
IECI TECHNICAL REPORT

APPENDIX A

**Methodology for Developing Baseline County-Level Population,
Household and Employment Projections for Use in
Transportation and Land Use Modeling**

*Circ-Williston EIS***Methodology for Developing Baseline County-Level Population, Household, and Employment Projections for Use in Transportation and Land Use Modeling****1.0 INTRODUCTION**

Analysis of future transportation and traffic conditions, and indirect and cumulative impacts (ICI) for the Circ-Williston EIS will involve the use of the Chittenden County Transportation Model (the model). To produce a forecast of transportation demand, the model requires, among other inputs, county-level household and employment totals for each 5-year forecast period (2005 through 2030). This memorandum describes recent trends in population, households and employment, a methodology for developing population and employment forecasts, and results of these forecasts.

2.0 RECENT TRENDS AND FORECAST PERFORMANCE

In 2000, the Chittenden County Regional Planning Commission (CCMPO) and Chittenden County Metropolitan Planning Organization (CCMPO) commissioned a forecast of regional population, households, and employment. Following completion of the regional forecast in September 2000, results of the 2000 Census were released by the U.S. Census Bureau. Since the release of decennial census tabulations, the Census Bureau has produced population estimates for the years 2001 through 2004. In addition, records of building permits issued from 2000 through year end 2004 allow for an estimation of household and population growth through mid-year 2005. This section evaluates the performance of the forecast for Chittenden County in light of these newly available data sources.

In June 2001, CCRPC/CCMPO released a report evaluating the demographic forecast in light of the tabulations from the 2000 Census (2001 Forecast Update).¹ The forecast was updated by recalculating the estimates for the Northwest Region and Chittenden County using the 100 percent population count for 2000 rather than the Census Bureau estimate available prior to the decennial census. The recalculation employed the same forecasting methods used to develop the pre-Census 2000 forecast. The population count from the 2000 Census was 0.5 percent higher than estimated for Northwest Vermont and 1.2 percent lower than the original estimate for Chittenden County. Based on the results, the 2005-2035 forecast for Northwest Vermont was not altered and the forecast for Chittenden County was adjusted downward by approximately 0.5 percent through the end of the forecast term. The compound annual growth rate with the revised county forecast remained the same: 1.4 percent per year through 2010 and 1.6 percent per year from 2010 through 2035.

Through the 2000 Census, the trend since the 1900s has been for Northwest Vermont to experience growth in population and for Chittenden County to see an ever increasing share of that regional growth. For example, in 1950 Chittenden County accounted for 36.90 percent of the Northwest region's population, by 1990 that proportion was 46.28 percent. In 2000 the county's

¹ Economic & Policy Resources, Inc., *Demographic Forecast Update for Chittenden County 2000 to 2035*, CCRPC/CCMPO, June 2001 (2001 Forecast Update).

share of regional population rose slightly to 46.36 percent. U.S. Census Bureau population estimates for 2001 through 2004, point to a potential break in that trend.

Table 1 shows population for Vermont and the six counties making up the Northwest Region from 1990 to 2004. The table shows that from 1900 to 1980, Chittenden County was the center of growth in Vermont and the Northwest Region. The County grew at a rate of 1.35 percent per year during that period, nearly twice the rate of the other counties in the Northwest. In the 1980s and 1990s, other counties in the Northwest Region began to see rising growth rates with several counties growing at a faster pace than Chittenden, particularly Franklin, Grand Isle, and Lamoille counties. The 2004 Census Bureau estimates, based on projections of natural population increase, migration, and housing unit creation, show that annual growth rates have remained high in these three counties but have slowed substantially in Chittenden, which grew by 0.46 percent per year from 2000 to 2004 versus 1 percent from 1990 to 2000 and 1.3 percent from 1900 to 1990.

Table 1: Population, Growth Rate, and Share by County, 1900-2004

Geographic Area	Share of Northwest Region			Annual Growth Rate*				Population				
	2004	2000	1990	2000-2004	1990-2000	1980-1990	1900-1980	2004**	2000	1990	1980	1900
Vermont	-	-	-	0.51%	0.79%	0.96%	0.50%	621,394	608,827	562,758	511,456	343,641
Northwest Vermont	-	-	-	0.68%	1.05%	1.17%	0.70%	324,836	316,132	284,675	253,501	145,068
Chittenden County	45.96%	46.36%	46.28%	0.46%	1.07%	1.32%	1.35%	149,286	146,571	131,761	115,534	39,600
Addison County	11.35%	11.38%	11.58%	0.62%	0.88%	1.15%	0.37%	36,865	35,971	32,953	29,406	21,912
Franklin County	14.64%	14.37%	14.04%	1.16%	1.28%	1.40%	0.18%	47,556	45,417	39,980	34,788	30,198
Grand Isle County	2.35%	2.18%	1.87%	2.59%	2.64%	1.43%	0.04%	7,643	6,901	5,318	4,613	4,462
Lamoille County	7.52%	7.35%	6.93%	1.25%	1.65%	1.64%	0.39%	24,418	23,233	19,735	16,767	12,289
Washington County	18.18%	18.36%	19.29%	0.44%	0.55%	0.47%	0.45%	59,068	58,039	54,928	52,393	36,607

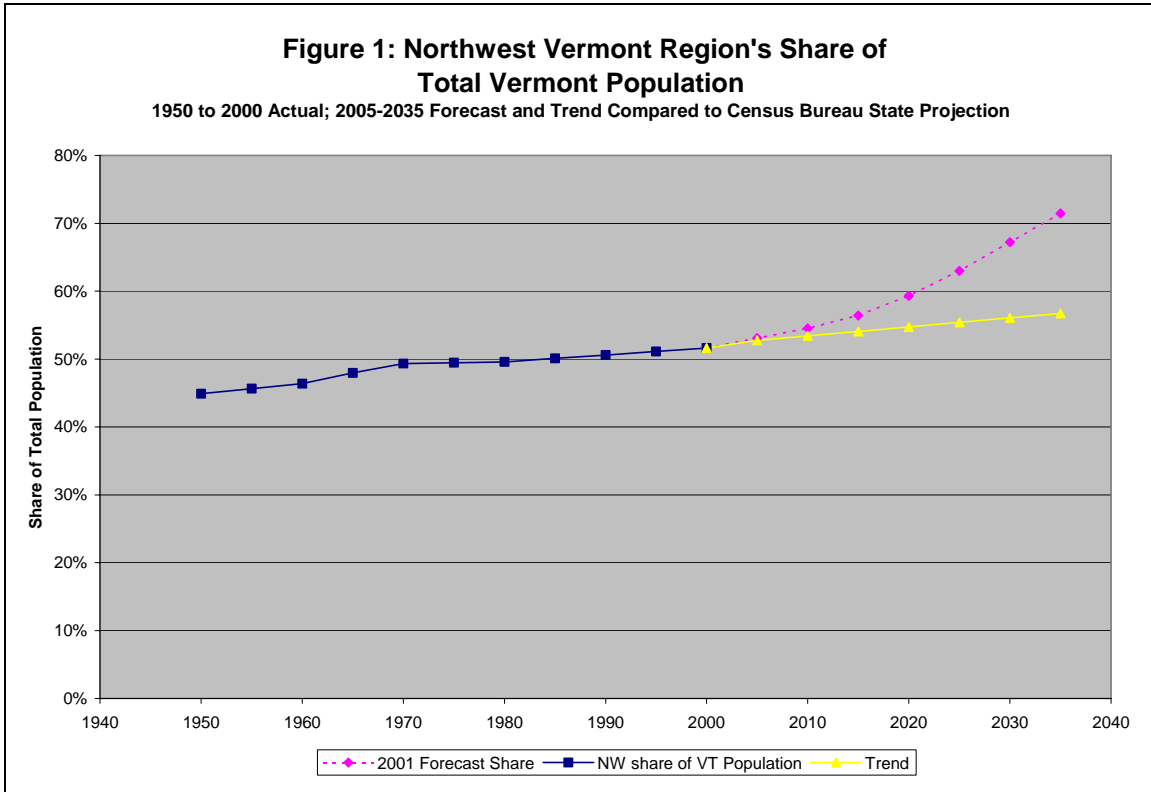
*Compound Annual Average Rate of Growth
**Annual Estimates of the Population for Counties of Vermont: April 1, 2000 to July 1, 2004 (CO-EST2004-01-50) Release Date: April, 2005
Source: Population Division, U.S. Census Bureau

This lower growth rate has also translated to a slight decline in Chittenden's share of regional growth—the 2004 population estimate yields a share of 45.96 percent. Franklin, Grand Isle, Lamoille counties gained in their share of the regional population continuing a trend from 1990.

Extrapolation of the U.S. Census Bureau estimates for population growth in the six county Northwest Vermont Region through 2004 to 2005 suggest that growth in Northwest Vermont during the first five-years of the forecast period was 2.4 percent lower than anticipated (326,915 projection of census estimates versus 334,937 from the 2001 Forecast Update). This is within the forecast's margin of error and does not suggest an adjustment is necessary through the end of the forecast term.

The 2001 Forecast Update for Northwest Vermont projects more population growth for the region through 2035 than Census Bureau estimates for the state would suggest. Census Bureau forecasts for the Vermont as a whole estimate the state's population will reach 711,870 by 2030. Since 1950, the six county Northwest Vermont Region has averaged 48.8 percent of the state's population. This share has increased at an average of just over 0.6 percent every five years from 1950 to 2000. Extending this increase in share into the future to 2030 would bring Northwest Vermont's share of the state population to 57 percent or 408,700. This estimate is 20 percent lower than the 2001 Forecast Update of 514,900 for 2035. Figure 1 illustrates the difference in the extrapolation of Northwest Vermont's share of the Census Bureau's estimates versus the

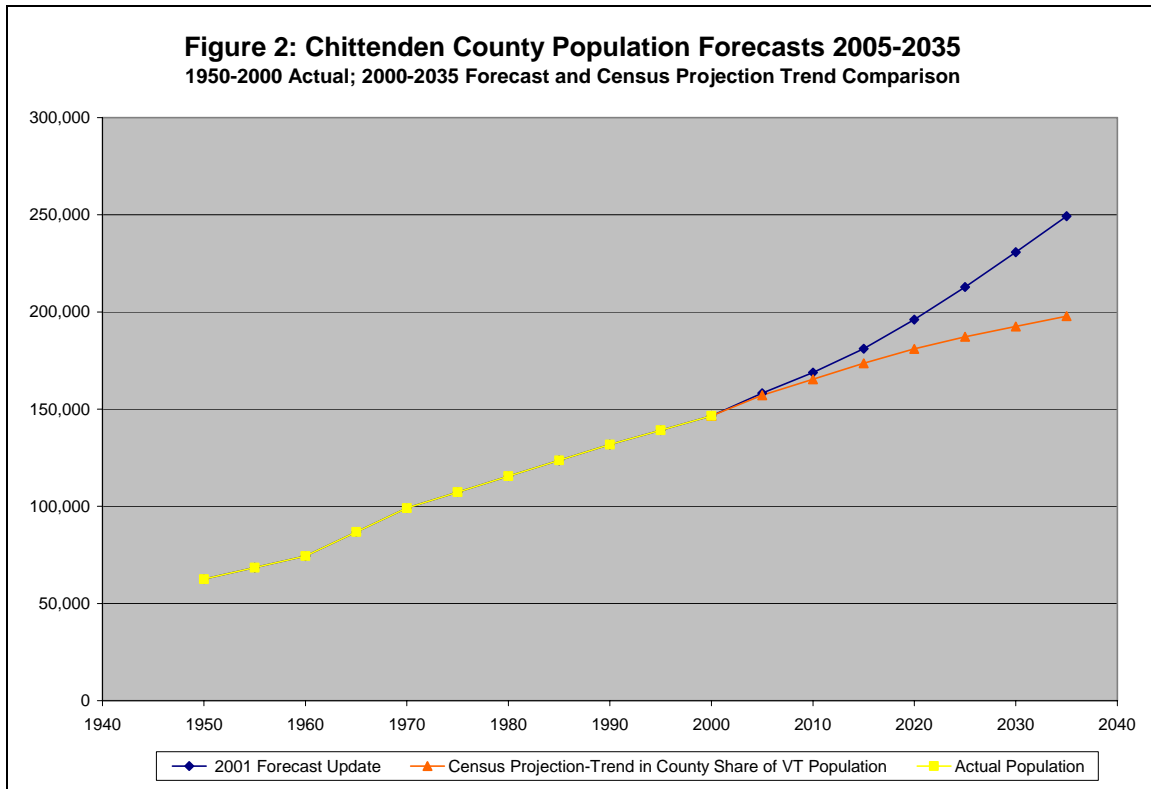
share implied by the 2001 Forecast Update when compared to the Census Bureau’s estimate for the state.



Source: U.S. Census Bureau Projection for State of Vermont, extrapolation of trend for Northwest Vermont’s share of state population; CCMPO/CCRPC 2001 Forecast Update.

The Census Bureau in its projection for Vermont relies on trends in demographic change (births, deaths, and migration) and the state’s trend in share of the nation’s population. The 2001 Forecast Update is based on modeling techniques (REMI model) that consider the region’s competitive advantage, potential for growth in jobs, and the relationship between jobs and population growth. Given the difference in the two methodologies, a difference in population estimates of approximately 20 percent is to be expected. It should also be noted that a statewide forecast using the REMI methodology may likely produce a higher forecast estimate leaving the Northwest Vermont share of the state total in line with historical values.

A lower rate of growth in the region’s population could be expected to affect the population predictions for Chittenden County. Figure 2 illustrates the difference between the 2001 Forecast Update and the estimate based on Census projections for the state described above. As with the regional forecast, the difference for 2035 is approximately 20 percent or 51,400 persons. In each estimate it is assumed that Chittenden County continues to capture a growing share of the Northwest Region’s population. The assumption that Chittenden County maintains a steady rather than growing share of regional and state population is examined in more detail below.



Source: U.S. Census Bureau Projection for State of Vermont, extrapolation of current ratio for Chittenden County's share of state population; CCMPO/CCRPC 2001 Forecast Update.

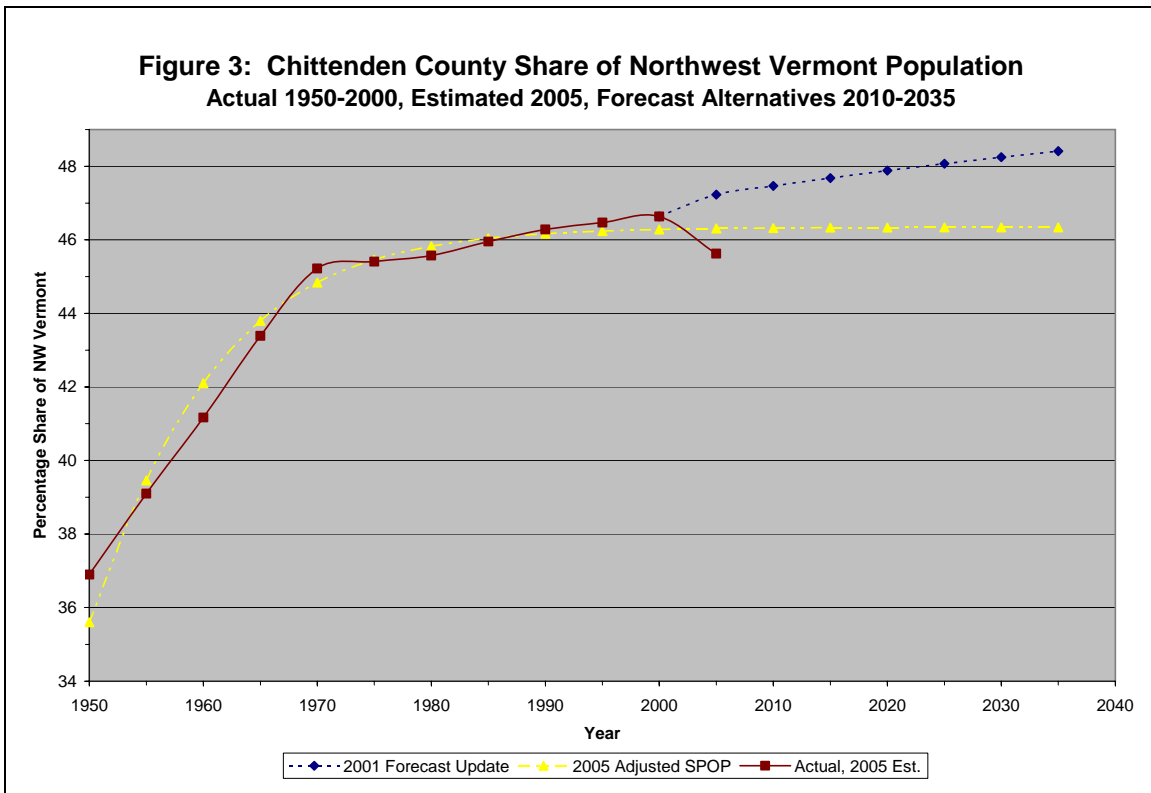
To account for the likelihood that Chittenden County's share of regional growth will post its first decline in over 50 years by 2005, we undertook an analysis of trends in shares by replicating the SPOP² model used to share down the 2001 Forecast Update regional forecast to Chittenden County. This was accomplished in the following steps:

- The SPOP model was adapted to accommodate a 1950-2005 time series in 5-year increments (12 observations up from 6 observations).
- Mid-decade data points (e.g., 1955, 1965) were interpolated from decennial census counts.
- The compound average annual growth observed in the Census Bureau population estimates for 2000 through 2004 (0.46 percent) was applied to the period 2000 to 2005 yielding a Chittenden County share of 45.62 percent of Northwest regional population.
- To confirm the validity of the assumption for 2005 we examined recent trends in building permit applications. Chittenden County's share of the housing units permitted in the Northwest Region declined in the 2003-2004 period in comparison with the 2000-2002 period from 45 percent to 43 percent.³
- To verify the operation of the model we retained the assumptions used in the 2001 Forecast Update and obtained consistent results.
- The SPOP model was run with the 2005 estimate to evaluate the best fitting curve based on the R² statistic.

² Small Area Population Projection method, for more information see Gabbour, I. "SPOP: Small Area Population Projection" in R.E. Klosterman, R.K. Brail, and E.G. Bossard (eds), *Spreadsheet Models for Urban and Regional Analysis*, Center for Urban Policy Research, New Brunswick, New Jersey, 1993.

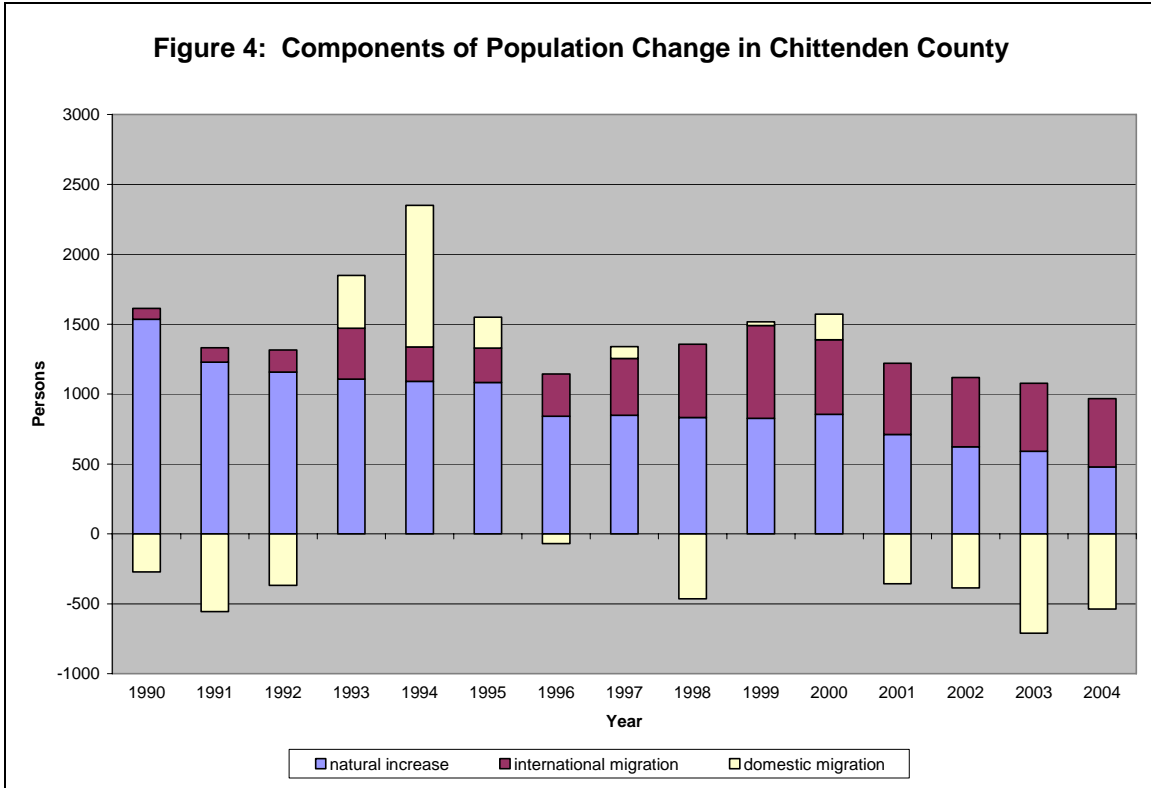
³ U.S. Census Bureau, Monthly New Privately-Owned Residential Building Permits by Place, 1996-2004.

The SPOP procedure determined that the Logistic Curve best fit the data with an R^2 of 0.9670—the equation for this curve is: $y^{-1} = 46.3408^{-1} + 0.0113 (0.5774^x)$. The results of the forecast are illustrated in Figure 3. The 2001 Forecast Update projects a steady increase in Chittenden County’s share of regional population growth from 47.23 in 2005 to 48.41 in 2035. This would result in a total population of 249,257 in 2035. When the 2005 estimate is factored in, the best fitting logistic curve results in a constant share of regional population through the forecast period from 46.33 in 2005 to 46.36 in 2035, yielding a total population of 238,600 in 2035.

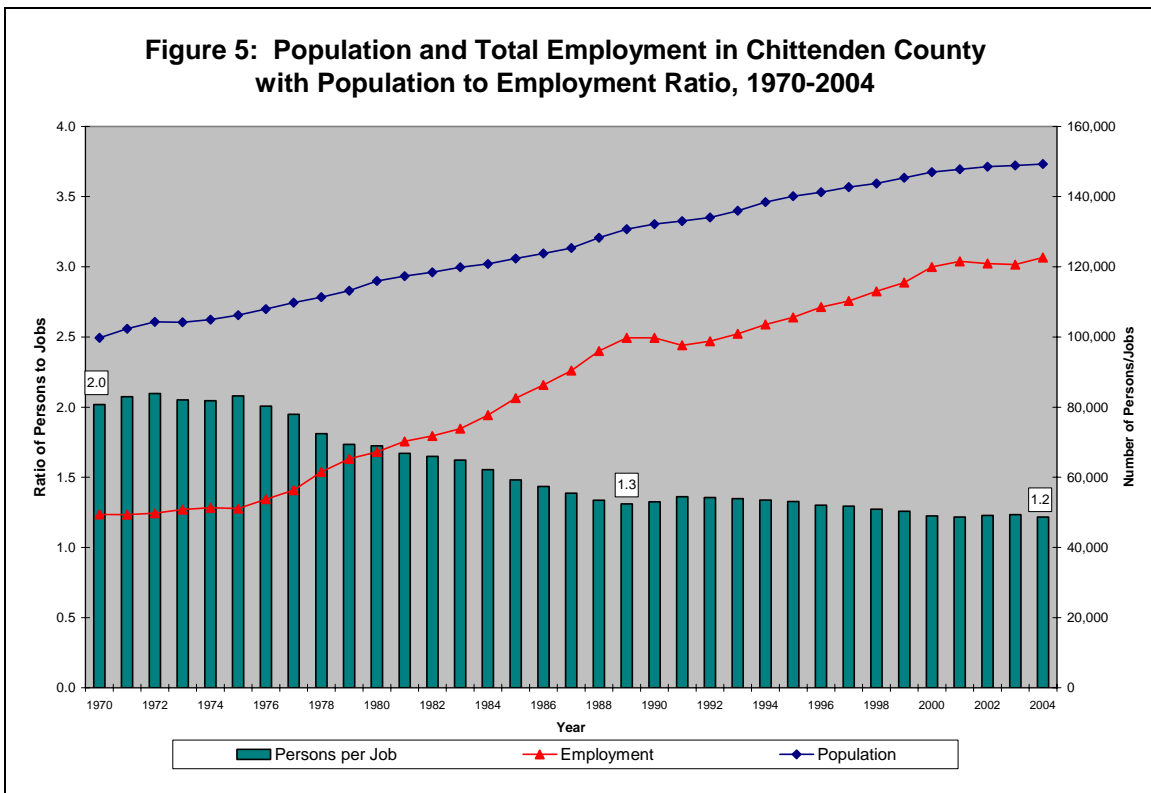


Source: U.S. Census Bureau; CCMPO/CCRPC 2001 Forecast Update.

The decline in the rate and share of population growth in Chittenden County can best be explained through examination of the key components of population change: births, deaths, and net migration. Figure 4 shows these components of change for each year from 1990 to 2004 in Chittenden County as estimated by the U.S. Census Bureau. The graphic shows that while on balance population change has been positive from 2000 through 2004, the contribution of natural increase (births-deaths) has been declining steadily. International immigration remained a significant contributor to population growth but since 2000 the increase in immigration has been countered or outweighed by the number of persons leaving the county to live elsewhere in Vermont and the United States.



Source: U.S. Census Bureau.



Source: U.S. Census Bureau; U.S. Bureau of Economic Analysis, Regional Economic Information System, 2005.

Figure 5 shows trends in population and employment over time and how they are related. In general, since 1970 the total number of jobs in the county has been growing faster than the number of residents. This is due in part to a greater number of households with multiple wage-earners (expanded labor force participation) and wage earners with multiple part-time jobs. It is also due in part to an increase in the number of county jobs held by residents commuting from outside the county. Over time then, the ratio of population to employment has fallen from 2 persons per job in 1970 to 1.2 persons per job in 2004.

The figure illustrates that although population is not as subject to variations in the business cycle as employment, there is some interaction. Downturns or slower rates of employment growth in the county seen in the early 1970s, late 1980s, and over the past four years have been accompanied by a flattening in the growth rate of population. In terms of the components of population change, this interaction between population and employment occurs primarily in the net balance between in-migration and out-migration.

The Vermont Economy Newsletter notes that the latest Census Bureau estimates place Vermont as the 9th slowest growing state in the nation.⁴ The evaluation notes that Vermont's slow rate of growth has mirrored that of other Northeast states—out of pace with high levels of growth in the South and West. Slower growth is attributed to low rates of natural increase and low net migration linked to sluggish economic performance. The economic outlook for 2006 is better, however. Unemployment is low and the labor market has tightened. For the state, small declines in manufacturing and construction are expected, job gains are seen overall (on the order of 0.6 percent), concentrated in health care and professional business services. With unemployment low and prospects for growth in the labor force low—the demand for employment will be satisfied through increased net migration.

3.0 CIRC-WILLISTON FORECASTING APPROACH

The recent trends in population and employment in Chittenden County and Vermont outlined above suggest that methods for developing a revised forecast for use in the Circ-Williston EIS should include a re-evaluation of prospects for employment growth and how that growth could be expected to influence population change through migration to satisfy the demand for labor. Demographic changes such as an aging population and declining birth rates have implications for both future population growth and household formation. Estimation of future households should be linked to these underlying considerations. This section will outline a comprehensive forecasting approach for employment, population, and households to be used in development of baseline future year No-Build assumptions for the Circ-Williston EIS.

3.1 Employment Forecast Approach

Neither the Census Bureau state projections, nor other available demographic projections provide estimates of growth in employment. Adoption of lower estimates for population and households would imply lower forecasts in employment however since levels of overall population and net-migration are closely linked to the demand for labor associated with employment. Employment estimates released since the completion of the 2001 Forecast Update also suggest (at least in the near-term) that those forecasts estimates are not achievable. To investigate the whether a change

⁴ Vermont Economy Newsletter, Volume 16, No. 1, January 2006, Northern Economic Consulting, Inc.

in forecast assumptions for employment is necessary, the consultant team produced an employment forecast for Northwest Vermont as outlined below.

- Step 1 – Assembled data on trends in employment for each of the six-counties in Northwest Vermont. Employment measured is total employment (including wage and salary employment, proprietorship employment, and farm employment) as reported in the U.S. Bureau of Economic Analysis Regional Economic Information System (REIS, 1969 through 2004).⁵

The REIS data source represents the most complete time-series of employment data available for counties in the United States. The earliest year for which the data is assembled is 1969 and the latest full year of data is 2004. Use of the full data series from 1969 to 2004 allows for the inclusion of several iterations of the business cycle (national recessions, oil shocks, periods of economic expansion) and the largest sample of data points for use in a statistical model.

- Step 2 – Assembled data on trends in U.S. Gross Domestic Product (GDP) and productivity (GDP/labor force) for 1969 through 2004 from U.S. Bureau of Economic Analysis, and U.S. Bureau of Labor Statistics. Forecasts on GDP and productivity growth 2005 through 2025 from U.S. Social Security Administration and Congressional Budget Office (CBO) *Current Economic Projections* were obtained.

The forecasts of these key national indicators represented the primary source for a future economic outlook available from the U.S. government and the only publicly available source for this information for the time period required (present through 2025). There are no publicly available sources for state or regional economic outlook corresponding to the time period required.

- Step 3 – Used multivariate, ordinary least-squares regression analysis to establish relationship between national-level economic indicators (GDP and productivity) and total employment for each of the Northwest Vermont Region and each six counties in Northwest Vermont. Annual forecast to 2025 was developed based on model results. County-level models were used to share out Northwest Vermont regional total. Model specified as follows:⁶

Regional or County Employment = $f(\text{U.S. GDP} - \text{U.S. Productivity})$

- Step 4 – For purposes of estimating future retail employment for use as an input to the transportation demand model, the current share of retail to total employment was assumed to hold steady through the forecast term for both county and zonal level totals. To validate and benchmark the forecast against other readily available data, the following additional steps were undertaken.

To validate and benchmark this new employment forecast against other readily available data, the following additional steps were undertaken.

⁵ U.S. Bureau of Economic Analysis, Regional Economic Information System, 2004. This measure of employment would encompass “covered” employment (ES-202 unemployment insurance reporting) and other full and part time positions including self-proprietorships and farm employment.

⁶ See Section 4.1 for results and model statistics as well as information on the performance of the CBO national indicators. See Appendix A for more information on alternate specifications.

- Employment estimates were benchmarked against ratio of employment to labor force and population to determine correspondence of population and employment totals to historic patterns for these indicators.
- Compared/benchmarked against other available forecast sources (2001 Forecast Update, Woods and Poole, Vermont Department of Labor Occupational Projections 1998-2012.)

3.2 Population Projection Method

The methodology used to prepare projections of population and demographic characteristics at the county level is a disaggregate cohort-component method.⁷ The method employs detailed age, and sex data from the U.S. Census Bureau and state agencies. The method produces estimates of population change attributable to natural increase (births minus deaths) and net migration (net population flows into or out of the county). The approach is common to many demographic studies and is consistent with methods used by the Vermont Department of Health and Vermont Department of Aging and Independent Living (DAIL). Age cohort projections provide a useful foundation for estimating underlying trends and forecasts of housing demand, and labor force. The steps for accounting for population growth involve estimating the effect of each component of population change.

The following formula illustrates the accounting technique for capturing the three components of population change from time (t) to time ($t+1$):

$$POP_{it+1} = POP_{it} + Births_i - Deaths_i + In - Migrants_i - Out - Migrants_i$$

Where:

POP_{it+1} = Population residing in region i in end year

POP_{it} = Population residing in region i in base year

$Births_i$ = Number of resident births recorded in region i during interval period

$Deaths_i$ = Number of resident deaths recorded in region i during interval period

$In - Migrants_i$ = Number of persons moving into region i during interval period

$Out - Migrants_i$ = Number of persons moving out of region i during interval period

The following steps describe in detail the method for forecasting the two components of population change.

- Key data sets to support the cohort-component projection model were gathered from publicly available information from the U.S. Census Bureau, and state agencies.

⁷ See Colin Newell, *Methods and Models in Demography*, Belhaven Press, London, 1988.

- Data on Chittenden County population by age in 5-year cohorts for the baseline year of 2000 was obtained from the U.S. Census Bureau. The April population counts from the Census were adjusted to match the Census Bureau estimate of population in July 2000 (mid-year) the basis for the cohort-component projection.
- Vital statistics relevant to Chittenden County and the State of Vermont were obtained from the Vermont Department of Health. Data obtained included fertility rates and mortality rates by 5-year age cohort by sex for 2000 and the latest available year (2003) for Chittenden County and the State of Vermont.
- Data on domestic and international in and out migration by age for 1995-2000 was obtained from the U.S. Census Bureau along with total net migration data 1970-2000 and an estimation on the components of change (births, deaths, migration) in the Census Bureau's estimates for Chittenden County, 2001 through 2004, as well as projected changes in fertility and survival rates (from the middle-series national population projections).
- Labor Force, employment, and unemployment data from 1990 to 2004 for Chittenden County was obtained from the Vermont Labor Market Information Service (Department of Labor).
- The natural increase in population from 2000 to 2005 was estimated through the cohort-component method as follows.
 - Births were estimated by multiplying the age-cohort specific fertility rate by the number of female residents in the baseline population in each age-cohort in the child-bearing years (15-19 through 40-44). Births estimated for each year were reduced by the county-specific infant mortality rate and distributed to the 0 to 1 age cohort and the 1 to 4 age cohort.
 - Population in each cohort was moved forward to the next cohort after accounting for the cohort-specific 5-year survival rates.
 - Fertility and mortality rates and the resultant population estimates were calibrated to match the Census Bureau estimates of births and deaths for the county mid-year 2000 through 2005 (straight-line extrapolation from the 2004 estimate). This resulted in a slight increase in the survival rate and decrease in the fertility rate.
- A baseline estimate of net migration was added to the survived population in 2005 to match Census Bureau estimates mid-year 2000 through 2005 (straight-line extrapolation from the 2004 estimate). The net migration estimate was distributed to the age-cohorts based on in and out-migration estimates for the State of Vermont by age cohort 1995-2000 so that the decreases and increases in each age cohort that sum up to net migration would be available for the calculation of natural increase in the next round (2010).⁸
- The calibrated fertility and survival rates were applied to the 2005 population estimate to produce an estimate of natural increase for 2010 in each age cohort. A net migration estimate corresponding to the average rate of five-year net-migration for the State of Vermont, 1970-2000 (0.27% of total population or approximately 2,000 persons) was added to the survived population as a placeholder for further rounds of calculation.

⁸ Migration patterns by age are available only for the state of Vermont as a whole, not for individual counties. See Richard Klosterman, *Community Analysis and Planning Techniques*, Rowman & Littlefield Publishers, Inc., Savage, Maryland, 1990, pp. 97-99 for "plus-minus" correction factors for distributing net migration estimates.

- The cohort-component accounting exercise was repeated for 2015, 2020, and 2025 as described above. Small adjustments were made in the fertility rates (downward) and survival rates (upward) to account for Census Bureau estimates for change in these indicators through 2030 from in U.S. middle-series population projection. These adjustments allowed the model to account for long-term trends in vital statistics: decline in birth rates and increase in life-expectancy and survival rates. Estimates on the continuation of these trends are available only for the nation as a whole through the U.S. Census Bureau.
- After the initial cohort-component projection was completed, net-migration estimates for 2010 through 2030 were adjusted to account for deficits in the labor force required to meet the employment forecast (see above) in each five-year period. The cohort-component model was then re-run for each time period with these new net-migration estimates. The net-migration estimates based on labor force demand were calculated in the following manner.
 - The working-age population (ages 15 and up) was estimated for the year 2000 and adjusted to account for labor force participation; unemployment rate; and proportion of county residents working within the county and county jobs held by residents of other counties (commute adjustment) to develop an estimate of employment. This was then compared to the total employment figure for 2000 (U.S. Bureau of Economic Analysis) to derive an adjustment to account for part-time employment/dual job-holding proprietorships, etc. (see Table 2). The process was repeated for 2005 using known estimates for labor force participation, unemployment, total employment, and net-migration.
 - The estimated working-age population for the forecast years (2010-2030) was obtained from the initial cohort component model. The parameters for labor force participation, commute adjustment, and total employment adjustment were carried forward for the forecast years; unemployment was set at 3.4 percent. The parameter estimates were used to calculate an estimate of labor force demand. The gap between labor force available (from the cohort component model) and labor force demanded was noted (see Table 2) and the net migration estimate for each forecast year was adjusted until the gap was eliminated. In this way, the population projection takes into account the demand for labor by assuming that shortfalls in the natural increase of the population will be made up through greater positive net migration until the demand for labor is satisfied.

Cohort-component modeling is a time-tested technique for estimating population change. The technique is used by numerous state and regional planning agencies to develop population projections. By itself, the technique is most useful for regions where trends in vital statistics have remained steady over time and where natural increase is a major component of population change. For areas like Chittenden County, where net-migration is a significant proportion of population change, cohort-component techniques are often combined with methods for estimating net migration related to labor force demand to provide a theoretically complete framework of population change. These modeling frameworks are used frequently in state and regional forecasting applications.⁹

⁹ For more information on considerations on migration estimation in cohort-component modeling see Isserman, Andrew M. 1993. "The Right People, the Right Rates: Making Population Estimates and Forecasts with an Interregional Cohort-Component Model," *Journal of the American Planning Association*, Vol. 59, No. 1, pp. 45-64. Examples of regional application of cohort-component forecasts with net-migration estimates adjusted for labor force demand include: Association of Bay Area Governments (Oakland, California): *HENRY—A Regional Simulation System for Demographic-Economic Modeling, 2003*; Atlanta Regional Commission: *2000-2030 Long Range Population and Employment Forecast*; *Washington State Population Projection 2000-2025*, Office of Financial Management 2002; and North

3.3 Household Estimation Approach

The cohort-component projection model described above estimates population only, it does not incorporate estimates of future households or housing need. Since households are the base unit for estimation of travel demand in the model, it is necessary to develop estimates for this key variable as well. Given the approach for population assumptions outlined above, the following steps in estimation of the number of households were followed at the county level in five-year increments from 2000 through 2030.

- Step 1 – Estimates of population by age-cohort (in five-year increments ages 0 through 85 and beyond) assembled for each forecast period.
- Step 2 – The U.S. Census Bureau Public Use Microdata Sample (PUMS - 1 Percent Sample) for Vermont (Super PUMA 50100) was used to develop cross-tabulation of household formation rates (headship rates) and group-quarter rates by age.
- Step 3 – Group-quarters estimates by age group were used to deduct group-quarters population (dormitories, prisons, health institutions) from population in households, calibrate group-quarters rates to Census 2000 100-percent count totals for each county.
- Step 4 – Headship rates were applied to population-in-households for each age-cohort in each county. Calibrated estimated households to Census 2000 100 percent count totals for each county.
- Step 5 – Calibrated group-quarters and headship rates were multiplied by age-cohort estimates for each forecast year for each county to develop household formation estimate. Group-quarters estimates were allowed to grow in proportion to overall population forecast. Household formation estimates by age group were aggregated to county totals.

To validate and benchmark the forecast against other readily available data, the following steps were performed.

- Household estimates for 2005 were benchmarked to near-term Census Bureau estimates available at the county level (2001 to 2004, extrapolated to 2005).
- Average household size for each county in each forecast year was benchmarked against recent trends in the decline in overall household size.

Beyond Chittenden County the DAIL population projections by age cohort were used to develop household estimates in the same manner as described for Chittenden County.

This approach offers an alternative to the application of average household-size factors for the estimation of households and is widely used for regional demographic studies and fiscal impact studies.¹⁰ These studies have shown that differences in the age composition of a region have more effect on the formation of households than other factors which may vary by geography. This approach accounts for the rate at which age groups form households in Vermont and applied

Jersey Transportation Planning Authority: *Access and Mobility 2030*, Appendix A-Regional Demographic Forecasts.

¹⁰Robert W. Burchell and David Listokin, *The Fiscal Impact Handbook: Estimating Local Costs and Revenues of Land Development*, The Center for Urban Policy Research, New Brunswick, NJ, 1978, see Chapter 14, Using Census Data to Calculate Demographic Multipliers, pp. 291-302.

it to the age structure in each county to derive the estimates.¹¹ The approach accounts for different levels of household formation rates as the baby-boom moves through the population and tracks with recently observed trends toward lower average household size.

4.0 CIRC-WILLISTON FORECAST RESULTS

Following the identification of methods, the steps required to develop the baseline future estimates were implemented. This section of the memorandum describes the implementation of the forecasting methods and the results.

4.1 Employment Forecast

To address the need for a revised estimate of future employment, Berger developed a county-level employment forecast for Northwest Vermont as outlined in Section 2.0, above. The forecast method established the relationship between total full and part-time employment in the region and each of the counties with two national level indicators: GDP and productivity.

Assumptions regarding future GDP and productivity through 2025 were obtained from the U.S. Congressional Budget Office's (CBO) *Current Economic Projections* (2005). The CBO estimates an average annual growth in real GDP of approximately 3.2 percent through 2010 and 2.6 percent from 2011 and beyond.¹² Labor force productivity nationally is expected to experience average annual increases of 2.1 percent through the forecast term. Labor force productivity represents the ratio between GDP and labor force—in general the U.S. economy has been able to achieve increases in output per worker over the long term. Productivity increases averaged 1.8 per year from 1950 to 2004.

Tables 6 and 7 show the equations and statistics associated with the regression analyses for the 6-county Northwest Vermont Region and Chittenden County. The forecast equations are specified as follows:

$$\ln(\text{Region Total Employment}) = \beta_0 + \beta_1(\ln(\text{U.S. GDP})) + \beta_2(\ln(\text{Productivity Ratio}))$$

The regression analysis revealed a strong relationship between the national economic indicators and regional and county employment—the variation in these two indicators explains most of the observed variation over the period of analysis: 1969-2004. Each indicator is significant in the estimation and as expected, productivity is negatively correlated with employment growth.¹³

¹¹ PUMS 1-percent Sample data is available only for the State of Vermont as a whole not individual counties.

¹² See Appendix B for notes on the performance of CBO forecasts.

¹³ To ensure the validity of the forecast specification, alternative specifications were tested. These alternative specifications produced fits to historical values consistent with the original specification and forecast values within 1 percent (Northwest Region) and 1.5 percent (Chittenden County) of the results of the original specification. Testing of alternative specifications and additional information on statistical results is outlined in Appendix B.

**Table 2:
Northwest Vermont Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	4.5561	0.1508	30.2096
GDP	1.3692	0.0836	16.3702
Productivity	-1.1435	0.1919	-5.9584

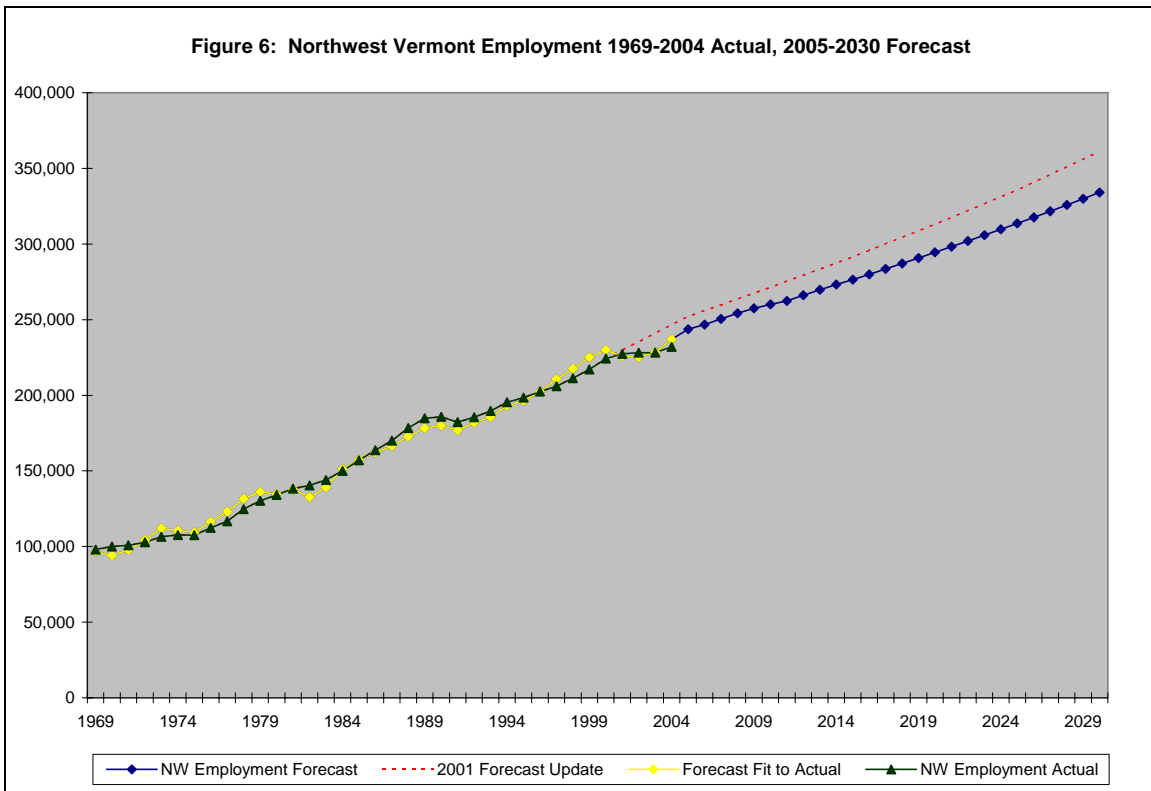
Regression Statistics	
R-squared	0.9945
Adjusted R-sq.	0.9883
Standard Error	0.0310

**Table 3:
Chittenden County Employment Forecast**

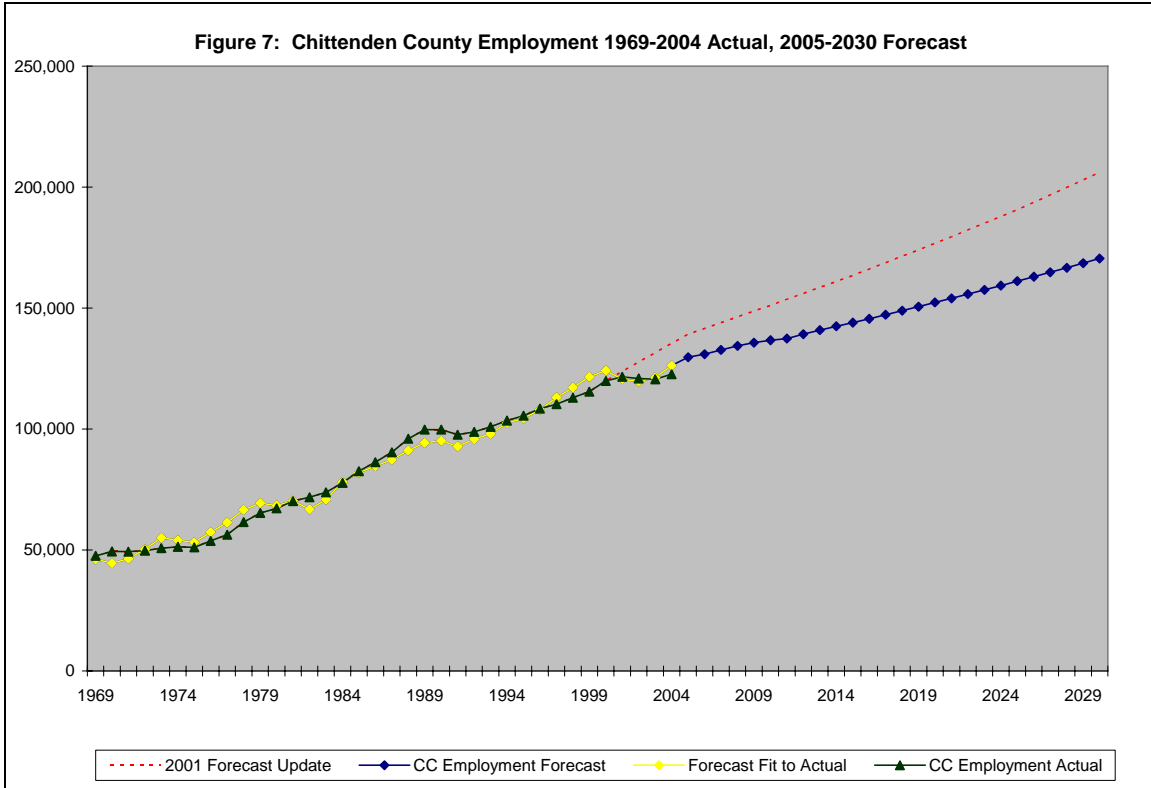
Variable	Coefficients	Standard Error	T-Statistic
Intercept	2.9953	0.2336	12.8243
GDP	1.7011	0.1295	13.1336
Productivity	-1.6459	0.2972	-5.5378

Regression Statistics	
R-squared	0.9898
Adjusted R-sq.	0.9785
Standard Error	0.0481

The fit of the equations to historical data and forecast results for the region and Chittenden County are displayed in Figures 6 and 7. Results of the 2001 Forecast Update are shown for reference.



Source: U.S. Bureau of Economic Analysis Regional Economic Information System, 2005; CCMPO/CCRPC 2001 Forecast Update; The Louis Berger Group, Inc. 2006.



Source: U.S. Bureau of Economic Analysis Regional Economic Information System, 2005; CCMPO/CCRPC 2001 Forecast Update; The Louis Berger Group, Inc. 2006.

The regression analysis was performed for all six counties in Northwest Vermont with similar results in terms of model fit and output values (See Appendix A for details on county models). Since the model specification performed best for the Northwest Region as a whole, that forecast was taken as a control total for each forecast year. The control total was allocated to the counties based on their share of the total as estimated through the individual county forecast estimates.¹⁴ Results are summarized in Table 4 for each five-year period in the forecast term.

¹⁴ The Northwest Regional Forecast yielded slightly better evaluation statistics (adjusted R² and T-statistics for individual variables than many of the county-level forecasts. The regional equation produced a forecast that was 1.2 percent higher than the sum of the county equations—county level totals were adjusted upward to match the regional equation estimate for each forecast year. See Appendix A.

**Table 4:
Employment Forecast Summary**

	2000	2005	2010	2015	2020	2025	2030	CAA	CAA
								2000-2030	1969-2000
Addison	22,025	24,741	27,585	30,237	33,112	36,256	39,693	2.0%	2.6%
% of Region	9.6%	10.2%	10.6%	10.9%	11.2%	11.6%	11.9%		
Chittenden	124,203	129,791	137,465	145,116	153,809	163,000	172,718	1.1%	3.1%
% of Region	54.3%	53.3%	52.8%	52.5%	52.2%	52.0%	51.7%		
Franklin	21,652	23,658	25,568	27,565	29,703	32,002	34,475	1.6%	2.0%
% of Region	9.5%	9.7%	9.8%	10.0%	10.1%	10.2%	10.3%		
Grand Isle	2,176	2,514	2,746	2,992	3,259	3,550	3,865	1.9%	1.9%
% of Region	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.2%		
Lamoille	15,256	16,662	17,711	18,762	19,959	21,230	22,579	1.3%	3.4%
% of Region	6.7%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%		
Washington	43,245	46,232	49,101	51,751	54,603	57,605	60,763	1.1%	2.1%
% of Region	18.9%	19.0%	18.9%	18.7%	18.5%	18.4%	18.2%		
Northwest VT	228,557	243,598	260,177	276,423	294,446	313,643	334,092	1.3%	2.8%

Source: The Louis Berger Group, Inc. 2006.

The application of the forecasting methods outlined above produced an employment forecast for 2030 that is approximately 16 percent lower than the 2001 Forecast Update commissioned by CCRPC/CCMPO. That is outside the margin of error for that forecast but reflective of new data on employment and revised outlook on national indicators available to date. The forecast results are similar to two other available forecast sources: the growth rate implied for the Burlington labor market area from the Vermont Department of Labor 2010 Occupational Forecast, and Woods & Poole a private source of forecast data available through a subscription obtained by CCRPC. Table 5 shows the employment estimates in five-year increments for these available sources. Overall the annual growth rate using the forecast method described in this memo is approximately 1.1 percent.

**Table 5:
Chittenden County Employment Forecast, 2000-2030
Comparison to other available sources**

	2000	2005	2010	2015	2020	2025	2030	CAA
Employment Forecast	124,203	129,791	137,465	145,116	153,809	163,000	172,718	1.1%
2001 Forecast Update	124,203	139,205	151,112	163,466	176,676	190,583	206,027	1.7%
VT Dept. of Labor Growth Rate*	124,203	132,276	140,874	-	-	-	-	1.3%
Woods & Poole	119,519	125,691	133,672	141,658	149,640	157,621	165,594	1.1%

2001 Forecast Update = Economic & Policy Research Forecast, CCMPO/CCRPC, 2001

Dept. of Labor Growth Rate = Annual growth rate from 2002-2012 Occupational Employment Projections, Burlington Area

Woods & Poole = Woods & Poole, Inc., 2005

CAA = Compound Average Annual Growth Rate

Source: The Louis Berger Group, Inc., 2006

4.2 Population Forecast

The cohort-component method produced a projection of population for Chittenden County that reflects key trends in the core components of population change:

- The birth rate in Chittenden County is declining. This is a function of a lower rate of births among women of childbearing age, and declines in the number of women of childbearing age. This is consistent with trends in the state as a whole—overall Vermont

has one of the lowest birth rates in the nation and that is expected to continue into the future.¹⁵

- The survival rate is increasing. Mortality for all age groups is declining and life expectancy is increasing. As the baby boom segment ages, the composition of the population is skewed toward the upper age groups. This is in line with trends for the state and the nation.
- Net migration will need to be an increasing component of population change to meet the demand for labor force implied by the employment forecast. Although the overall rate of growth will be similar to past years, declines in natural increase will need to be compensated by decreases in out-migration of current residents and increases in domestic and international in-migration. This demand for labor force may be mitigated to some extent by increases in labor market participation (such as senior citizens) and growth in dual job-holding and part-time employment.

Table 6 illustrates how the initial results of the cohort-component modeling can be evaluated against demand for labor. The initial estimation included an evaluation of natural increase and an assumed growth in net migration to match historic patterns (approximately 2,000 persons every five years). The table shows how these initial assumptions resulted in a gap between the demand for labor and the supply of workers in the county. The evaluation considered the following factors:

- *Labor force participation* – approximately 70 percent of residents over 15 years of age participated in the labor force in Chittenden County according to the latest estimates of the Vermont Department of Labor.
- *Unemployment* – rates of unemployment from 1993 onward have been at or below 4 percent, this is near full employment and must be accounted for in the estimation.
- *Commute Adjustment* – not every resident of the county works in the county and a significant proportion of county jobs are held by residents of surrounding counties, this has also been factored out of the supply/demand estimation.
- *Total Employment Adjustment* – The total number of jobs usually exceeds the number of workers due to multiple part-time jobs held by the same worker and proprietorships. This was estimated by comparing total employment in 2000 with estimated labor supply. This parameter was carried forward in the analysis.

¹⁵ 2003 State of Vermont Vital Statistics Report, Vermont Department of Health.

Table 6:
Estimate of Labor Force Demand for Net Migration Adjustment

	2000	2005	2010	2015	2020	2025	2030
Working Age Population*	118,202	122,530	125,972	132,364	139,333	148,149	157,438
Labor Force Participation Rate	0.717	0.717	0.717	0.717	0.717	0.717	0.717
Est. Labor Force	84,787	87,792	90,259	94,839	99,832	106,149	112,804
Unemployment	0.040	0.032	0.034	0.034	0.034	0.034	0.034
Commute Adjustment	1,210	1,210	1,210	1,210	1,210	1,210	1,210
Est. Labor Supply	98,498	102,830	105,500	110,853	116,690	124,073	131,852
Est. Total Employment	124,203	129,791	137,465	145,116	153,809	163,000	172,718
Total Employment Adjustment	0.7930	0.7930	0.7930	0.7930	0.7930	0.7930	0.7930
Est. Labor Demand	98,498	102,930	109,016	115,083	121,977	129,266	136,973
Gap - Labor Force Demand vs. Supply	0	100	3,516	4,230	5,287	5,193	5,120
Gap - Total Population**	0	120	4,198	5,050	6,313	6,200	6,114

*Supply Basis: Initial Cohort-Component Model Natural Increase + Historic Net Migration Rate, Age Cohorts 15+

**Gap in total population = approx. 120% of gap in labor force demand vs. supply to account for labor force participation, unemployment, and commute adjustments.

2000, 2005 labor force participation, and unemployment, VT Dept. of Labor.

Source: The Louis Berger Group, Inc., 2006

The estimation of the gap between labor force demand and supply was used to adjust the net migration assumptions in a second round of the cohort-component population projection for each forecast year. In the years 2010 through 2030 it was assumed that net migration would equal the estimate in the last row of Table 6 so that total population and labor force would be balanced with the employment estimate. The assumption for net migration for 2005 is based on the Census Bureau estimate of the net balance of in and out-migration for Chittenden County for 2000 through 2004.

Table 7 shows the results of the cohort-component projection method and the adjustments in net migration to meet the demand for labor implied in the county employment forecast.

Table 7:
Chittenden County Population Projection, 2000-2030
Components of Change

	2000*	2005	2010	2015	2020	2025	2030
Births	8,955	8,043	7,533	7,438	7,440	7,634	7,862
Deaths	3,895	4,897	5,441	5,849	5,806	4,911	4,385
Natural Increase	5,061	3,146	2,093	1,588	1,633	2,722	3,476
Net Migration	2,616	120	4,198	5,050	6,313	6,200	6,114
Total Increase	7,677	3,266	6,291	6,638	7,946	8,922	9,590
Total Population	146,973	150,239	156,530	163,168	171,114	180,037	189,627
CAA**	1.1%	0.4%	0.8%	0.8%	1.0%	1.0%	1.0%

* 2000 Total Population represents Census Bureau mid-year (July) estimate not April 100% count.

Components of change and average annual growth for 2000 derived from 1995 intercensal estimate.

**CAA = compound average annual growth.

Source: The Louis Berger Group, Inc., 2006

The projection for Chittenden County is shown in reference to the other counties in Northwest Vermont in Tables 8 and 9. For those counties, population is derived from the Census Bureau, projection for the State of Vermont as a whole, distributed to the counties based on each county's share of the state total in the DAIL projection.¹⁶ When combined with the projection for

¹⁶ Project schedule and resources did not permit development of a cohort-component model for counties outside of Chittenden. Results of the cohort-component projection in Chittenden for 2025 are within 2 to 3

Chittenden County described here, the overall trend is for a relatively steady share in Chittenden County's share of the region's population with slightly growing shares for surrounding counties, consistent with recent trends.

Table 8:
Projected Population by County, 2000-2030, Northwest Vermont

	2000	2005	2010	2015	2020	2025	2030	CAA
Northwest Vermont	316,135	331,170	345,441	359,006	371,111	384,465	403,215	0.81%
Addison County	35,974	38,161	39,576	40,785	41,459	42,378	44,277	0.69%
Chittenden County	146,571	150,239	156,530	163,168	171,114	180,037	189,627	0.86%
Franklin County	45,417	49,042	51,766	54,338	56,300	57,548	60,126	0.94%
Grand Isle County	6,901	7,645	8,271	8,863	9,328	9,535	9,962	1.23%
Lamoille County	23,233	25,174	26,728	28,121	29,051	29,695	31,025	0.97%
Washington County	58,039	60,910	62,569	63,730	63,858	65,272	68,197	0.54%

Notes: Chittenden County forecast source: The Louis Berger Group, Inc., 2006

Other Counties: DAIL county projections adjusted to match Census Interim Population Projections for State of Vermont

CAA = Compound Average Annual Growth Rate

Source: The Louis Berger Group, Inc. 2006.

Table 9:
Projected County Shares of Regional Population, 2000-2030, Northwest Vermont

	2000	2005	2010	2015	2020	2025	2030
Addison County	11.4%	11.5%	11.5%	11.4%	11.2%	11.0%	11.0%
Chittenden County	46.4%	45.4%	45.3%	45.4%	46.1%	46.8%	47.0%
Franklin County	14.4%	14.8%	15.0%	15.1%	15.2%	15.0%	14.9%
Grand Isle County	2.2%	2.3%	2.4%	2.5%	2.5%	2.5%	2.5%
Lamoille County	7.3%	7.6%	7.7%	7.8%	7.8%	7.7%	7.7%
Washington County	18.4%	18.4%	18.1%	17.8%	17.2%	17.0%	16.9%

Source: The Louis Berger Group, Inc. 2006.

Table 10 compares the cohort-component forecast totals to the DAIL projection (extrapolated through 2030) and the 2001 Forecast Update for Northwest Vermont and Chittenden County for 2030. For Chittenden County the method described in this memo produces a projection with an average annual growth rate (0.86 percent) that falls between the 2001 Forecast Update (1.5 percent) and the DAIL projection (0.61 percent). Results for Chittenden County are further illustrated in Figure 8.

percent of results that would be expected through a distribution of the Census projection for the state or the DAIL projection (see Table 11).

**Table 10:
2030 Population Forecast Comparison**

	2001			DAIL	Diff. from 2001	CAA	Cohort Projection	Diff. from 2001	CAA
	Forecast	CAA	2000-30						
2000	2030	2000-30		2030	Forecast	2000-30	2030	Forecast	2000-30
Chittenden	146,571	230,798	1.52%	175,690	-23.9%	0.61%	189,627	-17.8%	0.86%
Other NW VT	169,564	247,592	1.27%	203,170	-17.9%	0.60%	213,588	-13.7%	0.77%
All NW VT	316,135	478,390	1.39%	378,860	-20.8%	0.61%	403,215	-15.7%	0.81%

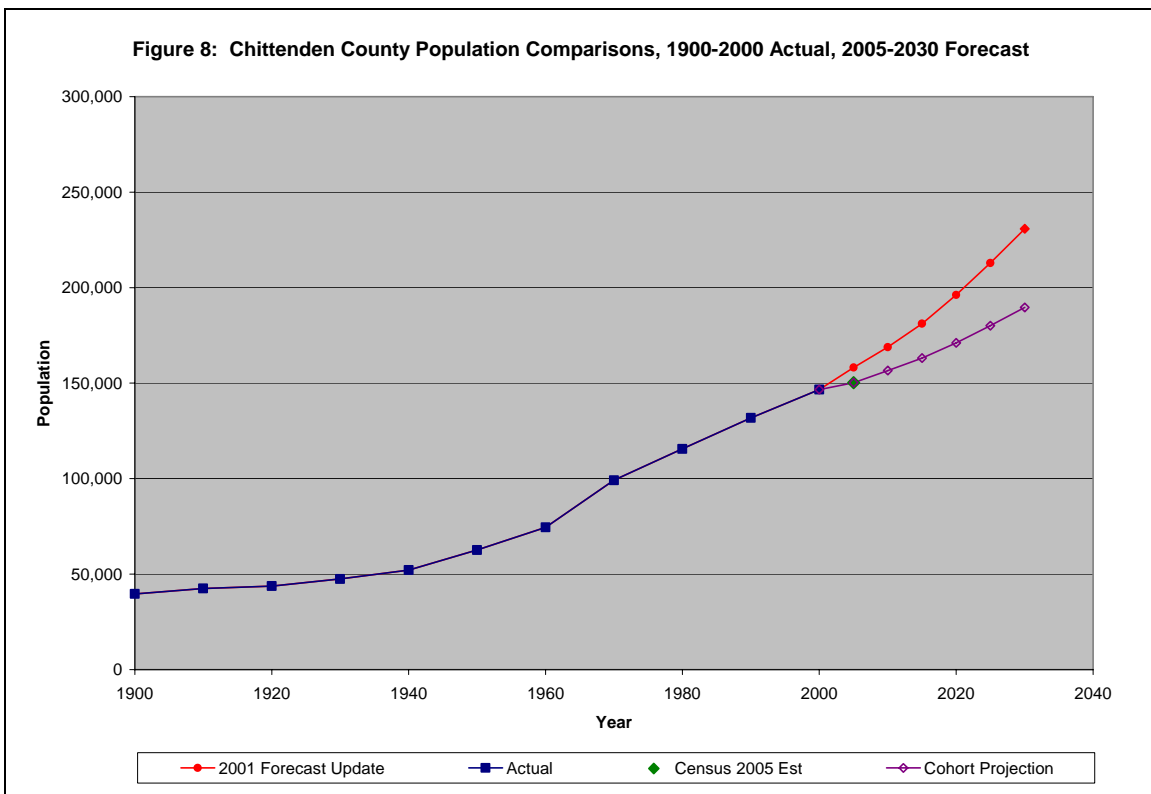
Notes:

CAA = Compound Annual Average Growth Rate

2001 Forecast = Northwest Vermont and Chittenden County Economic and Demographic Forecast, 2030 (2000, updated 2001)

DAIL = Department of Aging and Independent Living 2020 Forecast extrapolated to 2030.

Cohort Projection source: The Louis Berger Group, 2006.



Source: CCMPO/CCRPC 2001 Forecast Update; The Louis Berger Group, Inc. 2006.

The population projection for Chittenden County described in this memo is approximately 18 percent lower than the 2001 Forecast Update, as would be expected in a projection based on data reflecting slower rates of growth since the 2000 Census. The projection method described in this memo is similar to other currently available forecast sources as depicted in Table 11.

Table 11:
Chittenden County Population Projection, 2000-2030
Comparison to other available sources

	2005	2010	2015	2020	2025	2030
Cohort Projection	150,239	156,530	163,168	171,114	180,037	189,627
2001 Forecast Update	158,194	168,883	181,134	196,161	212,884	230,798
DAIL	152,846	157,471	161,491	165,813	-	-
Census State Proj.	154,078	160,740	166,684	171,948	176,891	180,461
Census County Est.	150,239	-	-	-	-	-
Woods & Poole	151,550	158,145	165,161	172,484	180,183	188,515

2001 Forecast Update = Economic & Policy Research Forecast, CCMPO/CCRPC, 2001

DAIL = VT Dept of Aging and Independent Living Projection, 2003

Census State Proj. = Census Bureau Projection for VT, county share from DAIL, 2001

Census County Est. = Census Bureau Estimate for 2000-2004 extrapolated to 2005

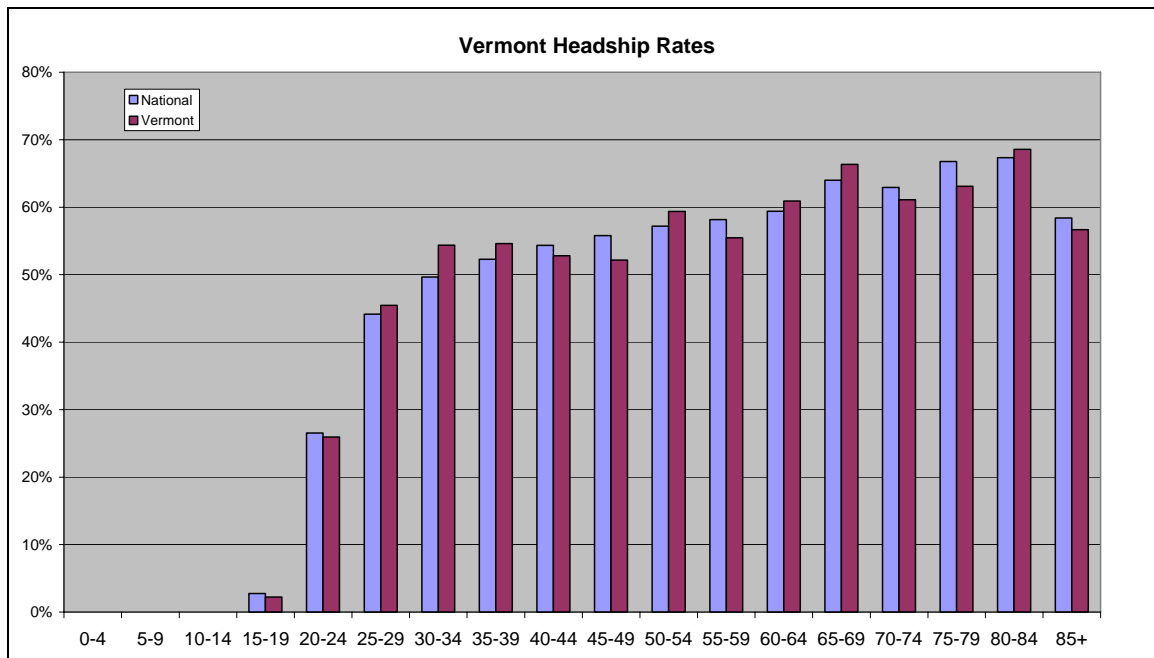
Woods & Poole = Woods & Poole, Inc., 2005

Source: The Louis Berger Group, Inc., 2006

4.3 Household Projections

As outlined in Section 3.3, age detail in the cohort-component model may be used to develop projections of the number of households by applying average rates of household formation (headship) in each age group after adjusting for population in group quarters. For the Circ-Williston EIS estimate of future households, headship rates for Vermont were compiled from the U.S. Census Bureau Public Use Microdata Sample (PUMS) for the state (Super PUMA 50100). Household formation rates for each age group in Vermont and those in the U.S. as a whole are illustrated in Figure 9.

Figure 9



Source: The U.S. Census Bureau, Public Use Microdata Sample (PUMS), 2000.

Household formation rates and the adjustment for group-quarters population in Chittenden County for the 2000 baseline year are illustrated in Table 12 below.

Table 12: Estimated Population in Group Quarters and Households, Chittenden County, 2000

Age	Population	GQ Pop	Calibrated GQ Rate	Pop. in Households	Household Headship	Calibrated Headship Rate	Avg. HH Size
0-4	8,487	0	0.0%	8,487	0	0.0%	
5-9	10,012	0	0.0%	10,012	0	0.0%	
10-14	10,193	0	0.0%	10,193	0	0.0%	
15-19	11,861	2588	21.8%	9,273	306	2.6%	
20-24	13,191	2660	20.2%	10,531	2,787	21.1%	
25-29	10,272	113	1.1%	10,159	5,200	50.6%	
30-34	10,933	113	1.0%	10,820	7,217	66.0%	
35-39	12,685	100	0.8%	12,585	7,467	58.9%	
40-44	13,066	215	1.6%	12,851	6,248	47.8%	
45-49	11,310	126	1.1%	11,184	5,152	45.5%	
50-54	9,438	0	0.0%	9,438	4,115	43.6%	
55-59	6,624	106	1.6%	6,518	5,810	87.7%	
60-64	4,719	51	1.1%	4,668	3,008	63.7%	
65-69	3,930	112	2.8%	3,818	2,729	69.4%	
70-74	3,434	200	5.8%	3,234	2,195	63.9%	
75-79	2,718	166	6.1%	2,552	1,795	66.0%	
80-84	1,858	212	11.4%	1,646	1,333	71.7%	
85+	1,840	669	36.4%	1,171	1,091	59.3%	
Totals	146,571	7,431	5.1%	139,140	56,452	38.5%	2.46

Source: U.S. Census Bureau, SF1; DAIL Forecast, PUMS household file.

When calibrated household formation and group-quarters rates are applied to projected age cohorts for each county in each forecast year, an estimate of household formation can be derived. Households and population in households for each forecast year is summarized below for Chittenden County and the remainder of the Northwest Vermont region.

**Table 13:
Household Projection Summary, 2000-2030**

		2000	2005	2010	2015	2020	2025	2030
Chittenden County	Households	56,452	59,859	64,082	68,655	73,763	79,621	85,582
	Population in Households	139,140	142,622	148,719	155,155	162,890	171,590	180,947
	Avg. HH Size	2.46	2.38	2.32	2.26	2.21	2.16	2.11
Other NW Vermont Counties	Households	65,474	70,946	76,074	81,081	84,255	86,013	89,768
	Population in Households	162,584	172,072	179,634	186,234	189,512	191,178	197,733
	Avg. HH Size	2.48	2.43	2.36	2.30	2.25	2.22	2.20

Source: Louis Berger Group, Inc., 2006

The rate of decline in average household size implied in these projections is consistent with U.S. Census Bureau estimates for 2004 from the American Community Survey (ACS) for Vermont. The ACS estimates that household size has declined from 2.44 to 2.41 for the state as a whole from 2000 to 2004. ACS estimates are not available at the county level in Vermont.

4.4 Summary

The revised population, household, and employment forecasts discussed in this memorandum are summarized in Table 14 for Chittenden County and the Northwest Vermont region as a whole.

Table 14
Circ-Williston EIS, Population, Household, and Employment Estimates

		2000	2005	2010	2015	2020	2025	2030
Chittenden County	Population	146,571	150,239	156,530	163,168	171,114	180,037	189,627
	Households	56,452	59,859	64,082	68,655	73,763	79,621	85,582
	Employment	124,203	129,791	137,465	145,116	153,809	163,000	172,718
Other NW Vermont Counties	Population	169,564	180,931	188,911	195,838	199,996	204,428	213,588
	Households	65,474	70,946	76,074	81,081	84,255	86,013	89,768
	Employment	100,080	113,807	122,711	131,308	140,637	150,643	161,374

Source: The Louis Berger Group, Inc. 2006.

Table 15
Ratio of Population to Employment, Chittenden County

	2000	2005	2010	2015	2020	2025	2030
Cohort Projection	1.18	1.16	1.14	1.12	1.11	1.10	1.10
2001 Forecast Update	1.18	1.14	1.12	1.11	1.11	1.12	1.12

Source: The Louis Berger Group, Inc. 2006.

The 2001 Forecast Update took into account the relationship between population and employment as it has changed over time and is likely to change in the future. The forecast produced for the Circ-Williston EIS as described in this memorandum, while lower in magnitude for each variable captures the decline in the ratio of population to employment over time and corresponds closely to the magnitude of the relationship between these output variables as outlined in Table 15.

Table 16:
Forecast Revision Summary, 2000-2030

		Baseline 2000	Forecast Revision 2030	CAA	2001 Forecast Update 2030	CAA	% Difference
Chittenden County	Population	146,571	189,627	0.86%	230,798	1.52%	-17.8%
	Households	56,452	85,582	1.40%	102,652	2.01%	-16.6%
	Employment	124,203	172,718	1.11%	206,027	1.70%	-16.2%
Northwest Vermont Region	Population	316,135	403,215	0.81%	478,390	1.39%	-15.7%
	Households	121,926	175,350	1.22%	212,500	1.87%	-17.5%
	Employment	227,104	334,092	1.30%	361,070	1.56%	-7.5%

Source: The Louis Berger Group, Inc., 2006

The estimates for employment, households, and population developed for use as the baseline No-Build assumptions for the Circ-Williston EIS are based on established modeling techniques and use the latest available data sources for national, state, and county indicators that are used in the estimation process. Evaluation statistics for the employment forecast for the counties and the Northwest Vermont Region as a whole indicate a margin of error of 7 percent to 10 percent per year in the forecast. Since population and households are related to employment through the

estimation of net-migration and the demand for labor, it can be expected that these forecasts will have a similar margin of error.

Benchmarking with other available forecasts indicates that the estimates produced for the Circ-Williston EIS are consistent with other recent employment and population projections.

As the evaluation of the previous forecast commissioned for the region indicates, variation in results can be expected in the near-term and long-term especially during periods of change in local and regional employment conditions. Since other variables are involved in the estimation process, the consultant team will explore the sensitivity of the model outputs to reasonably expected variations in the model input variables. These sensitivity tests will be documented in a subsequent technical memorandum.

Appendix A – County Employment Model Results

To develop estimates of county-level employment for the six-county Northwest Vermont region, a forecast model was developed for the region as a whole, and for each of the six counties individually. Results from the regional model and from the sum of the counties models produced results that were very close overall. For example, the regional model estimate for employment in 2025 was 313,643; the sum of the counties models totaled 310,035—a difference of 1.2 percent. The regional model fit to the historic employment series (Adjusted $R^2 = .988$) and the significance of the individual variables in the equation were marginally better overall than some of the individual equations in the county models. In one of the county models (Franklin) the productivity variable was not significant in the equation and was omitted, in Grand Isle the productivity variable was retained but significance is low. In the other county models the overall fit and significance of the variables was found to be comparable to the regional model. Results and summary statistics of the individual county models are presented below. Because the regional model performed better overall than the county models the regional employment estimate in each forecast year was used as a control total and distributed to each county based on each county's share of the total in the forecast models. This resulted in each county total being adjusted upward by approximately 1 percent. An example of this allocation for 2025 is provided in Table A-1.

Table A-1
2025 County-Level Employment Forecast Totals
Compared with Allocated Regional Total

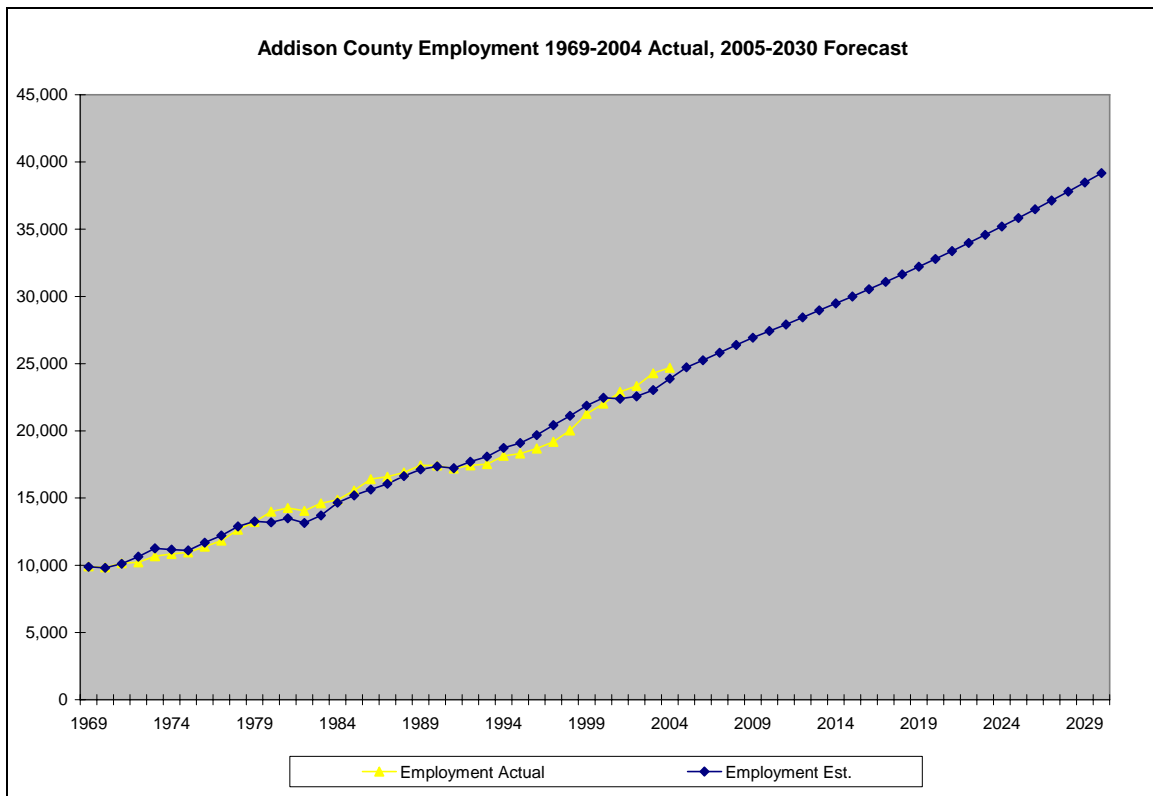
	2025 Allocated	2025 Forecast	% Difference
Addison	36,256	35,839	1.2%
<i>% of Region</i>	11.6%	11.6%	
Chittenden	163,000	161,125	1.2%
<i>% of Region</i>	52.0%	52.0%	
Franklin	32,002	31,634	1.2%
<i>% of Region</i>	10.2%	10.2%	
Grand Isle	3,550	3,509	1.2%
<i>% of Region</i>	1.1%	1.1%	
Lamoille	21,230	20,986	1.2%
<i>% of Region</i>	6.8%	6.8%	
Washington	57,605	56,942	1.2%
<i>% of Region</i>	18.4%	18.4%	
Northwest VT	313,643	310,035	1.2%

Source: The Louis Berger Group, Inc. 2006.

**Table A-2
Addison County Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	2.3618	0.1845	12.8001
GDP	1.0384	0.1023	10.1483
Productivity	-0.4500	0.2348	-1.9167

Regression Statistics	
R-squared	0.9821
Adjusted R-sq.	0.9810
Standard Error	0.0380

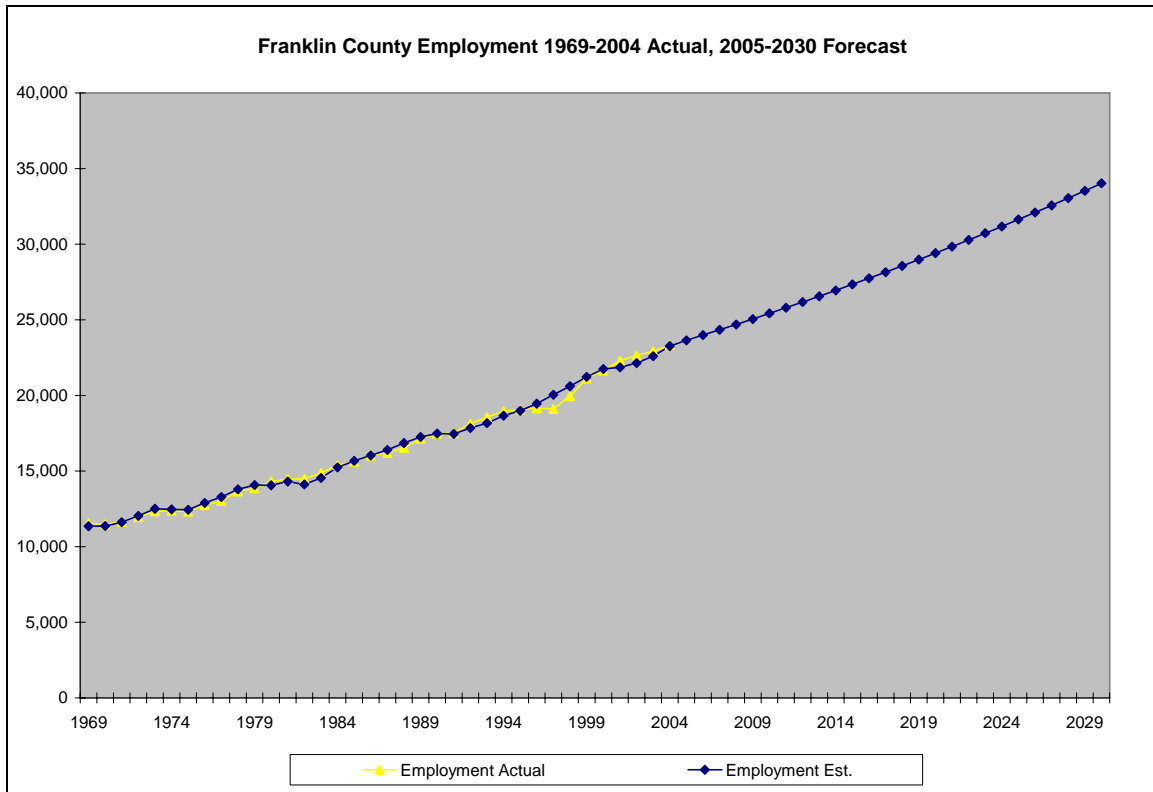


Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

**Table A-3
Franklin County Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	3.7488	0.0775	48.3492
GDP	0.6787	0.0089	76.6457
Productivity	N/A*		

Regression Statistics	
R-squared	0.9942
Adjusted R-sq.	0.9941
Standard Error	0.0169

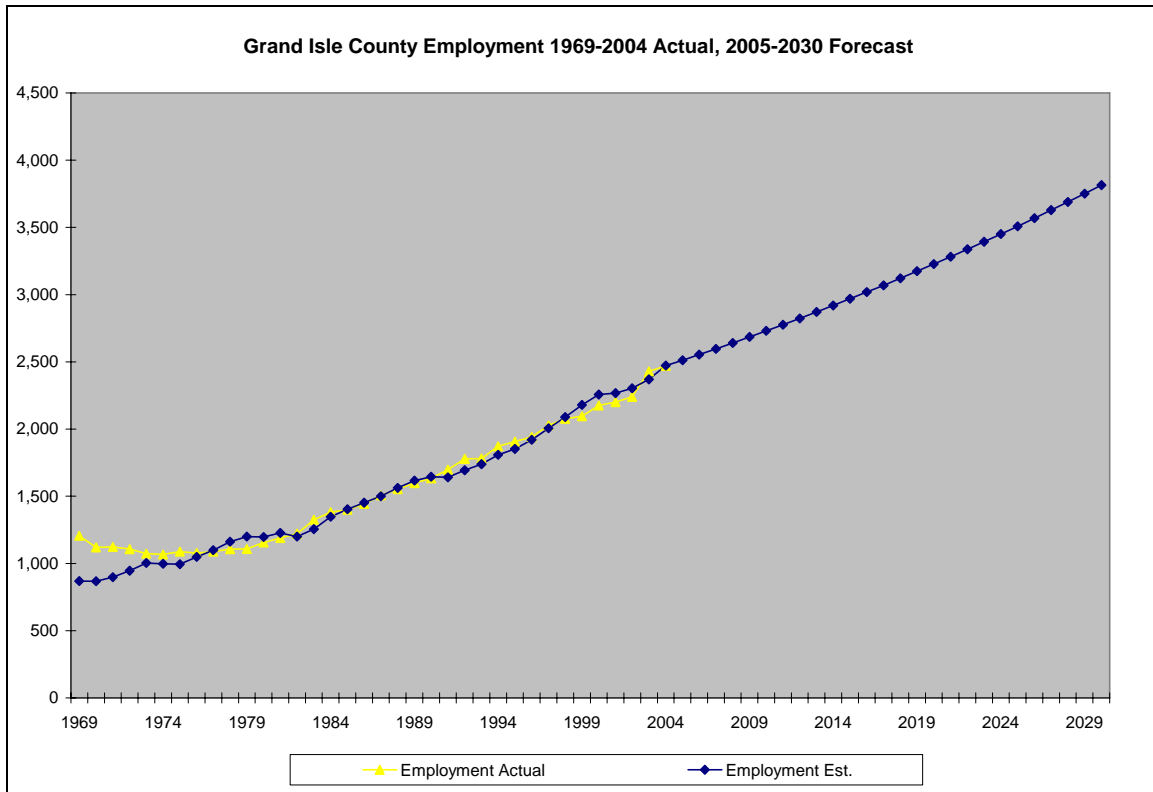


Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

**Table A-4
Grand Isle County Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	-1.3657	0.2994	-4.5618
GDP	1.0487	0.1894	5.5380
Productivity	-0.1316	0.3680	-0.3577

Regression Statistics	
R-squared	0.9826
Adjusted R-sq.	0.9811
Standard Error	0.0325

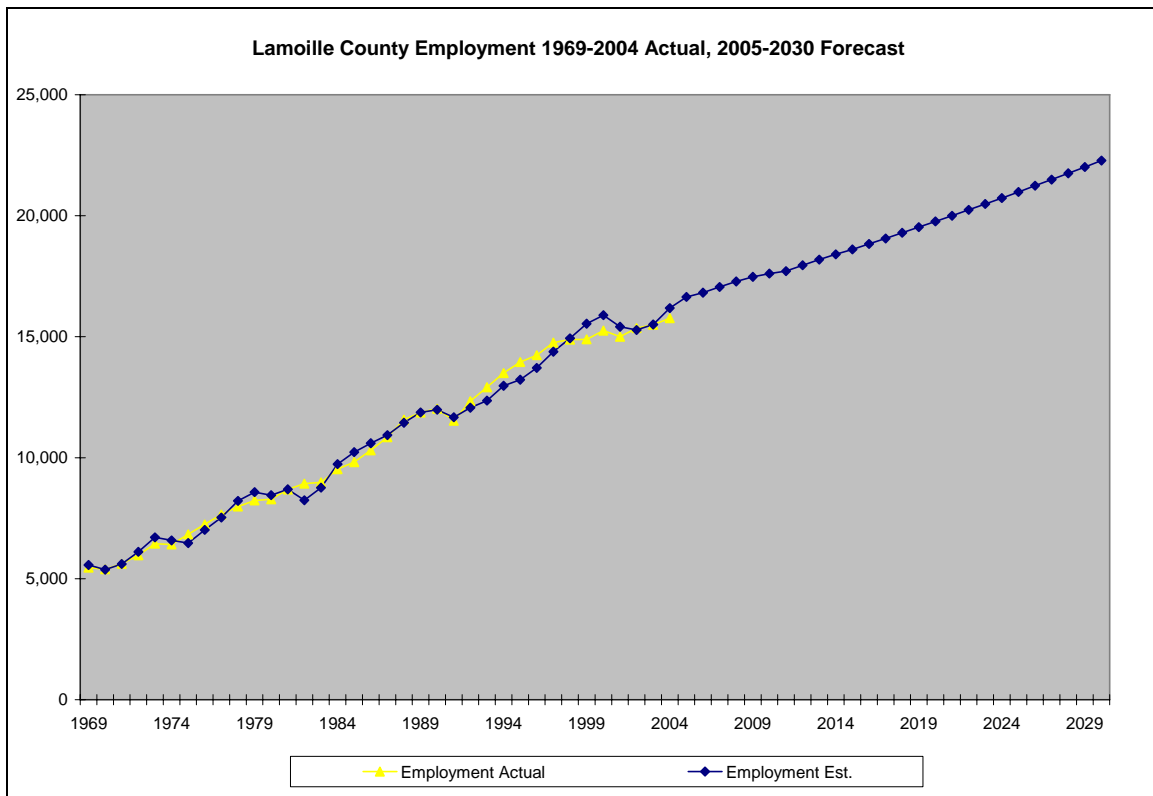


Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

**Table A-5
Lamoille County Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	0.4270	0.1576	2.7100
GDP	1.7966	0.0874	20.5591
Productivity	-1.7330	0.2005	-8.6422

Regression Statistics	
R-squared	0.9917
Adjusted R-sq.	0.9912
Standard Error	0.0324

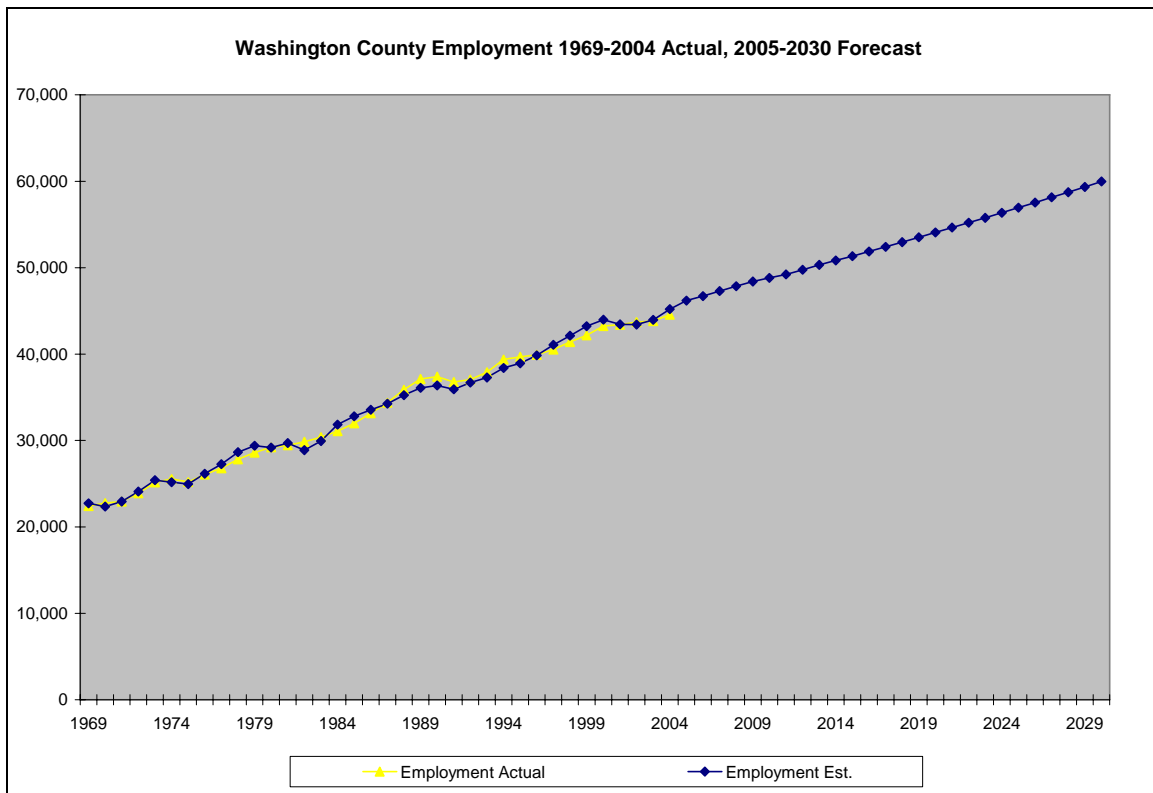


Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

**Table A-6
Washington County Employment Forecast**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	4.7241	0.0890	53.0864
GDP	1.0100	0.0493	20.4659
Productivity	-0.7908	0.1132	-6.9830

Regression Statistics	
R-squared	0.9934
Adjusted R-sq.	0.9930
Standard Error	0.0183



Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

Appendix B – Data Sources and Alternative Employment Model Specifications

In the development of the forecast models, several alternative specifications were tested to determine the best performing forecast models. Performance of the forecast models was judged by the goodness of fit to the historical employment data, significance of the individual variables in the forecast model, standard error, and the reasonableness of the forecast result given previous rates of growth and comparisons with the other models developed for the counties and the region.

The development of the forecast model required both a full time-series of historical data points for the independent variables to match the data series available for the dependent variable (county and regional total employment from 1969 to 2004) and a forecast for the independent variables through 2030. Review of publicly available data sources revealed that U.S. Congressional Budget Office (CBO) estimates for Gross Domestic Product, productivity, and national labor force were the best available sources for independent variables.

The reliability of data inputs is an important consideration in the evaluation of a forecast model. Recently the CBO released an evaluation of the performance of its short-term forecasts (*CBO's Economic Forecasting Record, 1976-2003*, Congressional Budget Office, October 2005) indicating that its results are comparable to other available private forecasting products and that on the whole the model has a bias to underpredict growth in output by 0.3 to 0.4 percentage points based on an evaluation of mean error.

Several alternative model specifications were tested during the development of the employment forecast models. Each independent variable was tested on its own and in combination with other variables. First differences, forecasts of shares, log transformations, and other alternatives were tested. For example, the consultant team initially evaluated fitting curves to historic time-series of county shares of the regional employment total as a method for distributing regional employment forecasts to counties, but found this approach problematic due to the recent decline in the Chittenden County share since 2000. Forecasting with shares at this transition point through a curve fitting exercise (as employed by EPR in the previous forecast) yielded several plausible fits for curves with markedly divergent results (see Section 2.0 above).

Overall, the specification outlined in Section 4.1 proved to be the best performing in terms of the evaluation statistics and model outputs.

Inclusion of the productivity measure in addition to the GDP variable, was found to contribute to the performance of the model and the interpretation of its results. In the Chittenden County employment forecasting model, for example, inclusion of the productivity measure increases the adjusted R^2 and decreases overall standard error indicating a better fit between historical employment estimated with the equation (backcast) and actual employment. The variable allows the model to account for increasing output per employee a trend that is expected to continue into the future.

Although the model results are stable in that they produce similar results for both the regional and the county formulations, statistical tests indicated the presence of co-linearity in the model specification due to the presence of GDP as an independent variable itself and the formulation of the productivity variable. Co-linearity is not necessarily a flaw in a forecasting model but can in some case lead to instability in model results as input variables are altered. To ensure the validity of the specification for forecasting, an alternative specification (differing independent variables and formula structure) was developed and tested against the original formulation. To eliminate co-linearity, the productivity variable was transformed into an index. (Productivity index = percent change in productivity over previous year / average percent change in productivity for series 1969-2004). The specification with the best performance with these variables substituted the CBO estimate of national labor force for GDP as follows:

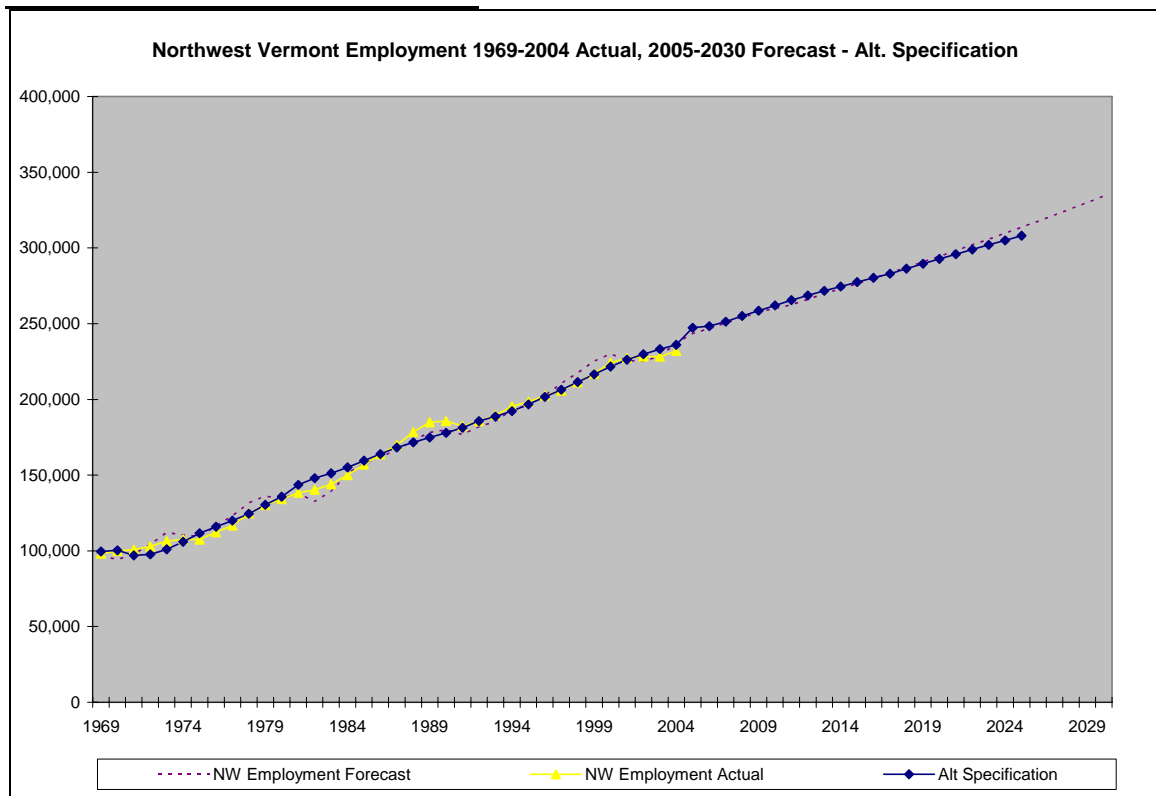
$$(\text{Region Total Employment}) = \beta_0 + \beta_1(\text{U.S. Labor Force}) + \beta_2(\text{Productivity Index})$$

This alternative specification produced summary statistics and results close to that of the original specification—supporting the validity of the modeling framework. The 2025 estimate for employment in the region produced by this specification is 1.8 percent lower for the regional model and 3.5 percent higher for the Chittenden County model. The confidence interval at 95% for the regional model is ± 7.7 percent and for the county model, ± 10.1 percent. Results of the alternative specification are presented below.

**Table B-1:
Northwest Vermont Employment Forecast - Alt.
Specification**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	-93430.1	4407.5	-21.2
US Labor Force	1614.3	34.0	47.4
Productivity Index	7202.4	1863.1	3.9

Regression Statistics	
R-squared	0.9918
Adjusted R-sq.	0.9913
Standard Error	4160

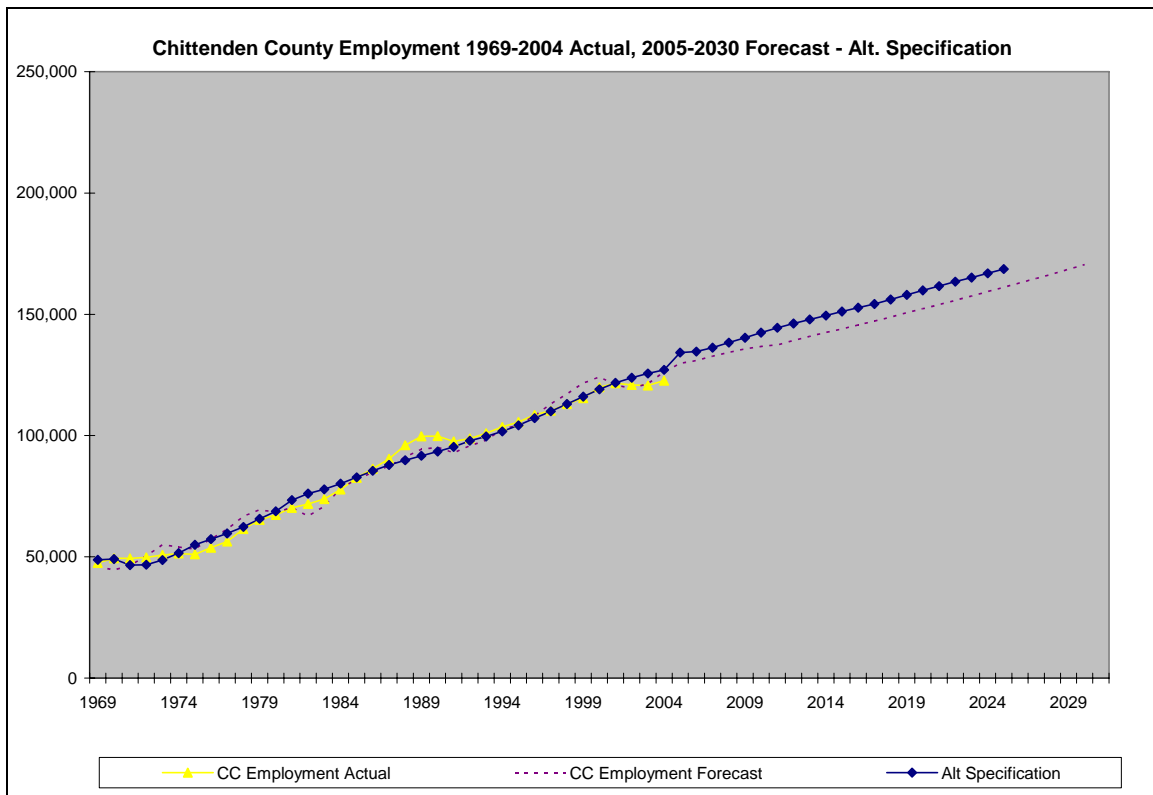


Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.

**Table B-2:
Chittenden County Employment Forecast - Alt.
Specification**

Variable	Coefficients	Standard Error	T-Statistic
Intercept	-63610.8	3376.9	-18.8
US Labor Force	930.5	26.1	35.7
Productivity Index	4732.2	1427.5	3.3

Regression Statistics	
R-squared	0.9858
Adjusted R-sq.	0.9850
Standard Error	3187



Source: U.S. Bureau of Economic Analysis, Regional Economic Information System; The Louis Berger Group, Inc. 2006.