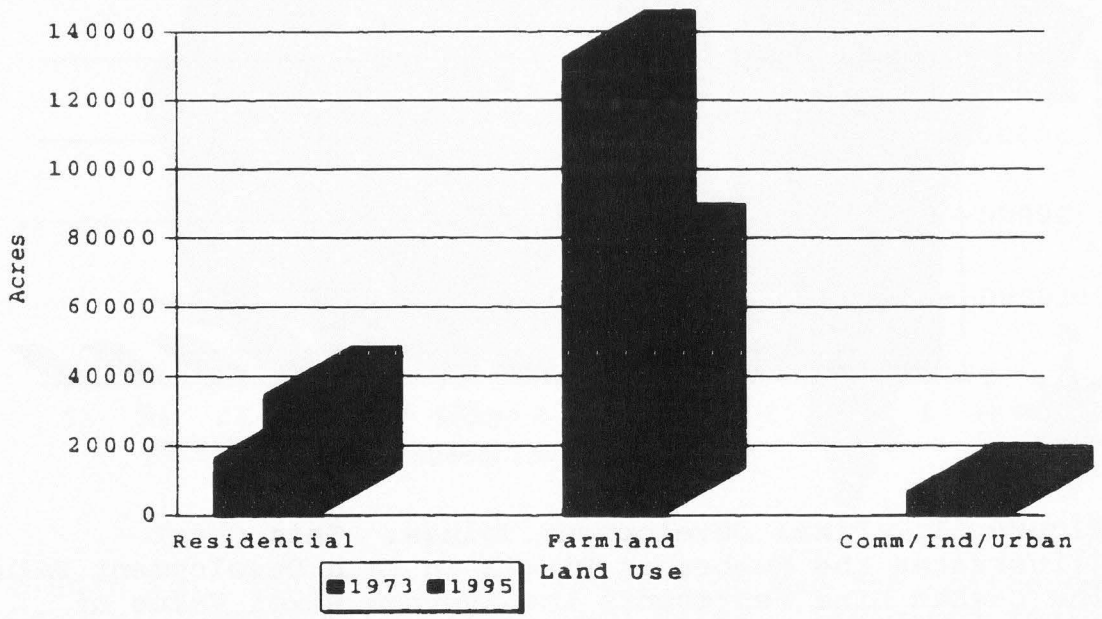

Figure 12. Converted Acres 1973 - 1995.

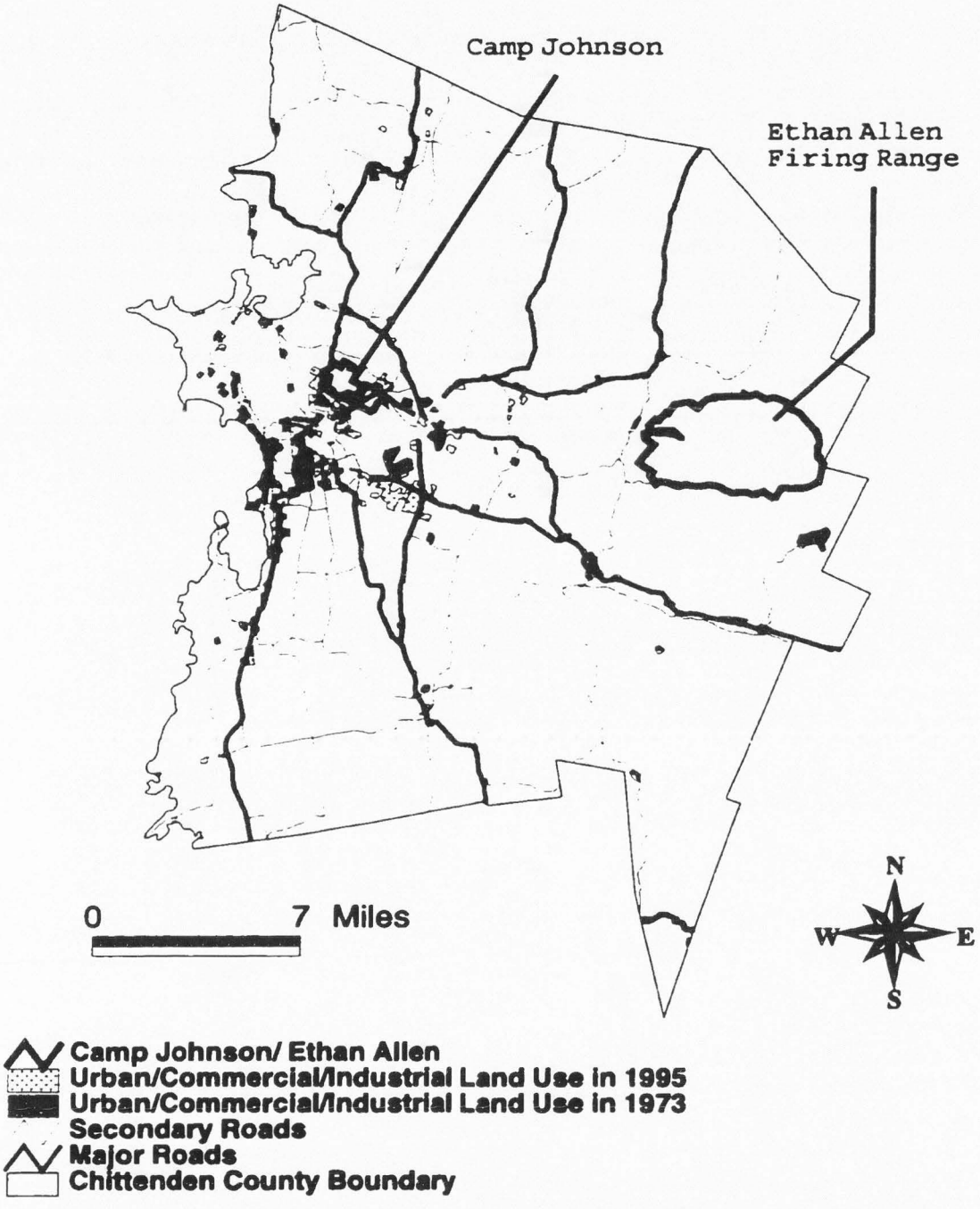

Figure 13. Urban, Commercial, and Industrial Land Use in Chittenden County, Vermont Between 1973 and 1995.

Table 6 shows the trend of population growth through the year 2015 while Table 7 indicates an average of two acres converted to residential use, from other land uses (usually farmland), for every one-person increase in the population.

Table 6. Population of Chittenden County 1950 - 2015

Year	Actual	Predicted	
1950	62,570(a)		
1960	74,425(b)		
1966	80,400(c)		
1970	99,131(d)	88,357(b)	
1973			104,051(*)
1979		120,000(d)	113,891(*)
1980	115,534(e)	100,767(b)	
1983		120,778(e)	120,403(*)
1985	123,078(f)		123,648(*)
1990	131,761(g)	113,952(b)	
1995		140,086(g)	139,875(*)
2000		147,372(g)	147,988(*)
2005		155,119(g)	156,102(*)
2010		159,700(g)	164,215(*)
2015		165,241(g)	173,329(*)

a = GBIC (Greater Burlington Industrial Corp.)County Profile 1970
b = 1960 Census
c = Office of Economic Opportunity Demographic Profile 1970
d = GBIC County Profile 1976
e = GBIC County Profile 1983
f = County Profile, Vermont Agency of Human Services 1987
g = Vermont Health Care Authority, Center for Rural Studies 1993
* = Author's estimate (mathmatical extrapolation of historical rate of change)

Table 7. Acreage Patterns 1973 - 2015

Year	1973	1995	2015(est.)
Population	104,052	140,086	165,241
Residential Acres	16,526	34,625	50,058
Population Increase 1973-1995			36,034
Residential Acres Increase 1973-1995			18,099
Population to Acres Ratio			1.99

Overall, the development prediction, land sales, and the growth center plans of the county show a general concentric outward expansion from urban centers. If this continues for another twenty-five years, it will be increasingly difficult to maintain training schedules at Camp Johnson and at the EAFR.

The Camp Johnson area in Colchester fits many of the parameters for development (Figure 14). It has, therefore, taken on the "attributes" of sprawl in recent years. The growth of the Colchester subregional growth center, which includes Camp Johnson, has been an impetus for a proposal to open the camp's roads to public traffic. This may bring any weapons training to a halt at Camp Johnson. If the expansion continues toward the EAFR, there may be an

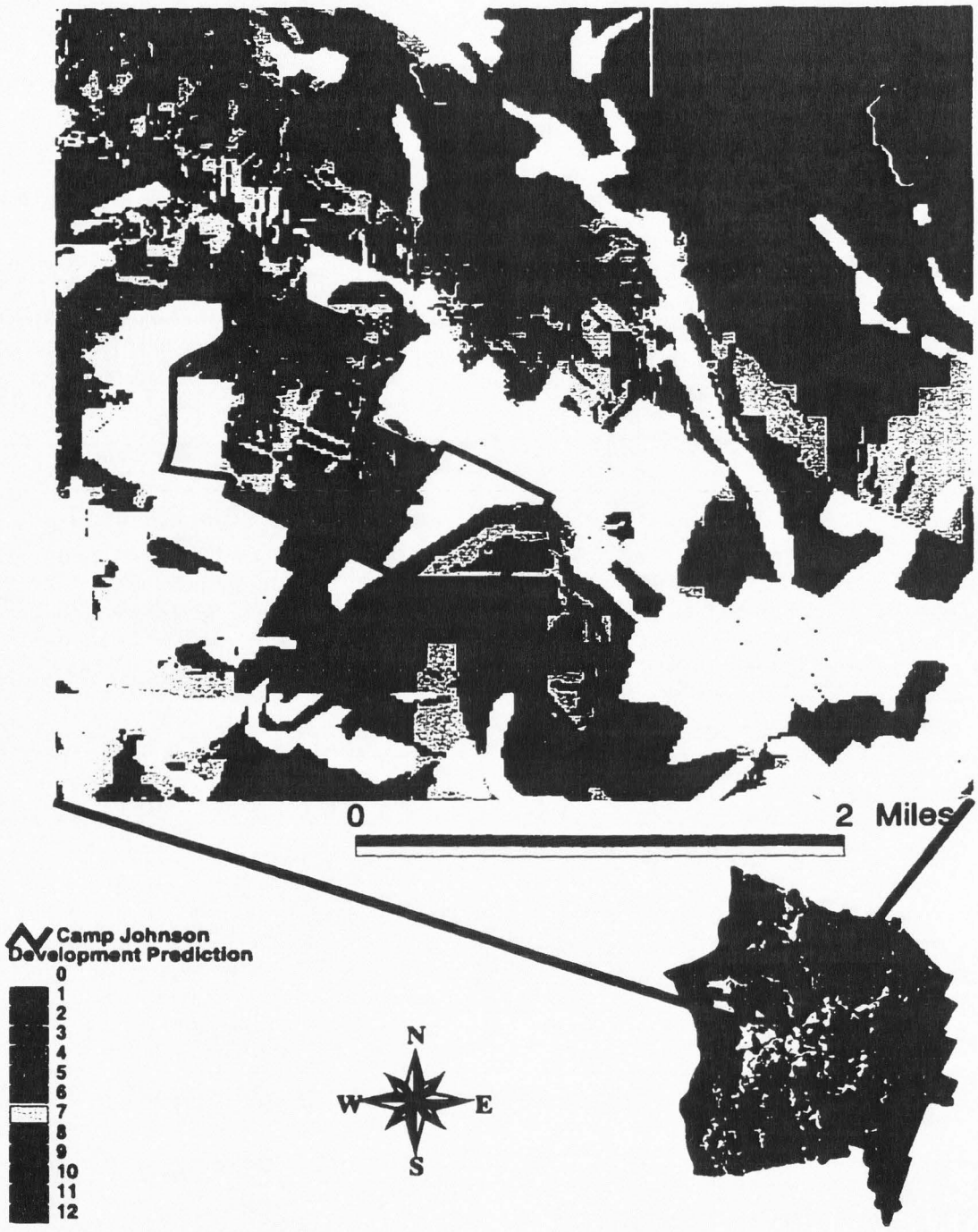

Figure 14. Development Prediction Detail of the Camp Johnson Area in Chittenden County, Vermont. The Greater the Number in the Pixel the More Likely Development Would Occur.

increasing number of people uneasy about living with the noise and vibration that usually accompany military training.

The continuation of this pace of change is difficult to predict. As mentioned previously, towns in Vermont control most of the planning regulations. In the interest of preserving rural character and a valued quality of life, many of the towns surrounding the EAFR have become somewhat anti-development. According to some real estate agents and at least one official of a rural town in the eastern end of the county, large-scale developments will be more difficult to implement in the near future. Zoning and building regulations are expected to change in the next few years. Preserving the rural character of Vermont has been studied as recently as 1990 but implementing the steps necessary to adhere to community values is sometimes difficult.

CONCLUSIONS

Based on the development prediction map (Figure 9) and the location of recent land sales (Figure 10), the established scenario is that the growing population of Chittenden County may increase pressure on National Guard activities at the EAFR facility, thus decreasing the value of this facility as a training site. As mentioned previously, as population increases and suburbia spreads, the EAFR may become a valuable "buffer" to surrounding towns. However, a "buffer" to most people may mean a park-like setting without the activities common to most training areas.

An alternative scenario is that the area around the EAFR is so rural that even the jump in population (expected 82% in Underhill by the year 2010) will have little effect on the type of activities allowed at this facility. The likelihood of this scenario would be bolstered if anticipated changes in zoning occur in the towns that surround the EAFR.

When attempting to predict future patterns of land use within Chittenden County, it will be impossible to avoid some assumptions and unknowns. The most obvious assumption in this kind of temporal extrapolation is the belief that

land use will continue on its present course. Land use attitudes may change, planning and zoning measures may change, large paper companies may sell off land holdings to developers, etc. It may be advantageous to conduct further interviews with county and town planners to see where their plans take land use.

What this thesis has shown is a particular trend of development within Chittenden County. Population change, technological change, relative affluence/poverty, the political/economic structure, and the beliefs and attitudes of the community are all factors that cannot always be accounted for in a predictive environment.

In 1998, Macro International conducted a poll for the Vermont Forum on Sprawl. This poll indicated 94% of the respondents believed the preservation of open land to be "desirable" or "extremely desirable." The proposal to "downzone" Camp Johnson mentioned previously is a reflection of this desire for open space. The factors involved in creating sprawl make this desired goal easier said than done. There are many factors in the creation of sprawl. Sam Hemingway, a columnist for the Burlington Free Press (1998), describes this nature well, "Sprawl, after

all, never looks like sprawl when it starts" (Vermont Forum on Sprawl 1999, np).

This thesis and its results are not static. Factors used to create the predictive map of the county will change. When they will change and in what direction cannot be predicted. The following are some of the factors to watch in order to assess the future viability of training at Camp Johnson and the EAFR.

Planning and zoning in each town and the county as a whole is not always conducive to preventing sprawl. Planning laws and guidelines are sometimes vague in their directives. A planning goal such as "maintaining town character" is difficult to achieve without clear implementation goals (Ewing, Humstone, and Farley 1999). Many zoning regulations do not match the objectives of planning goals.

Public investments also play a large role in sprawl creation. Subsidizing of infrastructure helps make sprawl the path of least resistance. The cost of a new road is paid by the developer, which in turn is most assuredly passed on to the homebuyer. The cost of road maintenance is usually taken over by the town (Yacos 1999). These costs cannot always be absorbed by higher taxes on the

homeowners. Sometimes programs are cut instead. The added cost to the town is not reflected in the rents paid by suburban businesses either. The rent per square foot for retail space on Church Street in downtown Burlington is $16.00 - $25.00. The suburban retail sites average between $11.00 and $16.00 per square foot (Ewing, Humstone, and Farley 1999).

Another type of subsidy is in public utilities. The cost of bringing utilities and telecommunications to rural areas is not always reflected in the pricing policies. Financial "incentives" abound for sprawl-type development. In the fourth report in the series "Exploring Sprawl" (Glitman and Perkins 1998, np), it was stated that "Loans made by the Vermont Economic Development Authority (VEDA), for example, have no anti-sprawl or pro-town criteria." Building larger projects in the space suburbia provides also contributes to lower costs.

Septic capabilities and limitations also play a large role. There are a couple of reasons why soil septic suitability was added to the predictive map. The "ten-acre loophole" mentioned earlier lets one avoid septic review by the state on ten-plus-acre-lot developments. Some town centers may wish to build in the traditional village style

but may have septic limitations due to poor soils nearby. Without funding for major sewer development, this situation makes it difficult to avoid spreading out and consuming more land in order to accommodate septic necessities.

And finally, the individual choices made by new homeowners may not always reflect their stated values. It is sometimes human nature to make one's new surroundings similar to the place a person left behind instead of moving to a place that is already like the way that person wants it. If everyone agrees on the ingredients of sprawl but no one wants to sacrifice what it takes to eliminate these ingredients, the training activities of Camp Johnson and the EAFR may have a limited life span.

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APPENDIX

Data Layers
(Title, Description, Source)

Environmental

Ctyclip: Chittenden County clipped from the statewide county coverage, Utah St. Univ. (Author)
Deerwntrarea: Deer wintering areas inside of Chittenden County, University of Vermont, Spatial Analysis Lab
Duckboxes: Duckbox locations within the Ethan Allen Firing Range (EAFR)
Endangsp: Rare, threatened, and endangered species and significant natural communities, VCGI
Foresttype: Forest cover types within the EAFR in NAD83, EAFR
Hazwaste: Hazardous waste sites statewide, VCGI
Lakes: Statewide lake coverage, VCGI
LC73: Landcover in 1973 for the county, Chittenden County Regional Planning Commission (CCRPC)
LC95: Landcover in 1995 for the county, CCRPC
Manarea: Point coverage for managed areas statewide (state parks, WMA's, municipal forests, etc.), VCGI
Neaquifer: New England's major aquifers, clipped from nationwide coverage at Utah St. Univ.
Nflbnd: Northern Forest Land boundary
Prvtconlnd: Private conservation land within the Northern Forest Lands, VCGI
Publand: Statewide public lands, VCGI
Pubwatersorc: Public water sources statewide, VCGI
Q24K: Statewide index of 24K quads, United States Geological Survey (USGS)
Recareas: Recreational facilities within the boundary of the Northern Forest Lands that border the northeast section of the EAFR, VCGI
Residential73: Regional residential land use in 1973
Residential95: Regional residential land use in 1995
Rivbasins: Watershed basins statewide, VCGI
Rivers: Statewide rivers
Shoredevelop: Shoreline developments within the Northern Forest Lands, VCGI
Trails: Statewide coverage of trails, VCGI
Watersheds: Individual stream/tributary watersheds (more detailed than rivbasin), VCGI
Wellprotect: Wellhead protection areas, Vermont Geographic Information Service (VGIS)

Whitewater: Statewide coverage of whitewater rafting areas, VCGI

Digital Elevation Models (DEM)

Ctytotal: All seventeen DEMs that cover the county stitched together, Utah St. Univ.
Dem8quadh: Hillshade version of the eight quads covering Camp Johnson and Ethan Allen Firing Range, Utah St. Univ. (Author)
Demboltonmtn: Bolton Mt. 24K quad, USGS
Demburlington: Burlington 24K quad, USGS
Demcolchester: Colchester 24K quad, USGS
Demcolchesterpt: Colchester Point 24K quad, USGS (Author)
Demeightquad: The eight quads covering Camp Johnson and the Ethan Allen Firing Range stitched together, Utah St. Univ. (Author)
Demessexctr: Essex Center 24K quad, USGS
Demessexjct: Essex Junction 24K quad, USGS
Demgilsonmtn: Gilson Mt. 24K quad, USGS
Demgrgaplain: Georgia Plain 24K quad, USGS
Demhinesburg: Hinesburg 24K quad, USGS
Demhuntington: Huntington 24K quad, USGS
Demmilton: Milton 24K quad, USGS
Demmtellen: Mt. Ellen 24K quad, USGS
Demmtmtmfld: Mt. Mansfield 24K quad, USGS
Demmtphilo: Mt. Philo 24K quad, USGS
Demrichmond: Richmond 24K quad, USGS
Demunderhill: Underhill 24K quad, USGS
Demwaterbury: Waterbury 24K quad, USGS
Slgridtotal: Countywide slope derived from the 'ctytotal' DEM and converted to a grid

Development Prediction

Futlu96: Future land use plans for Chittenden County as of 1996, CCRPC
Innerring: Towns comprising the inner ring of the regional plan, Utah St. Univ. (Author)
landsales: Point coverage of land sales around the EAFR in the last few years, Utah St. Univ. (Author) (data provided by Lang Realtors, Burlington, Vermont)
locgrow: Polygon coverage of the local growth centers in Chittenden County, extracted from futlu96, Utah St. Univ. (Author)

Outerring: Towns comprising the outer ring of the regional plan, Utah St. Univ. (Author)
Regcore: A polygon of the regional core extracted from the futlu96 coverage, Utah St. Univ. (Author)
Soilsepsuit: A countywide coverage of soil suitability for septic systems, CCRPC
Suitable: The soil polygons that are suitable for septic systems extracted from the soilsepsuit coverage, Utah St. Univ. (Author)
Urbanarea2: Statewide urban areas (generalized)

Development Prediction (Grids)

Ctytotal: All seventeen DEMs that cover the county stitched together, Utah St. Univ. (Author)
Develop: A grid of all development criteria combined (summed) together (Author)
Develop3: A grid of all development criteria combined with existing development subtracted (Author)
Slgridtotal: Original seventeen DEMs stitched together and generated into a slope coverage then converted to a grid (Author)
Soilsuitgrd: Original grid of soils suitable and unsuitable for septic systems
Sumtest5: Development criteria combined (summed) without the surface water buffers added (Author)

Infrastructure

Aadt94n83: Annual average daily traffic, 1994, (includes vehicles per day for 1986, 1988, 1990, 1992, 1994), VCGI
Boltonpar93: Town of Bolton parcels, 1993, Ed Moore, Consultant in Underhill, Vermont
Boltonzone89: Town of Bolton zoning, 1989, Ed Moore, Consultant in Underhill, Vermont
Collanduse86: Colchester land use in 1986, Colchester town planner, Sheldon Laidman
Collanduse95: Colchester land use in 1995, Colchester town planner, Sheldon Laidman
Colzoning97: Colchester zoning in 1997, Mr. Ed Moore, Consultant in Underhill, Vermont
Counties: Statewide coverage of county borders, VCGI
Ctytowns: Chittenden County towns clipped from statewide coverage, Utah St. Univ. (Author)
Eafrbnd: Firing range boundary only with town boundary intersection, EAFR

Insbndry: Outline of the Camp Johnson and Ethan Allen Firing Range boundaries, Camp Johnson
Jerichop92: Jericho parcel map of 1992, Mr. Ed Moore, Consultant in Underhill, Vermont
Jerichozn92: Jericho zoning in 1992, Mr. Ed Moore, Consultant in Underhill, Vermont
Landfillscol: Landfills in Colchester, Colchester town planner, Sheldon Laidman
Nflowner: Large forest land ownership blocks within the Northern Forest Lands, VCGI
Polbndry: Town/village ID's (minor civil division boundaries for census mapping), VGIS
Railrds: Major railroads statewide, VCGI
Richmond: Town of Richmond parcels, Mr. Ed Moore, Consultant in Underhill, Vermont
Richzone96: Town of Richmond zoning in 1996, Mr. Ed Moore, Consultant in Underhill, Vermont
Roads: Statewide coverage of all roads, VCGI
Stbnd: State boundary coverage.
Trancorridor: Transportation corridors, planned by the transportation study in 1995, (Author), Utah St. Univ.
Uhbuildoutn83: Theoretical expansion areas in Underhill Vermont, Mr. Ed Moore, Consultant in Underhill, Vermont
Underhilln83: Underhill parcels, Mr. Ed Moore, Consultant in Underhill, Vermont
Underhillzn91: Underhill zoning for 1991 with attributes, Mr. Ed Moore, Consultant in Underhill, Vermont
Vectgridlat: Latitude/Longitude grid in one-minute increments for UTM zone 18, Utah St. Univ.
Vectgridutm: 10K grid of UTM lines covering installation boundary, Utah St. Univ.

Military Training

500mbuffer: 500-meter buffer around the inside of the perimeter of the Ethan Allen Firing Range to show the limitations to pyro and obscurant use. (author)
Artpos: point coverage of firing points at the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Cantonmentcj: Buildings and facilities of Camp Johnson (digitized over aerial photos) (Author)
Cantonmentfr: Buildings and facilities of the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Firebrk: line coverage of the firebreaks used around the impact area of the Ethan Allen Firing Range (digitized over aerial photos) (Author)

Fordsite: Hardened stream crossing at the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Fueltank: point coverage of fuel storage tank types and capacity within the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Guardpoints: Guard positions at the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Landzone: Helicopter landing zones at the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Obspts: Observation points at the Ethan Allen Firing Range (digitized over aerial photos) (Author)
Photos: point coverage of photo locations (digitized over aerial photos) (Author)
Trainfac: statewide point coverage of National Guard facilities (armories, etc.)(EAFR)
Trngbndy: map of training area designations (EAFR in digital format and updated by hardcopy information) (Author)
Trnconst: Off limit areas (digitized over aerial photos) (Author)