REPORT TO

Chittenden County
Regional Planning Commission

for

INTERCHANGE FEASIBILITY STUDIES
AT FOUR LOCATIONS IN THE
CHITTENDEN COUNTY MPO AREA

submitted by

STORCH ENGINEERS
235 Promenade Street
Providence, R.I.

July, 1987
July 10, 1987

Mr. Arthur Hogan, Jr.
Executive Director
Chittenden County Regional Planning Commission
P.O. Box 108, 66 Pearl Street
Essex Junction, Vermont 05452

Subject: Interstate Interchange Study

Dear Mr. Hogan:

We are pleased to submit twenty five (25) copies of our Final Report.

The results of our study have indicated that construction of either a new interchange at Route 116 in South Burlington or the modification of the existing Interchange 13 can be considered economically justified based upon economic benefit-cost criteria. However, the construction of full interchanges at both locations in South Burlington is not recommended due to interchange spacing considerations for Interstate 89.

Our studies have found that the modification of Interchange 15 in Winooski to provide a full diamond interchange is not economically justified.

Our study of the proposed interchange in the Town of Milton indicates that the interchange would be economically justified only if full development of the Catamount Industrial Park were to take place in the very near future. Given an assumption of phased development of the Industrial Park, the interchange cannot be considered justified at this time.

We are available to meet with you at your convenience, to discuss any comments you may have on the final report.

Very truly yours,

STORCH ENGINEERS

David A. Kinnecom, P.E.
Associate

DAK/sjm/p
Pecr 5007
Enclosure
REPORT TO

CHITTENDEN COUNTY
METROPOLITAN PLANNING ORGANIZATION

ON
FEASIBILITY STUDIES
FOR
INTERCHANGE IMPROVEMENTS
ON
VERMONT'S INTERSTATE HIGHWAY SYSTEM
IN
THE CHITTENDEN COUNTY M.P.O. AREA

Prepared By

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235 Promenade Street
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JULY, 1987
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EXECUTIVE SUMMARY
EXECUTIVE SUMMARY

Purpose of the Study

The purpose of this study is to conduct economic benefit-cost analyses of interchange improvements at four locations on Interstate 89 in Chittenden County, Vermont. The study has evaluated the feasibility of new interchanges at the following locations:

- Interstate 89 at Hinesburg Road (VT 116) in South Burlington.
- Interstate 89 at Mayo Road (TH 6) in Milton.

The feasibility of modifying existing interchanges to provide additional traffic movements has been evaluated at the following two locations:

- Interchange 13 (I-89 at I-189 and Kennedy Drive) in South Burlington.
- Interchange 15 (I-89 at VT 15) in Winooski.

The study has been undertaken in order to determine if new interchanges or improvements to existing interchanges would be warranted under economic criteria established by the Federal Highway Administration. However, it should be noted that this study has not addressed in detail all of the environmental impact and design issues that are typically considered in the project planning and design process.

Study Process

At each of the four locations, the following steps were undertaken:

- Identification and evaluation of alternative interchange design concepts.
- Selection of most feasible interchange design concept in terms of construction costs, environmental impacts and general traffic service.
- Preparation of preliminary cost estimates including construction cost, right-of-way, and engineering.
- Projection of future traffic volumes that would use the new interchange.
- Estimation of road user benefits to be provided by the interchange improvements in terms of travel time savings, savings in vehicle operating costs and costs of accidents.
- Determination of economic benefit-cost ratios and net benefits.

Summary of Major Conclusions

South Burlington Area (General)

A study area consisting of a large portion of the City of South Burlington was evaluated in order to prepare detailed traffic projections for Interstate 89 between Interchanges 12 and 14, and most major streets and highways in South Burlington. Within this study area, socioeconomic data (population and employment) were projected to the year 2010 using information provided by the City of South Burlington and the Chittenden County Regional Planning Commission. Total population in the City of South Burlington was projected to increase by 84% between 1985 and the year 2010. Employment was projected to increase by 64% over this 25 year period.

Much of the growth in population was projected to occur in areas of the city south of Interstate 89, while the projected increase in employment is concentrated in the Dorset Street area, in the proposed City Center area.

Based upon this anticipated growth in population and employment, significant increases in traffic volumes on many of South Burlington's streets and highways can be expected. In particular, Dorset Street, Hinesburg Road, and Kennedy Drive are projected to experience major increases in traffic volumes. Several key intersections in this area of the city, including Dorset Street at Williston Road, Dorset Street at Kennedy Drive, Kennedy Drive at Hinesburg Road and Hinesburg Road at Williston Road are projected to face traffic capacity problems if no improvements to these intersections are undertaken.
The effects upon traffic patterns of the construction of a new interchange at Hinesburg Road (Route 116) or the modification of the existing Interchange 13 are relatively complex.

Construction of either interchange would have both positive and negative effects on local street traffic volumes, but overall would result in significant savings in travel time and vehicle operating costs. This study has found that, considered independently, the construction of either interchange would be firmly justified on a benefit-cost basis. However, some improvements to the local street network would be required in conjunction with the construction of either interchange in order to provide adequate levels of intersection level of service in the future.

Construction of full interchanges at both locations would also be economically justified; however, this scenario would result in inadequate interchange spacing on I-89 and substandard weaving lengths, and is therefore not recommended. Construction of a new interchange at Route 116 is projected to provide road user benefits in the same order of magnitude as those that would be provided by the modification of Interchange 13. In comparison to Interchange 13, an interchange at Route 116 would provide better access to the portions of the city to the south of Interstate 89, where future residential industrial and industrial development is projected to occur. An interchange at Route 116 would also provide more direct access to the Burlington Airport, than is currently provided by Interchange 12.

Modification to the existing Interchange 13 would provide better access to the commercial and retail areas of Dorset Street than an interchange at Route 116. Although the total road user benefits provided by either interchange are somewhat the same, construction of a new interchange at Route 116 is projected to have a much higher benefit-cost ratio since the projected costs are substantially less than those for the modification of Interchange 13.
The following is a summary of the major findings at each interchange location:

A. **Interstate 89 at Route 116, South Burlington**

An interchange at this location would provide improved access to the City of South Burlington general, the Burlington Airport, and areas south of I-89 on Route 116. This study reached the following conclusions regarding the interchange at Route 116 in South Burlington:

- Several interchange alternative designs were found to be feasible at this location from an engineering construction standpoint. Right-of-way factors were the primary considerations in determining the recommended ramp configurations.

The recommended interchange configuration consists of a full "diamond" interchange. Widening of Route 116 through the interchange would be required.

- The estimated cost of the proposed ramps and the widening of Route 116 is $2,150,000.

- The interchange would be used by approximately 23,700 vehicles per day by the year 2010.

- Based upon the estimated savings in travel time and vehicle operating costs, the interchange would provide road user benefits with a net present value of $35,636,000. The benefit-cost ratio provided by the interchange would be 16.6.
B. Interchange 13, South Burlington

The existing ramps at Interchange 13 provide access from I-189 eastbound to I-89 southbound, Kennedy Drive, and I-89 northbound; from I-89 southbound to I-189 westbound; and from I-89 northbound to I-189 westbound. This study evaluated the feasibility of constructing additional ramps providing access from I-89 northbound to Kennedy Drive; from Kennedy Drive to I-89 northbound; from I-89 southbound to Kennedy Drive; and from Kennedy Drive to I-89 southbound. The study concluded the following:

- Construction of new ramps to provide the additional traffic movements will require extensive modification to the existing interchange including relocation of existing ramps, the realignment of a portion of I-189, the construction of a collector-distributor road on the southbound side of I-89, and the modification of several existing bridge structures.

- The estimated cost of the interchange improvements is $8,633,000.

- The proposed new ramps would be used by approximately 26,400 vehicles per day by the year 2010.

- Based upon the estimated savings in travel times and vehicle operating costs, the interchange would provide road user benefits with a net present value of $27,151,000. The benefit-cost ratio provided by these ramps is 3.2.
C. Interchange 15, Winooski

The existing ramps at Interchange 15 provide access only to I-89 southbound and from I-89 northbound. This study evaluated the feasibility of constructing an additional on-ramp from VT 15 to I-89 northbound and an off-ramp from I-89 southbound. The study concluded the following:

- The construction of "diamond ramps" is the only practical alternative from an engineering aspect for providing the additional ramp movements.
- The construction of the proposed ramps would require the acquisition of twelve residential buildings.
- The estimated present value cost of the proposed ramps and associated improvements is $2,500,000.
- The proposed ramps would be used by approximately 3,400 vehicles per day by the year 2010.
- Based upon the estimated savings in travel times and vehicle operating costs, the interchange would provide road user benefits with a net present value of $683,000. The benefit-cost ratio provided by these ramps is 0.28.
- Since the benefit-cost ratio is significantly less than 1.0, the proposed additional ramps cannot be considered economically justified.
D. Interstate 89 at Mayo Road, Milton

An interchange at this location would provide improved access to the Town of Milton, and to the Catamount Industrial Park from the north on I-89. This study reached the following conclusions regarding an interchange at Mayo Road in Milton:

- Several interchange configurations are possible from engineering aspects.

- Construction of ramps in the northeast or southeast quadrants of the I-89/Mayo Road interchange area would severely impact the Checkerberry Village area, a historic district eligible for the National Register of Historic Places. For this reason, the northbound on- and off-ramps evaluated in this study have been proposed to be located to the south of the Checkerberry Village area, connecting to US Route 7 rather than Mayo Road.

- The Catamount Industrial Park has the potential to be a significant generator of traffic. If full development of the 174 acre park occurs, it has the potential to have 3,200 employees, generating a total of 10,400 trips per day.

- The proposed Milton interchange would not significantly improve access to the industrial park from the south. The optimum route to the industrial park from the south would remain via the existing Interchange 17 and U.S. Route 7.

- The estimated present value cost of the Milton interchange is $3,400,000.

- Substantial improvements to Mayo Road and US Route 7 would be required in conjunction with the construction of the interchange.
Benefit-cost analyses of the proposed Milton interchange were prepared for different development scenarios. Based upon the assumption of full development by year 1990, the proposed interchange would provide a benefit-cost ratio of 0.96. Scenarios under which development of the industrial park would be phased over a longer time period were found to have lower benefit-cost ratios.

Since the benefit-cost ratio is less than 1.0 under the most rapid development scenario, the proposed interchange is not considered economically feasible at this time.
I. INTRODUCTION
I. INTRODUCTION

A. Purpose of Study

In April of 1985, Storch Engineers was retained by the Chittenden County Metropolitan Planning Organization to conduct feasibility studies of proposed interchange improvements at four locations on Vermont's Interstate Highway System. The study locations are shown in Figure I-1. This report represents the results of detailed economic benefit-cost analyses and feasibility studies for the construction of proposed interstate interchanges or interchange improvements at the following locations:

1. Proposed interchange at I-89 and VT Route 116 in the City of South Burlington.

2. Proposed interchange improvements at I-89/I-189, System Interchange 13 at Kennedy Drive in the City of South Burlington, Vermont.

3. Proposed interchange at I-89 Interchange 15 at VT Route 15 in the City of Winooski, Vermont.

4. I-89 and Mayo Road (TH6) in the Town of Milton.

The purpose of the studies is to conduct detailed economic benefit-cost analyses in order to determine whether construction of any of the proposed interchanges and interchange improvements is justified, considering the estimated construction costs and the potential volumes of traffic that would use the interchange. The study has been carried out in accordance with the Scope of Work set forth by the Chittenden County Regional Planning Commission and is based upon design standards and economic analysis procedures adopted by the Federal Highway Administration.
B. Study Limitations

It should be noted that the emphasis of this study has been to determine whether the proposed interchanges are feasible in engineering and economic terms. Preliminary designs have been developed in sufficient detail to ensure that design standards can be achieved and in order to make reasonable cost estimates. However, this study is not intended to address all of the environmental impact and design issues normally addressed during the project planning stages.

At all of the locations with the exception of the Winooski location, several schematic interchange designs were identified and evaluated. Many of the alternative interchange designs were found to be relatively similar in terms of engineering feasibility and construction costs.

Based upon overviews of environmental engineering and economic considerations, one schematic design was then selected at each location for more detailed design development and construction cost estimates.

It should be noted, however, that the selected schematic interchange designs will be subject to further analysis and possible modification should the projects proceed to the subsequent Environmental Assessment and Engineering Design phases.

C. Organization of the Report

Section II of this report describes the technical methodology which was employed to conduct a feasibility analysis at each location. The methodology generally consisted of three separate procedures consisting of; a) Traffic Analyses; b) Conceptual Designs and Cost Estimates; and c) Benefit-Cost Analyses.

Sections III, IV, and V describe the results of the feasibility studies for the South Burlington area, the Winooski location and the Milton location respectively. Since the two proposed South Burlington locations have interrelated traffic considerations and the same regional study area, they have both been addressed in the same chapter of the report.

The appendices to this report contain technical supporting data and calculations, including the results of additional traffic counts conducted for this study, and traffic capacity, construction cost, and benefit-cost analysis calculations.
II. METHODOLOGY
II. METHODOLOGY

The methodology used in conducting the feasibility studies for interchange improvements at the four locations is summarized below:

A. Traffic Analyses

1. Define Study Area and Highway/Street Network

At each location under study, an "area of influence" has been defined. This area consists of those highway and street links that are likely to be significantly altered in volume by the construction of a new interchange or improvements. All major street and highway links within each study area have been identified for the purpose of determining traffic assignments for existing and future conditions.

The detailed study areas have formed the basis for the road user cost analysis and the peak hour traffic capacity impact analysis.

The detailed study areas are as follows:

City of South Burlington (Locations A & B)

The detailed study area includes I-89 between Interchange 12, Interchange 14, including Interchange 13, the proposed interchange at VT Route 116, U.S. Route 2, Kennedy Drive, Dorset Street, and the major intersections. The detailed study area is shown in Figure III-1.

City of Winooski (Location C)

The detailed study area includes I-89 between Interchanges 15 and 16, VT Route 15, U.S. Route 7, and East Spring Street; and the major intersections. The detailed study area is shown in Figure IV-1.
Town of Milton (Location D)

The detailed study area includes I-89 between Interchanges 17 and 18, Interchanges 17 and 18, U.S. Route 7, Mayo Road (TH 6), and the proposed interchange at Mayo Road. The detailed study area is shown in Figure V-1.

2. Compile Available Traffic and Socioeconomic Data

All existing turning movement and automatic traffic count data within the study area for each location has been collected from the Vermont Agency of Transportation. Traffic data from the Chittenden County Circumferential Highway Study and other available sources also has been collected.

3. Collect Additional Traffic Data

The Vermont Agency of Transportation and the Chittenden County Regional Planning Commission provided Storch Engineers with sufficient recent traffic data for the South Burlington study area. However, to supplement the traffic data provided by the agencies for the Milton and Winooski study area, additional traffic data was collected by Storch Engineers for use in conducting traffic capacity analyses and in developing a base year traffic flow map. Two hour peak hour turning movement counts were taken at the following intersections:

City of Winooski
a. VT Route 15 (East Allen Street) and East Spring Street
b. U.S. Route 2 (Main Street) and East Spring Street

Town of Milton
a. U.S. Route 7 (Ethan Allen Highway) and Route 104
b. U.S. Route 7 (Ethan Allen Highway) and Lake Road (TH 3)
c. U.S. Route 7 and Railroad Street and Middle Road
d. Mayo Road (TH 6) and Bartlett Road (TH 45)
Automatic traffic recorders were used to collect 24 hour traffic counts at the following locations:

**City of Winooski**

a. Interchange 16 - Ramp from U.S. Route 2/7 to I-89 NB  
b. Interchange 16 - Ramp from I-89 SB to U.S. Route 2/7  
c. U.S. Route 2/7 NB - North of ramp from U.S. Route 2/7 to I-89 SB  
d. U.S. Route 2/7 SB - South of ramp from I-89 SB to U.S. Route 2/7 NB  
e. VT 15 WB - West of ramp from VT 15 to I-89 SB  
f. VT 15 EB - East of ramp from VT 15 to I-89 SB

**Town of Milton**

a. Interchange 18 - Ramp from U.S. Route 7 to I-89 NB  
b. Interchange 18 - Ramp from I-89 SB to U.S. Route 7  
c. U.S. Route 2 EB - East of Interchange 17  
d. U.S. Route 2 WB - West of ramp from I-89 NB to U.S. Route 2 EB  
e. U.S. Route 7 - North of U.S. Route 2  
f. U.S. Route 7 - North of TH 2 (Main Street)  
g. U.S. Route 7 NB - North of TH 31 (Park Street) and South of ramp from U.S. Route 7 to I-89 SB  
h. U.S. Route 7 SB - North of Interchange 18  
i. Exit 17 - Ramp to I-89 SB from U.S. Route 2 WB  
j. Exit 17 - Ramp from I-89 NB to U.S. Route 2 EB

At each location a 1985 base year traffic flow map was developed for each study area showing average daily traffic, including turning movements at existing interchanges and major intersections. See Figures III-1, IV-1, and V-1 for traffic count locations in the South Burlington, Winooski, and Milton study areas.
4. **Determine Base-Year Trip Table**

After base year traffic flows were determined, the origin-destination pattern of the trips in each of the study areas was estimated. Each study area was broken up into "internal" traffic analysis zones and "external zones". Internal zones consisted of areas entirely within the study area. "External zones" were represented by a point on the highway link at the boundary of the study.

In the Milton and Winooski study areas, estimates of origin-destination patterns were based on a license plate survey conducted by Storch Engineers in June, 1985. In these surveys, license plate numbers were recorded at several key points within each study area, including the existing interchanges on I-89, and at points in the vicinity of the proposed interchanges. By matching license plate numbers recorded at various points, it was possible to estimate the number of motorists who would be diverted to the proposed interchanges. License plate matches were recorded over a four hour period and expanded to an estimated 24 hour volume.

At these two locations, an origin-destination table showing daily zone-to-zone trip volumes was estimated by using available traffic counts supplemented by the results of the license plate matching survey.

In the South Burlington area, a somewhat different methodology was followed due to the size of the study area and the fact that a license plate matching study would be inapplicable in this area. Estimates of the base year trip table were made using regional modelled travel data from the Chittenden County Regional Planning Commission.

5. **Estimate Future Year Trip Table**

Future year trip tables were generally estimated by applying specific growth rates to the zone-to-zone interchange volumes determined under Task A4. The growth rates applied to most through traffic movements on the Interstate System and the interstate parallel roadways were obtained from the Vermont Agency of Transportation Project Planning Division. Growth rates for other "internal" trip interchanges have been based upon socioeconomic projections...
provided by Chittenden County Regional Planning Commission. In the South Burlington area a more elaborate trip generation and distribution modelling procedure was employed. The methodology that was used in this study area is explained in more detail in Section III of the report.

6. **Assignment of Future Year Trip Table**

Future year trips were then assigned to both a "no-build" network and a "Build" network which included the new interchange or the improvements to the existing interchange as the case may be.

Traffic assignments for the Winooski and Milton study areas were done using an assignment procedure based upon procedures described in NCHRP Report No. 187 Quick-Response Urban Travel Estimation Techniques and Transferable Parameters. Logical travel paths through the highway network have been determined generally by visual inspection and judgement. Where alternative travel paths were very close, travel times on alternative routes were measured with field travel time runs and the corresponding traffic volumes were proportionally assigned to the alternative routes. The traffic assignments for the Winooski and Milton locations were tabulated using a spreadsheet procedure on a micro-computer.

The traffic assignments for the South Burlington study area were performed using the TMODEL traffic forecasting model.

Within the detailed study areas of each location, forecasts have been made for both AADT and directional design hourly volumes (DDHV).

7. **Conduct Traffic Impact Analysis**

The purpose of this task was twofold: a) To examine general impacts on the regional network of proposed interchange modifications, and b) To conduct detailed peak hour traffic level of service analyses at the critical intersections within the detailed study areas. The capacity analysis was conducted using the methodology of TRB Circular 212 Interim Materials on Highway Capacity and the 1985 Highway Capacity Manual. This task identified the impacts (both positive and negative) on local streets due to changed traffic volumes associated with the proposed interchanges or interchange improvements.
B. Conceptual Designs and Cost Estimates

At each of the four locations, studies were conducted in order to identify feasible interchange configurations.

This step began with field reconnaissance of the proposed sites. Alternative locations and designs were then briefly evaluated with respect to traffic service, engineering and environmental factors, and construction cost. The result of this step was the selection of a recommended interchange configuration to be evaluated in more detail in a benefit-cost study.

Preliminary plans and profiles were then prepared for each location in order to determine proposed horizontal and vertical alignment of ramps and cross roads. The plans were developed in sufficient detail to evaluate the overall engineering feasibility of each interchange and to permit estimation of construction costs.

Construction cost estimates were prepared based on the estimated quantities of several major pay items, including earthwork structures, bituminous pavement and gravel base. The cost estimates were based upon 1983 Vermont Agency of Transportation Unit Prices, adjusted to 1986 assuming an inflation rate of 10%. Twenty percent was than added to the cost of the major items to account for other miscellaneous items such as drainage, guardrail, signing, pavement markings, etc.

The preliminary designs are based upon the Vermont Agency of Transportation Standard Drawings and the American Association of State Transportation and Highway Officials Policy on Geometric Design of Highways and Streets, 1984.

C. Benefit-Cost Analysis

1. Methodology

The benefit-cost analysis was conducted following the procedures described in the AASHTO Manual on User Benefit Analysis of Highway and Bus Transit Improvements. The following methodology was followed:
a. **Update User Cost Factors**

The user cost factors including the unit values of time, running cost, and unit accident cost, were updated from the 1975 base in the AASHTO Manual to 1985 values.

The unit values of time were updated using the 1985 consumer price index for the value of automobile travel time and 1985 wholesale price index as an indicator of the value of truck travel time.

User running cost factors, contained in Tables B-4 through B-9 and Figure 20 of the AASHTO Manual for passenger cars, single unit trucks, and 3-S2 combination trucks, were updated using the multiplier formulas in Table B-13 through B-15 of the AASHTO Manual. These equations were applied using the 1985 consumer price indices for gasoline, motor oil, auto tires, auto repairs and maintenance, and new autos; and the 1985 wholesale price indices for diesel fuel, motor oil, truck tires, and motor trucks.

Unit accident costs also were updated using 1985 consumer price index.

2. **Assign User Cost Factors to Highway Links**

For each study area, an analysis network of highway links was developed and then each link assigned unit running costs for passenger cars, single unit trucks, and 3-S2 combination trucks based on design speed, grades, curvature, speed transitions and stops. The associated unit values of time and accident costs also were determined for each link.

3. **Estimate Annual Road User Costs for Each Alternative**

Total road user costs were estimated for the "no-build" and the "build" alternatives of each study area. Total road user running costs were estimated by summing projected volume times and estimated unit running costs over all highway links in the study area.
This is represented mathematically by:

\[ RC = \sum_{i,j} V_{ij} \times L_j \times U_{ij} \]

Where:

- \( RC \) = Total Road User Cost ($/day)
- \( V_{ij} \) = Volume of Vehicle Type \( i \) on Link \( j \) (veh/day)
- \( L_j \) = Length of Link \( j \) (mi)
- \( U_{ij} \) = Unit Running Cost of Vehicle Type \( i \) on Link \( j \) ($/veh-mi)

The value of travel time was obtained by the following:

\[ TTC = \frac{\sum_{i,j} V_{ij} \times L_j \times T_{Ti}}{S_{ij}} \]

Where:

- \( TTC \) = Total Travel Time Cost ($/day)
- \( V_{ij} \) = Volume of Vehicle Type \( i \) on Link \( j \) (veh/day)
- \( L_j \) = Length of Link \( j \) (mi)
- \( T_{Ti} \) = Speed of Vehicle Type \( i \) on Link \( j \) (mi/hr)
- \( S_{ij} \) = Value of Travel Time for Vehicle Type \( i \) ($/veh-hr/day)

The annual benefits of the proposed interchanges were then obtained by subtracting the road user costs of the "build" alternative from those of "no-build".

II-8
4. **Estimate Benefits over the Project Life**

The results of the above computations determine annual road user costs for any given year. In order to make a benefit-cost analysis, the series of annual benefits were converted to an equivalent present value.

Annual benefits were estimated for the year of construction, estimated to be the year 1990, and the year 2010. Estimated annual benefits for intermediate years were obtained by linear interpolation between these two points.

Following this step, the equivalent present value of the series of annual benefits was obtained. This was equal to:

\[ PV_i \times B_i \]

Where:

\[ i = \text{Year 1 to 20} \]

\[ PV_i = \text{Present Value Factor for Year } i \]

\[ B_i = \text{Road User Benefits in Year } i \]

The result was an estimate of the equivalent present value of road user benefits in each study area.

5. **Determine Benefit-Cost Ratios**

Benefit-cost ratios were then obtained by the ratio of the equivalent present value of benefits obtained in Step 6 to the present cost, derived from construction cost estimates in Step 2.
The benefit-cost analysis also is based upon the following key variables:

- Projected Life = 20 years
- Interest Rate = 12 Percent
- Cost Per Accident:  
  Property Damage Only = $900
  Injury Accident = $6,500
- Value of Travel Time (Per Vehicle-Hour)  
  Automobile = $7.00/Hour
  Trucks = $13.00/Hour
- Assumed Year of Construction = 1990

D. Major Assumptions of Study Methodology

1. Traffic Forecasting

   a. For the purpose of this study, it has been assumed that there will be no difference in land use development patterns between the "Build" and "No-Build" alternatives.

   b. Impacts to travel patterns (based upon optimum routes through the highway network) have been assumed to be limited only to the "area of influence defined in each interchange study area.

2. Economic Impact Analysis

   a. It has been assumed that construction will take place in the year 1990 and that all construction expenditures will take place in that year. It should be noted that construction cost estimates are expressed in terms of 1985 dollars. Actual cost in terms of 1990 dollars are likely to be higher due to inflation.
Road user benefits are assumed to begin in the year 1990. Road user benefits have also been calculated in terms of 1985 cost factors (value of travel time, cost of gasoline, etc.). It has been assumed that inflation would affect road user benefits at the same rate at which construction costs are affected. Therefore future costs and benefits have been calculated on a consistent basis, and benefit-cost ratios are not affected by these assumptions.

Future road user benefits have been discounted to the year 1990, the assumed year of construction.
III. SOUTH BURLINGTON
III. SOUTH BURLINGTON

A. Interchange Locations and Design Criteria

1. Interchange Location

Access to the City of South Burlington from I-89 is currently provided by Interchange 12 in the Town of Williston and Interchange 14 in the City of South Burlington to the north. At Interchange 13, there is no direct access to the local street system in South Burlington.

Interchange 12 is located approximately 1.0 miles south of the Williston/South Burlington city line, while Interchange 14 is located approximately 1.3 miles south of the Burlington-Winooski/South Burlington city line. The distances between Interchanges 12 and 13, and 13 and 14 are approximately 3.5 and 1.25 miles respectively.

The location of the proposed Route 116 interchange and the proposed Interchange 13 modifications that would serve the South Burlington area are shown in Figure III-1.

a. Location A: I-89 and Vermont Route 116

At this location, Vermont Route 116 (Hinesburg Road) is carried over I-89 by a three-span structure at a 10\degree\pm degree skew. There is a grade difference of approximately 20 feet between the two roadways. The curb-to-curb width of Route 116 on the bridge is 30 feet. South of the I-89 overpass, Route 116 is typically 44 feet wide with two twelve-foot wide travel lanes and two ten-foot wide shoulders. However, near the New England Telephone Company building, auxiliary turning lanes have been added. To the south of the I-89 overpass, the horizontal and vertical alignment of Route 116 is good, with a horizontal tangent section extending about 750 feet south of the I-89 overpass.

To the north of I-89, Route 116 intersects with the Old Farm Road approximately 500 feet north of the overpass. Route 116 begins to curve to the west about 250 feet north of the I-89 overpass. An auxiliary deceleration lane is provided on northbound Route 116 beginning at a point about 300 feet south of Old Farm Road.

The posted speed limit on Route 116 in the vicinity of the interchange is 40 mph, although there is also a 45 mph curve advisory speed plate posted.
The existing land uses in the vicinity of the proposed interchange may be
seen in Figures III-2 through III-4 and are summarized below:

- The northeast quadrant is primarily pasture land with one residence fronting
  on Route 116 approximately 400 feet north of the I-89 overpass.

- In the southeast quadrant, the New England Telephone Company is set back
  150 feet from the I-89 southbound Right-Of-Way line.

- The southwest quadrant is primarily pasture land with a barn located within
  the vicinity of possible ramp locations.

- The northwest quadrant has been developed in recent years with single
  family homes. There is a farmhouse in this quadrant which is considered
  eligible for the National Register of Historic Places.

b. Location B: I-89 and I-189

At this location I-89 is on a 2,000 foot long horizontal curve with a
radius of 2,300 feet and a central angle of approximately 100 degrees. I-189
intersects I-89 on the curve, approximately 900 feet west of the intersection of
Kennedy Drive and Dorset Street. There are currently ramps providing the
following turning moves: south to west, west to north, north to west, and west
to south.

I-89 is carried over Dorset Street and the I-189 eastbound roadway by three
span structures. The I-189 westbound roadway is carried over the west to north
ramp and I-89 by a three span and four span structures, respectively.

The existing land uses immediately east of I-89 are highly developed
commercial areas and high density residential developments. Land use north and
south of I-189 immediately west of I-89 is undeveloped pasture land.
2. **Interchange Design Criteria**

   a. **Location A: I-89 and Vermont Route 116**

   At this location, three alternative interchange designs were evaluated. These alternates are illustrated, in schematic form, in Figures III-2 through III-4. Additional interchange alternatives can be developed by various combinations of the on- and off-ramp alternatives. The illustrated alternatives are summarized as follows:

   **Northbound On/Off Ramps**

   Alternative A - Diamond alignment

   Alternative B - Trumpet alignment in the northwest quadrant

   Alternative C - Loop and outer connection in the northeast quadrant

   **Southbound On/Off Ramps**

   Alternative A - Diamond alignment

   Alternative B - Loop and outer connection in southwest quadrant
STORCH ENGINEERS
CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION
INTERSTATE INTERCHANGE FEASIBILITY STUDY
ROUTE 116
ALTERNATIVE C
RAMP ALIGNMENTS
SCALE: 1"=400'
FIGURE III-4
The interchange design recommended for further study is shown in Figure III-5. This design consists of a full diamond interchange. Design criteria are summarized in Table III-1. The general reasons for selection of the recommended ramp alternatives are summarized below:

**Northbound Ramps**

**Advantages of Recommended Alternative A**

1. The total amount of Right-Of-Way takings for Alternatives A is less than that of Alternative B and C.

2. Alternative A avoids significant conflict with developed land uses in the northwest quadrant.

**Disadvantages of Alternative A**

1. Construction in the northeast quadrant may take place primarily in a rock cut area adding to construction cost.
Southbound Ramps

Advantages of Recommended Alternative A

1. Alternative B is less cost effective than Alternative A due to the bridge reconstruction required to produce sufficient lateral clearance between the I-89 southbound travel way and the existing bridge piers.

2. Construction of a loop ramp in the southeast quadrant is not feasible due to the existing New England Telephone Company building.

Disadvantages of Alternative A

1. The southbound on-ramp terminal must be kept within the existing I-89 Right-Of-Way to minimize encroachment into the New England Telephone parking lot/maintenance area, resulting in a limited separation from the bridge structure.

2. The proposed off-ramp terminal cannot be placed directly across from the proposed on-ramp terminal because this location does not provide adequate sight distance along Hinesburg Road for an exit ramp terminal. Due to the required sight distance at the ramp terminal the New England Telephone Company driveway location, and the anticipated number of traffic moves from the off-ramp to New England Telephone Company, the recommended off-ramp terminal is directly opposite the Telephone Company driveway.
### TABLE III-1

LOCATION A

ROUTE 116 SOUTH BURLINGTON
SUMMARY OF DESIGN CRITERIA

**Interchange Spacing**

Prop. Distance to Interchange No. 12....2.20 miles

Prop. Distance to Interchange No. 13....1.25 miles

<table>
<thead>
<tr>
<th>Ramp Design</th>
<th>Ramp A NB-Off</th>
<th>Ramp B SB-On</th>
<th>Ramp C SB-Off</th>
<th>Ramp D NB-On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of I-89</td>
<td>550'</td>
<td>350'</td>
<td>350'</td>
<td>350'</td>
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<tr>
<td>Accel/Decel Lane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed @ Ramp</td>
<td>30mph</td>
<td>60mph</td>
<td>50mph</td>
<td>40mph</td>
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<tr>
<td>Exit/Entrance @ I-89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ramp Length</td>
<td>1065'</td>
<td>965'</td>
<td>1620'</td>
<td>1150'</td>
</tr>
<tr>
<td>Maximum Grade (%)</td>
<td>-3.47%</td>
<td>-3.71%</td>
<td>+4.97%</td>
<td>-3%</td>
</tr>
<tr>
<td>(In Direction of Ramp)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Stopping</td>
<td>450'</td>
<td>460'</td>
<td>400'</td>
<td>420'</td>
</tr>
<tr>
<td>Sight Distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on Vertical Curve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III-11
b. **Location B: I-89 and I-189 (Interchange 13)**

The existing ramps at this location link US Route 7 in the City of Burlington, located 1.4± miles west of I-89, directly to I-89 via I-189. However, there are no ramps which access from I-89 to the major streets in the City of South Burlington.

Figures III-6 through III-9 schematically illustrate the possible alignments for ramps providing the following turning moves: East-North, North-East, South-East, and East-South. The installation of these ramps would provide improved access between the City of South Burlington and I-89.

Each of the four traffic movements noted above was examined individually to determine the best location and alignment for a ramp serving that movement. The four best ramp alignments were then combined to provide a complete interchange. The following summarizes the advantages, disadvantages, and impacts of the various ramp alignments:

1. **East to North ramp (northbound on-ramp)**

   There are two possible alignments for this traffic movement. These are illustrated in Figure III-6.

   **Alternative A** - The on-ramp would begin at the Dorset St./Kennedy Drive intersection and would lie immediately north of, and parallel to I-189 westbound for approximately 350 feet until the proposed ramp turns north through a 125-foot radius curve and merges with the existing west-north ramp.

   **Alternative B** - The on-ramp would begin on Dorset Street approximately 200 feet north of the I-89 overpass and merge with I-89 northbound south of the I-189 westbound overpass.

   Of the two alternatives presented, Alternative A is the preferred alternative due to its shorter length, minimum Right-Of-Way requirement, and minimal impacts on I-89 through traffic operations.

III-12
PROPOSED RAMP A

PROPOSED RAMP B

STORCH ENGINEERS
CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION
INTERSTATE INTERCHANGE FEASIBILITY STUDY
SOUTH BURLINGTON
HINESBURG ROAD – ROUTE 116
PROPOSED PLAN AND PROFILE
RAMP A, B, C, D FIGURE III-5
2. **North to East ramp (southbound off-ramp)**

There are three proposed alignments for this movement. Two of the alternatives are loops which terminate at the Dorset St./Kennedy Drive intersection. The third alternative is a modified diamond alignment connecting with Dorset Street, just south of the I-89 overpass. The three alternative alignments are shown in Figure III-7.

**Alternative A** - A 310-foot radius loop ramp immediately south of I-189 westbound. This alignment would require a structure over I-89 and another structure over the West to North turning roadway. In addition, approximately 550 feet of I-189 eastbound, immediately to the west of Dorset Street, would have to be realigned.

**Alternative B** - A 310-foot radius loop ramp immediately south of I-189 eastbound. This alignment would require a 13-foot widening of the structure carrying I-89 southbound over I-189 eastbound. This alternative also would require the realignment of the existing West to South turning roadway, which would result in extensive excavation.

**Alternative C** - A modified diamond alignment terminating at Dorset Street. This alternative also requires a 13-foot widening of the structure carrying I-89 southbound over I-189 eastbound. A new structure carrying the proposed ramp over the existing West to South turning roadway would also be required.

Alternative B, is the recommended alignment, since the weaving section along I-89 is longer than that in Alternative A, and no new structures are required as under Alternative A or C.

3. **South to East ramp (northbound off-ramp)**

There are two potential alignments presented for this movement. One alignment connects with Dorset Street, while the other alignment merges with I-189 eastbound and terminates at the Dorset Street/Kennedy Drive intersection. These two alignments are illustrated in Figure III-8.
Alternative A - A diamond alignment connecting with Dorset Street. There is no bridge work required with this alignment. However, two residential buildings may have to be taken if the condominium access road were relocated. An alternative to relocation of the road would be a cul-de-sac within the site. Additionally, there may be environmental concerns associated with the filling of the Potash Brook floodplain.

Alternative B - An alignment which begins immediately east of the structure carrying I-89 over Dorset Street, merges with I-189 eastbound and ends at the Dorset Street/Kennedy Drive intersection. The structure carrying I-89 over Dorset Street, must be widened due to the required profile of the proposed ramp. A concrete retaining wall would be required to provide grade separation between I-89 and the proposed ramp.

Alternative A is recommended because it appears that it will be significantly less costly than Alternative B since Alternative B would require widening of the I-89 bridge over Dorset Street, and extensive retaining wall construction. Another advantage of Alternative A is that it terminates at Dorset Street rather than at the Kennedy Drive/Dorset Street intersection, thus avoiding potential traffic weaving problems on I-189 eastbound before the Kennedy Drive/Dorset Street intersection.

4. East to South ramp (southbound on-ramp)

There are four potential alignments for this movement, as shown in Figure III-9.

Alternative A - A 310-foot radius loop ramp located north of I-189 westbound. This alignment does not require any bridge reconstruction, however the existing North to West ramp must be realigned to the northwest of its present position.

Alternative B - A large loop which lies to the south of I-189 westbound. The ramp would begin immediately west of the structure carrying I-189 westbound over I-89, and joins with the existing West to South turning roadway, south of I-189 eastbound. This alignment will require a widening of the above mentioned structure and a new structure to carry the proposed ramp over I-189 eastbound.
Alternative C - A 310-foot radius loop ramp which begins on Dorset Street and joins with the existing West to South turning roadway. There is no bridge work required with this alternative.

Alternative D - A diamond alignment from Dorset Street, south of I-89, appears to be the least expensive of the four alternatives presented. No bridge work is required, however, it will require the taking of one residence.

The four alternatives presented for this ramp may be divided into two different groups; a) those which exit from I-189 and; b) those which exit from Dorset Street.

a. Alternative A is the recommended alternative for a ramp exiting from I-189. Even though the existing South to West ramp must be relocated, it appears that Alternative A will be less expensive and better, from a drivers viewpoint, than Alternative B. Alternative B provides a more direct connection but has the following disadvantages: 1) The I-89 westbound structure widening over I-89; 2) The new structure over I-189 eastbound; 3) The topography which the ramp must cross. (A ravine and Potash Brook).

b. For a ramp exiting from Dorset Street, Alternative D is preferred over Alternative C. Even though a residence must be relocated, Alternative D appears less costly and will provide a better level of traffic service.

Construction of the additional ramps to provide for the additional traffic movements will require extensive modifications to the existing interchange. Examination of the potential traffic operations of the entire interchange with the additional ramps indicated that a collector-distributor roadway would be desirable on the southbound roadway of I-89. The main advantage of the collector-distributor roadway is that there is only one exit and one entrance to I-89 rather than two. Other advantages of the collector-distributor roadway are: 1) Weaving is removed from the mainline and allowed to occur at a slower speed; 2) The signing and decision process is simplified; and 3) All traffic enters and exits the main line at a high speed.

III-18
The plan of recommended improvements to Interchange 13 is shown in Figures III-10 and III-11. This proposed interchange incorporates the recommended alternative of each ramp alignment illustrated in Figures III-6 through III-9 and the collector-distributor roadway parallel to I-89 southbound. A summary of design criteria is shown in Table III-2.

Construction of both the Route 116 interchange and the Interchange 13 modifications as proposed, would result in a distance of approximately 2500 feet between the southbound on-ramp at Interchange 13 and the southbound off-ramp at Route 16. AASHTO recommends a minimum interchange spacing of approximately one mile in urban locations. Therefore, construction of both interchanges would not conform to recommended AASHTO design policies.

In general, construction of the proposed modifications to Interchange 13 would generally have a minimal Right-of-Way impact. The land to the northwest of the interchange is agricultural, operated by the University Farm, and to the southwest of the interchange is undeveloped residential land. To the southeast of the interchange there is a high density residential development; however, due to the proposed alignment only a small corner of the residential land would fall within the proposed taking line. The property located to the northwest of the interchange could be impacted due to the construction of the east to north ramp. Depending upon the lane widths and arrangement it may be necessary to acquire some of the Professional Building parking which is located adjacent to the I-189 westbound roadway.

B. Existing Traffic Volumes

Existing 1985 traffic volumes in the South Burlington study area were estimated from traffic data compiled by the Vermont Agency of Transportation and the Chittenden County Regional Planning Commission. The traffic data consisting of counts taken between 1981 and 1984, was updated to 1985 volumes and includes the following:

- Continuous count data from automatic traffic recorders stationed on Interstate Route 89 U.S. Route 2, Vermont Route 116, U.S. Route 7, Interstate Route 189, Vermont Route 2A, Town Highways 1 and 3 in Williston, and Town Highway 5 in South Burlington.
### TABLE III-2

**LOCATION B**

**EXIT 13 SOUTH BURLINGTON**

**SUMMARY OF DESIGN CRITERIA**

**Interchange Spacing**

- Prop. Distance to Interchange No. 12...3.5 miles
- Prop. Distance to Interchange No. 14...1.25 miles

<table>
<thead>
<tr>
<th>Ramp Design</th>
<th>Ramp W-S</th>
<th>Ramp N-E</th>
<th>Ramp N-W</th>
<th>Ramp E-S</th>
<th>Ramp S-E</th>
<th>Ramp E-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of I-89</td>
<td>550'</td>
<td>1300'</td>
<td>350'</td>
<td>1300'</td>
<td>400'</td>
<td>Existing</td>
</tr>
<tr>
<td>Accel/Decel Lane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed @ Ramp</td>
<td>50mph</td>
<td>30mph</td>
<td>60mph</td>
<td>30mph</td>
<td>50mph</td>
<td>Existing</td>
</tr>
<tr>
<td>Exit/Entrance @ I-89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ramp Length</td>
<td>2060'</td>
<td>1500'</td>
<td>2085'</td>
<td>1260'</td>
<td>1015'</td>
<td>840'</td>
</tr>
<tr>
<td>Maximum Grade (%) (In Direction of Ramp)</td>
<td>+2.13%</td>
<td>-2%</td>
<td>-2.73%</td>
<td>-4.13%</td>
<td>-4.44%</td>
<td>+2.2%</td>
</tr>
<tr>
<td>Minimum Stopping Sight Distance on Vertical Curve</td>
<td>970'</td>
<td>770'</td>
<td>490'</td>
<td>440'</td>
<td>340'</td>
<td>390'</td>
</tr>
<tr>
<td>Length of I-189</td>
<td>250'</td>
<td>1000'</td>
<td>350'</td>
<td>800'</td>
<td>400'</td>
<td>350'</td>
</tr>
<tr>
<td>Accel/Decel Lane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed @ Ramp</td>
<td>50mph</td>
<td>30mph</td>
<td>60mph</td>
<td>30mph</td>
<td>35mph</td>
<td>20mph</td>
</tr>
<tr>
<td>Entrance/Exit @ I-189</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Six hour manual turning movement and vehicle classification counts recorded at interchanges or intersections along Interstate Route 89, Vermont Route 2A, Interstate Route 189, U.S. Route 2, Kennedy Drive, Dorset Street, Old Farm Road, White Street, Airport Road, Shunpike Road, Airport Drive, Town Highways 2 and 9 in Williston, San Remo Drive, Swift Street, Patcher Road.

All traffic data was adjusted as appropriate to produce an estimate of 1985 Annual Average Daily Traffic (AADT). The estimated 1985 AADT on the major highways and streets in the study area are shown in Figure III-12.

C. Projected Traffic Volumes

1. Methodology

Traffic projections for the South Burlington study area were developed using the TMODEL* travel forecasting model, and regional socioeconomic data supplied by the Chittenden County Regional Planning Commission.

The travel forecasting procedure utilized by TMODEL is based in part upon the methodology of National Cooperative Highway Research Report No. 187 Quick Response Urban Travel Estimation Techniques and Transferable Parameters. This technique bases estimates of trip generation by analysis zones on the following socioeconomic variables:

- Population
- Dwelling Units
- Total Employment
- Retail Employment

Socioeconomic data for ninety analysis zones was supplied by the Chittenden County Regional Planning Commission. This data was updated within the South Burlington study area. The following section describes the development of socioeconomic forecasts for the detailed study area.

* TMODEL is proprietary software of Professional Solutions, Inc.
2. **Socioeconomic Data**

Population projections were estimated using housing unit counts within the study area available from 1980 census block data and information from the South Burlington Planning Office listing past, currently permitted, and possible future construction of housing units. The South Burlington study area, comprising approximately two thirds of the City of South Burlington, was divided into transportation analysis zones and population projections were made for each zone. The traffic analysis zones are shown in Figure III-13. To obtain the 1985 estimated population for each zone, the number of new housing units that were constructed between 1980 and 1985 was multiplied by a factor of 2.3 persons per dwelling unit and added to the 1980 census population figure. The 1990 population projection was determined in a similar manner by multiplying the projected number of housing units, to be constructed between 1985 and 1990 by the factor of 2.3 persons per dwelling unit, and adding this to the 1985 population estimate. The number of units projected to be constructed between 1985 and 1990 was based upon the number of residential units presently permitted, but not yet constructed. Population projections were also made in this manner for the Year 2010. Data provided by the City of South Burlington indicated the potential for 2,000 new residential units by the year 2010. Table III-3 lists the population projections made by analysis zones and year.

Employment projections were estimated based on the following information:

- Estimated non-farm employment supplied by the Vermont Planning Office to Wilbur Smith and Associates (WSA) in 1983 for the Chittenden County Circumferential Highway Study.

- Employment projections to the Year 2004 from the Chittenden County Circumferential Study.

- Information from the South Burlington Planning Office listing past, permitted, and projected future, retail, commercial, and industrial development, and estimates of present employment by analysis zone.

- Aerial photographs and observations in the field.
### TABLE III-3

POPULATION PROJECTIONS BY ANALYSIS ZONE
SOUTH BURLINGTON STUDY AREA

<table>
<thead>
<tr>
<th>ZONE</th>
<th>1980</th>
<th>1985</th>
<th>1990</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2465</td>
<td>8</td>
<td>16</td>
<td>2520</td>
</tr>
<tr>
<td>9</td>
<td>1010</td>
<td>13</td>
<td>44</td>
<td>2520</td>
</tr>
<tr>
<td>10A</td>
<td>153</td>
<td>15</td>
<td>-</td>
<td>2520</td>
</tr>
<tr>
<td>10B</td>
<td>128</td>
<td>-</td>
<td>4</td>
<td>2520</td>
</tr>
<tr>
<td>10C</td>
<td>304</td>
<td>30</td>
<td>8</td>
<td>2520</td>
</tr>
<tr>
<td>10D</td>
<td>738</td>
<td>16</td>
<td>32</td>
<td>2520</td>
</tr>
<tr>
<td>12</td>
<td>892</td>
<td>197</td>
<td>59</td>
<td>2520</td>
</tr>
<tr>
<td>13</td>
<td>416</td>
<td>30</td>
<td>52</td>
<td>2520</td>
</tr>
<tr>
<td>14A</td>
<td>459</td>
<td>297</td>
<td>115</td>
<td>2520</td>
</tr>
<tr>
<td>14B</td>
<td>112</td>
<td>39</td>
<td>28</td>
<td>2520</td>
</tr>
<tr>
<td>14C</td>
<td>122</td>
<td>30</td>
<td>191</td>
<td>2520</td>
</tr>
<tr>
<td>15</td>
<td>285</td>
<td>-</td>
<td>5</td>
<td>2520</td>
</tr>
</tbody>
</table>

Study Area

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal</td>
<td>7,048</td>
<td>856</td>
<td>12,669</td>
<td>20,003</td>
</tr>
</tbody>
</table>

Balance of City

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>3,595</td>
<td>190</td>
<td>4,032</td>
<td>4,992</td>
<td>18,416</td>
</tr>
</tbody>
</table>

TOTAL

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10,679</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Data from 1980 Census Block Data.
2. Building permits for 499 units outstanding have been assumed to be filled by 1990.
3. Year 2000 potential development based upon data supplied by the City of South Burlington.
Discussions with the Chittenden County Regional Planning Commission.

Using the same transportation analysis zones that were used for population projections, employment projections were made for each zone. In using the county data for employment projections, it was assumed that the City of South Burlington employment would comprise 12.8% of the total county employment; the South Burlington study area employment would comprise 72% of the total City of South Burlington employment; and that 40% of the total employment opportunities are involved retail employment. Table III-4 lists the employment projections made by analysis zone and year.

The resulting estimate of population within the study area in the Year 2010 is 12,540 persons. The total projected number of persons employed within the study area in the Year 2010 was assumed to be 9,400 in accordance with the employment projections in the Chittenden County Circumferential Highway Report. An estimated 3,100 persons will be employed in retail businesses in the South Burlington study area in the Year 2010.

2. Trip Generation

Based upon the socioeconomic projection for each analysis zone, estimates were made of trip production and trip attractions at each zone using the TMODEL forecasting model. Trip generation estimates were made for the following three trip purposes:

- Home-Based Work Trips
- Home-Based Non-Work Trips
- Non-Home Based Trips

Estimates of trip productions and attractions for the base year (1985) and the year 2010 by analysis zone are shown in the Technical Appendix of the report.

III-29
### TABLE III-4

EMPLOYMENT PROJECTIONS BY ANALYSIS ZONE

<table>
<thead>
<tr>
<th>Zone</th>
<th>1983</th>
<th>1985</th>
<th>1990</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total/Retail</td>
<td>Total/Retail</td>
<td>Total/Retail</td>
<td>Total/Retail</td>
</tr>
<tr>
<td>8</td>
<td>980/455</td>
<td>1050/510</td>
<td>1070/530</td>
<td>1050/530</td>
</tr>
<tr>
<td>9</td>
<td>546/199</td>
<td>580/220</td>
<td>590/230</td>
<td>600/230</td>
</tr>
<tr>
<td>10A</td>
<td>506/488</td>
<td>550/550</td>
<td>900/900</td>
<td>950/950</td>
</tr>
<tr>
<td>10B</td>
<td>1410/892</td>
<td>1500/990</td>
<td>1580/1010</td>
<td>1700/1160</td>
</tr>
<tr>
<td>10C</td>
<td>89/0</td>
<td>100/0</td>
<td>100/0</td>
<td>100/0</td>
</tr>
<tr>
<td>10D</td>
<td>282/14</td>
<td>310/20</td>
<td>550/20</td>
<td>1500/20</td>
</tr>
<tr>
<td>12</td>
<td>76/0</td>
<td>80/0</td>
<td>80/0</td>
<td>200/0</td>
</tr>
<tr>
<td>13</td>
<td>190/0</td>
<td>410/0</td>
<td>610/0</td>
<td>1000/0</td>
</tr>
<tr>
<td>14A</td>
<td>113/0</td>
<td>130/0</td>
<td>130/0</td>
<td>200/0</td>
</tr>
<tr>
<td>14B</td>
<td>RESIDENTIAL - NO COMMERCIAL DEVELOPMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14C</td>
<td>1115/96</td>
<td>1190/110</td>
<td>1240/110</td>
<td>1400/110</td>
</tr>
<tr>
<td>15</td>
<td>633/90</td>
<td>700/100</td>
<td>700/100</td>
<td>700/100</td>
</tr>
<tr>
<td></td>
<td>TOTALS</td>
<td>5940/2234</td>
<td>6600/2500</td>
<td>7550/2900</td>
</tr>
<tr>
<td></td>
<td>PROJECTED TOTALS</td>
<td>6600/2500</td>
<td>7550/2900</td>
<td>9400/3100</td>
</tr>
</tbody>
</table>

1. From Chittenden County Circumferential Highway Report - Allocations to sub-zones by Storch Engineers.
3. **Trip Distribution**

The trip distribution is made by means of the "gravity model"

The gravity model can be mathematically expressed as the following:

\[
T_{ij} = \frac{A_j F_{ij} K_{ij}}{\sum_{j=1}^{n} P_i A_j F_{ij} K_{ij}}
\]

where \( T_{ij} \) = trips produced in analysis are \( i \), and attracted at analysis area \( j \)

\( P_i \) = total trip production at \( i \)

\( A_j \) = total trip attraction at \( j \)

\( F_{ij} \) = socioeconomic adjustment factor for interchange \( ij \) if necessary

\( T_{ij} \) = travel time (or impedance) for interchange \( ij \)

\( i \) = origin analysis area number, \( i=1,2,3,...,n \)

\( j \) = destination analysis area number, \( j=1,2,3,...,n \)

\( n \) = number of analysis area

Using the gravity model approach of the TMODEL procedure, trip interchanges were calculated for each type of trip: home-based work trips, home-based non-work trips, and non-home-based trips.
The result of this step was a trip table showing total average daily zone-to-zone trips for the ninety traffic analysis zones. Regional trip tables developed in this manner for the years 1985 and 2010 are shown in the Appendix to this report.

In order to efficiently conduct traffic assignments to the study area network, the regional trip table was then "compressed" to a twenty-one zone trip table. The compressed study area trip table was then "normalized" to make daily trips in and out of each zone equal.

4. Traffic Assignment

Following development of 1985 and 2010 study area trip tables, the first step was to calibrate the 1985 trip table and traffic assignment to accurately simulate 1985 counted volumes.

The 1985 trip table was assigned to the existing study area highway network using a capacity restrained, incremental traffic assignment. Minor adjustments were then made to the 1985 study area trip table and highway network coding until the 1985 traffic assignment was found to reasonably match 1985 counted volumes.

Adjustments to the trip table study area consisted primarily of increases to external through trips on Interstate 89. Traffic assignments for the year 2010 were then made for the "No-Build" Alternative, the "Build Interchange 13", Alternative, and the "Build Route 116 Alternative".

Calibration adjustments based upon screen line totals, and individual link assignments were made and Average Daily Traffic Volumes were rounded to the nearest 100 vehicles. The appendix to this report contains the study area trip table, modelled traffic assignments and calibration calculations.

Projected year 2010 Average Daily Traffic volumes for the "No-Build" condition are illustrated in Figure III-14.

Projected volumes for the "Build Interchange 13" condition are shown in Figure III-15, while those for the "Build Route 116 Interchange" are shown in Figure III-16.
NOTE: SEE APPENDIX B-1 FOR TURNING MOVEMENT DETAILS
NOTE: SEE APPENDIX B-1 FOR TURNING MOVEMENT DETAILS
5. **Summary of Traffic Impacts**

Construction of either the Interchange 13 modifications or the Route 116 interchange would have a complex effect on local street traffic volumes throughout the study area.

Construction of the Interchange 13 ramps would generally have a positive effect on Dorset Street traffic by diverting traffic from the northern terminus of Dorset Street. However, some of those trips would be diverted to the southern portion of Dorset Street near Interchange 13. Construction of the Interchange 13 ramps would significantly increase the volumes on the I-189 leg of the Dorset Street/I-189/Kennedy Drive intersection. Volumes on this approach would increase from 23,600 vehicles per day under the Year 2010 No-Build to 45,200 vehicles per day under the Build Interchange 13 Alternative.

Traffic capacity and level of service analysis were performed for five key intersections in the South Burlington study area for the base year (1985) peak hour conditions and for the design year (2010) peak hour conditions under the "No-Build", Interchange 13, and Route 116 alternatives. The level of service calculations are contained in Appendix B.

Under the "No-Build" alternative, several of the critical intersections were projected to have peak hour Levels of Service "F" by the year 2010. Therefore, it was assumed that future intersection improvements would take place in the next twenty-five years, whether or not construction of either interchange took place.

The suggested scope of the required intersection improvements are summarized in Table III-6. It should be noted that these improvements are based simply on lane requirements to provide acceptable levels of service and have not been evaluated in terms of construction feasibility. They do, however, serve to illustrate on a comparative basis, the impacts of the construction of either Interchange 13 or the Route 116 interchange.

The results of the capacity analysis are summarized in Table III-7. Generally, either interchange would have a significant positive benefit on the Dorset Street/US Route 2 intersection. However, it should be noted that the Dorset Street/I-189/Kennedy Drive intersection is projected to have a poor level of service under any of the alternatives, unless there are significant improvements beyond those currently planned under the proposed Dorset Street project.
### TABLE III-5

**SOUTH BURLINGTON**

**SUMMARY OF TRAFFIC LEVEL OF SERVICE ANALYSIS**

<table>
<thead>
<tr>
<th>INTERSECTION</th>
<th>1985 EXISTING CONDITIONS</th>
<th>2010 NO-BUILD</th>
<th>2010 BUILD AT INTERCHANGE</th>
<th>2010 BUILD AT ROUTE 116</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorset Street/US 2</td>
<td>.92</td>
<td>E</td>
<td>1.23</td>
<td>F</td>
</tr>
<tr>
<td>US 2/VT 116/Patcher Rd.</td>
<td>.56</td>
<td>B</td>
<td>.97</td>
<td>E</td>
</tr>
<tr>
<td>US 2/VT 2A</td>
<td>.53</td>
<td>A</td>
<td>.79</td>
<td>C</td>
</tr>
<tr>
<td>VT 116/Kennedy Drive</td>
<td>.62</td>
<td>B</td>
<td>1.73</td>
<td>F</td>
</tr>
<tr>
<td>Dorset St./Kennedy Dr.</td>
<td>.70</td>
<td>C</td>
<td>1.58</td>
<td>F</td>
</tr>
</tbody>
</table>

1. Includes Dorset Street improvements.

Methodology: TRB Circular 212 Planning Method using NCAP Program.
<table>
<thead>
<tr>
<th>INTERSECTION</th>
<th>IMPROVEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorset St./US 2</td>
<td>One lane added to the north, east, and south approaches.</td>
</tr>
<tr>
<td>US 2/VT 116/Patcher Rd.</td>
<td>One lane added to the north, east, and south approaches.</td>
</tr>
<tr>
<td>US 2/VT 2A</td>
<td>One lane added to the north, east, and west approaches.</td>
</tr>
<tr>
<td>VT 116/Kennedy Drive</td>
<td>One lane added to the north and east approaches. Two lanes added to the west approach.</td>
</tr>
<tr>
<td>Dorset St./Kennedy Dr.</td>
<td>Two lanes added to north, south, and east approaches. Three lanes added to west approach.</td>
</tr>
</tbody>
</table>

TABLE III-6
SOUTH BURLINGTON
SUGGESTED INTERSECTION IMPROVEMENTS

III-38
D. Construction Cost Estimates

The estimated cost of the proposed South Burlington Interchange 13 improvements is $8,633,000. The estimated cost of the proposed Route 116 is $2,150,000. The cost estimates are summarized in Tables III-7 and III-8.

E. Benefit Cost Analysis

Road user benefits are summarized in Table III-9. Road user benefits have been estimated by comparing total cost of travel time, vehicle operations, and traffic accidents for the "build at Interchange 13", "build at Route 116", and "no-build" cases for the years 1990 and 2010. The methodology by which road user benefits were calculated is illustrated in the Technical Appendix.

1. Proposed Interchange 13 Improvements

Construction of the Interchange 13 improvements would result in annual road user benefits of about $2,255,000 in 1990. These would increase to about $2,502,000 in the year 2010.

In general terms, improvements to the interchange would save motorists up to 3 minutes per trip depending on their origin and destination. The average savings is estimated to be about 2.5 minutes per trip.

The proposed new ramps are projected to result in an annual travel time savings of $2,407,000 by the year 2010. Vehicles accident savings of $60,000 and vehicle operating costs savings of $35,000 would result by the year 2010.

Based upon the estimates of construction costs and the road user benefits, construction of an interchange would result in a present value cost of $8,633,000 and a present value savings of $27,151,000 in road user benefits. This results in a benefit-cost ratio of 3.2. The benefit-cost analysis is summarized in Table III-10.

2. Proposed Route 116 Interchange

Construction of the Route 116 Interchange would result in annual road user benefits of about $3,598,000 in 1990. These would increase to about $4,617,000 in the year 2010.

III-39
# Table III-7

## Construction Cost Estimate

### Interchange 13

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing &amp; Grubbing</td>
<td>Acre</td>
<td>21.0</td>
<td>$3,500.00</td>
<td>$73,500</td>
</tr>
<tr>
<td>Common Excavation</td>
<td>C.Y.</td>
<td>274,000</td>
<td>4.00</td>
<td>$1,096,000</td>
</tr>
<tr>
<td>Gravel Subbase</td>
<td>C.Y.</td>
<td>43,310</td>
<td>8.00</td>
<td>$346,480</td>
</tr>
<tr>
<td>Plant Mixed Bit. Base Crse</td>
<td>Ton</td>
<td>12,670</td>
<td>36.00</td>
<td>$456,120</td>
</tr>
<tr>
<td>Bit. Concrete Surface Crse.</td>
<td>Ton</td>
<td>7,850</td>
<td>34.00</td>
<td>$266,900</td>
</tr>
<tr>
<td>Guardrail, Signing, Lighting</td>
<td>L.S.</td>
<td>1</td>
<td>606,500.00</td>
<td>$606,500</td>
</tr>
<tr>
<td>Bridge Work</td>
<td>L.S.</td>
<td>1</td>
<td>2,386,200.00</td>
<td>$2,386,200</td>
</tr>
<tr>
<td>Retaining Wall</td>
<td>L.S.</td>
<td>1</td>
<td>225,000.00</td>
<td>$225,000</td>
</tr>
</tbody>
</table>

**Subtotal: $5,456,700**

### Mobilization & Minor Items (20%)

$1,091,300

**Subtotal: $6,548,000**

### Construction Engineering & Contingencies (10%)

$654,800

**Construction Total: $7,202,800**

### Preliminary Engineering (15%)

$1,080,400

### Right-of-Way

$350,000

**Total: $8,633,200**

**SAY: $8,633,000**
TABLE III-8  
CONSTRUCTION COST ESTIMATE  
ROUTE 116 INTERCHANGE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>QUANTITY</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing &amp; Grubbing</td>
<td>Acre</td>
<td>11</td>
<td>$3,500.00</td>
<td>$38,500</td>
</tr>
<tr>
<td>Earth Borrow</td>
<td>C.Y.</td>
<td>32,400</td>
<td>4.00</td>
<td>$129,600</td>
</tr>
<tr>
<td>Rock Excavation</td>
<td>C.Y.</td>
<td>6,750</td>
<td>6.00</td>
<td>$40,500</td>
</tr>
<tr>
<td>Common Excavation</td>
<td>C.Y.</td>
<td>19,000</td>
<td>4.00</td>
<td>$76,000</td>
</tr>
<tr>
<td>Gravel Subbase</td>
<td>C.Y.</td>
<td>19,200</td>
<td>8.00</td>
<td>$153,600</td>
</tr>
<tr>
<td>Plant Mixed Bit. Base Crse</td>
<td>Ton</td>
<td>5,800</td>
<td>36.00</td>
<td>$203,800</td>
</tr>
<tr>
<td>Bit. Concrete Surface Crse.</td>
<td>Ton</td>
<td>3,900</td>
<td>34.00</td>
<td>$132,600</td>
</tr>
<tr>
<td>Guardrail, Signing, Lighting</td>
<td>L.S.</td>
<td>1</td>
<td>105,000.00</td>
<td>$105,000</td>
</tr>
<tr>
<td>Bridge Work</td>
<td>L.S.</td>
<td>1</td>
<td>500,000.00</td>
<td>$500,000</td>
</tr>
</tbody>
</table>

SUBTOTAL                           | $1,384,600

MOBILIZATION & MINOR ITEMS (20%)    | $276,900

SUBTOTAL                           | $1,661,500

CONSTRUCTION ENGINEERING & CONTINGENCIES (10%) | $166,200

CONSTRUCTION TOTAL                | $1,827,700

PRELIMINARY ENGINEERING (15%)      | $274,200

RIGHT-OF-WAY                       | $47,000

TOTAL                              | $2,148,900

SAY                                | $2,150,000
### TABLE III-9

**SUMMARY OF ROAD USER BENEFITS**
*(IN $1000)*

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EXISTING HIGHWAY NETWORK</th>
<th>WITH FULL INTERCHANGE 13</th>
<th>WITH INTERCHANGE ROUTE 116</th>
<th>NET BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANNUAL ROAD USER COSTS</td>
<td>NET BENEFITS</td>
<td>NET BENEFITS</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td>VEH OPER COST</td>
<td>TRAVEL TIME COST</td>
<td>VEH ACC COSTS</td>
<td>VEH OPER COST</td>
</tr>
<tr>
<td>1990</td>
<td>29,031</td>
<td>28,376</td>
<td>630</td>
<td>28,642</td>
</tr>
<tr>
<td>2010</td>
<td>44,360</td>
<td>47,051</td>
<td>949</td>
<td>44,325</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EXISTING HIGHWAY NETWORK</th>
<th>WITH INTERCHANGE ROUTE 116</th>
<th>NET BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANNUAL ROAD USER COSTS</td>
<td>NET BENEFITS</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td>VEH OPER COST</td>
<td>TRAVEL TIME COST</td>
<td>VEH ACC COSTS</td>
</tr>
<tr>
<td>1990</td>
<td>29,031</td>
<td>28,376</td>
<td>630</td>
</tr>
<tr>
<td>2010</td>
<td>44,360</td>
<td>47,051</td>
<td>949</td>
</tr>
</tbody>
</table>
### TABLE III-10

**SOUTH BURLINGTON INTERCHANGE**
**SUMMARY OF BENEFIT-COST ANALYSIS**
**BUILD AT INTERCHANGE 13**

1. Cost (Present Value) \(\times \$1,000\) .................................................. $8,633
2. Net Present Value of Road User Benefits \(\times \$1,000\) .......... $27,151
3. Benefit Cost Ratio .......................................................... 3.2

### TABLE III-11

**SUMMARY OF BENEFIT-COST ANALYSIS**
**BUILD INTERCHANGE AT ROUTE 116**

1. Cost (Present Value) \(\times \$1,000\) .................................................. $2,150
2. Net Present Value of Road User Benefits \(\times \$1,000\) .......... $35,636
3. Benefit Cost Ratio .......................................................... 16.6
A total of 23,400 vehicle trips per day are projected to use the proposed interchange by the year 2010, resulting in an annual travel time savings of $3,413,000. Vehicles accident savings of $67,000 and vehicle operating cost savings of $1,137,000 would result by the year 2010.

Based upon the estimates of construction costs and the road user benefits, construction of an interchange would result in a present value cost of $2,150,000 and a present value savings of $35,636,000 in road user benefits. This results in a benefit-cost ratio of 16.6. The benefit cost analysis is summarized in Table III-11.

F. Conclusions

The average travel time savings benefit provided by each interchange can be illustrated by dividing the total travel time savings by the projected traffic volume which would use the interchange.

For Route 116

\[
\frac{\$3,413,000 \text{ year}}{365 \text{ days year}} : \frac{23,700 \text{ vehicles day}}{23,700 \text{ vehicles day}} = \$0.39/\text{vehicle}
\]

Based upon a value of travel time of $7.00/\text{vehicle hour}, this is equivalent to:

\[
\$0.39/\text{vehicle} : \$7.00/\text{hour} = .056 \text{ hours} = 3.4 \text{ minutes}
\]

Thus the Route 116 interchange would save the average motorist about 3.4 minutes.

A similar calculation indicates that the Interchange 13 improvements would save the average motorist 2.1 minutes.

For Interchange 13

\[
\frac{\$2,407,000 \text{ year}}{365 \text{ days year}} : \frac{26,400 \text{ vehicles day}}{26,400 \text{ vehicles day}} = \$7.00/\text{hour} \times 60 \text{ mins. hour} = 2.1 \text{ minutes}
\]
Therefore, although Interchange 13 is projected to carry a higher volume of traffic than an interchange at Route 116, the Route 116 interchange is estimated to provide a greater savings per trip.

Both interchanges would provide substantial road user benefits and would have benefit-cost ratios greater than 1.0, indicating that either interchange can be justified on an economic basis. However, the Route 116 interchange is projected to have a significantly greater benefit-to-cost ratio than Interchange 13 primarily because of its lower estimated construction cost.

The results of this study have indicated that a new interchange at Route 116 would provide a more favorable benefit-cost ratio than would result from modifications to the existing Interchange 13.

However, there are a number of other considerations relative to this issue which are outside of the scope of this study. These issues must also be considered in selecting an interchange location. These include:

1. **Interchange Spacing**

   Modification of the existing Interchange 13 would not affect the existing interchange spacing on I-89. Construction of a new interchange at Route 116 would introduce a new interchange 2.2 miles north of Interchange 12 and 1.25 miles south of Interchange 13. This spacing would approach the recommended minimum interchange spacing of one mile for urban areas.

2. **Land Use Impacts**

   This study has assumed that land use development patterns would be the same with either interchange alternative. However, it is possible that future land development patterns would, in fact, be affected by the location of an interchange providing access to I-89. A complete interchange at Interchange 13 may serve to encourage development in the Dorset Street area, while an interchange at Route 116 may tend to encourage development in those currently less developed areas.

   It should also be noted that many of the benefits attributed to the Route 116 interchange are based upon development that is projected to occur during the period 1990 to 2010, particularly in areas of the City to the south of I-89. On the other hand, the road user benefits attributed to the Interchange 13 improvements are based to a greater extent upon traffic generated by existing commercial development in the Dorset Street corridor.
3. **Environmental and Right-of-Way Impacts**

Modification of Interchange 13 would take place primarily within the existing state Right-of-Way while a new interchange at Route 116 would require more extensive Right-of-Way acquisition.
IV. WINOOSKI
IV. WINOOSKI

A. Interchange Location and Design Criteria

1. Interchange Location

Access to the City of Winooski from I-89 is currently provided by Interchange 15 located in the City of Winooski itself and Interchange 16 in the Town of Colchester to the north.

Interchange 15 is located approximately 0.5 miles north of the Burlington - South Burlington/Winooski town line. Interchange 16 is located approximately 0.6 miles north of the Winooski/Colchester town line. The distance between Interchanges 15 and 16 is approximately 1.0 mile.

The location of the proposed interchange improvements is shown in Figure IV-1. Currently, Interchange 15 is a "half-diamond" and provides access only from I-89 northbound to Vermont Route 15 and from Vermont Route 15 to I-89 southbound. This study examined the feasibility of constructing an additional northbound on-ramp and southbound off-ramp.

2. Interchange Design Criteria

Route 15 is a four lane roadway, divided in the immediate vicinity of the interchange. The I-89 northbound and southbound roadways are carried over Route 15 by parallel three span structures. The grade difference between Route 15 and I-89 is approximately 26 feet.

LaFountain Street runs in an east-west direction parallel to Route 15, approximately 700 feet to the north. The I-89 northbound and southbound roadways are carried over LaFountain Street by parallel three span structures at a 4± degree skew. The minimum existing vertical clearance over LaFountain Street is 16.13 feet at the easternmost stringer of the northbound structure. The LaFountain Street profile rises at a slight grade to the east.

Due to the existing ramp alignments and the extensive residential development of the surrounding area, the only feasible alternative for providing the northbound on and southbound off traffic movements would be the construction of conventional diamond ramps in the northeastern and northwestern quadrants.
INTERCHANGE 15 INTERSTATE INTERCHANGE FEASIBILITY STUDY

WINOOSKI
STUDY AREA AND TRAFFIC COUNT LOCATIONS

STORCH ENGINEERS
CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION

FIGURE IV-1 SCALE: 1’=800’
The plan and profiles of the proposed ramps are shown in Figure IV-2. The design criteria of the proposed ramps is summarized in Table IV-1. Due to the introduction of additional turning movements on Route 15, extensive modification of the existing traffic signal system will be required.

In order to provide acceptable ramp grades, the ramp terminals would have to be located to the north of the LaFountain Street overpass, resulting in widening of the existing structure. The proposed widening of the northbound structure will reduce the vertical clearance over LaFountain Street. Preliminary calculations indicate the proposed vertical clearance to be approximately 13.75 feet. This is slightly less than the 14.0 feet allowed by AASHTO; however, if 14.0 feet is desired the LaFountain Street profile could probably be lowered 3 inches without too much utility interference.

An initial design investigation in which the ramp terminals were placed south of the LaFountain Street structures, thereby minimizing the amount of bridge reconstruction, resulted in unacceptable ramp profiles. The proposed ramp terminals were then moved northward until the maximum ramp grade was less than 5%.

Construction of these ramps would have a severe impact on residences located adjacent to I-89. There are twelve residential buildings which fall within the right-of-way line of the proposed ramps. Some of these buildings contain more than one family; therefore, approximately 15 to 20 families would have to be relocated at a cost estimated to be approximately 1 million dollars.

B. **Existing Traffic Volumes**

Existing 1985 traffic volumes in the study area were estimated from data compiled by the Vermont Agency of Transportation, the Chittenden County Regional Planning Commission and Storch Engineers. The traffic data available from the agencies was taken between 1981 and 1984 and consists of the following:

- Continuous Count Data from automatic traffic recorders stationed on I-89, US Route 2 & 7, and Vermont Route 15 within the study area.
# TABLE IV-1

**LOCATION C
WINOOSKI
SUMMARY OF DESIGN CRITERIA**

**Interchange Spacing**

Prop. Distance to Interchange No. 14....1.75 miles
Prop. Distance to Interchange No. 16....1.0 miles

<table>
<thead>
<tr>
<th>Ramp Design</th>
<th>Ramp A (NB-ON)</th>
<th>Ramp B (SB-OFF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of I-89</td>
<td>900'</td>
<td>350'</td>
</tr>
<tr>
<td>Accel/Decel Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed @ Ramp</td>
<td>50mph</td>
<td>50mph</td>
</tr>
<tr>
<td>Exit/Entrance @ I-89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ramp Length</td>
<td>795'</td>
<td>1000'</td>
</tr>
<tr>
<td>Maximum Grade (%) (In Direction of Ramp)</td>
<td>+4.83%</td>
<td>-4.80%</td>
</tr>
<tr>
<td>Minimum Stopping Sight Distance on Vertical Curve</td>
<td>430'</td>
<td>410'</td>
</tr>
</tbody>
</table>
Six hour Manual Turning Movement and Vehicle Classification Counts were recorded at the following intersections:

- Interchange 16 - US Route 2 & 7 and I-89 Ramps
- Interchange 15 Vermont Route 15 and I-89 Ramps
- Vermont Route 15 and US Route 2 & 7 (Main Street)
- Vermont Route 15 and Barlow Street

Supplemental traffic data was collected by Storch Engineers during the week of June 24, 1985 to June 28, 1985. This data consisted of 24 hour continuous automatic traffic counts at the following locations:

a. Interchange 16 - Ramp from US Route 2 & 7 to I-89 NB
b. Interchange 16 - Ramp from I-89 SB to US Route 2 & 7
c. US Route 2 & 7 NB - North of ramp from US Route 2 & 7 to I-89 SB
d. US Route 2 & 7 SB - South of ramp from I-89 SB to US Route 2 & 7 NB
e. Vt. 15 WB - West of ramp from Vt. 15 to I-89 SB
f. Vt. 15 EB - East of ramp from Vt. 15 to I-89 SB

Vehicle turning movement counts were taken by Storch Engineers at the following intersections:

a. Vermont Route 15 (East Allen Street) and East Spring Street
b. US Route 2 (Main Street) and East Spring Street

Traffic counts were then factored as appropriate to estimate 1985 Annual Average Daily Traffic (AADT) Volumes. Adjustment factors were based on continuous traffic data from Automatic Traffic Recorders located on I-89, US Route 2 & 7, and Vermont Route 15 within the study area.

Estimated 1985 AADT on the major highways, streets, and ramps in the traffic analysis study area are shown in Figure IV-3. Peak hour volumes are shown in Figure IV-4.
NOTE: SEE APPENDIX C-1 FOR TURNING MOVEMENT DETAILS
NOTE: SEE APPENDIX C-1 FOR TURNING MOVEMENT DETAILS

STORCH ENGINEERS
CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION
INTERSTATE INTERCHANGE FEASIBILITY STUDY

WINOOSKI
1985 PEAK HOUR TRAFFIC

SCALE: 1'=800'

FIGURE IV-4
C. Projected Traffic Volumes

The volumes of traffic projected to use the proposed ramps at Interchange 15 under the "build" alternative were estimated by using a table of trip origins and destinations and projected travel times over the highway network.

Trip origins and destinations in 1985 were estimated using the results of the license plate match study. License plates were recorded over an eight hour period at the following locations:

- Vermont Route 15 at I-89 Ramps (Interchange 15)
- US Route 2 & 7 at I-89 Ramps (Interchange 16)

License plate numbers recorded at each location were then matched to those recorded at the other locations. Based upon the results of the license plate surveys and an analysis of the turning movements in the study area, a trip table of average daily traffic volumes from point to point within the study area was estimated. The estimated 1985 trip table is shown in Appendix E of the report.

The estimated travel times and mileage between key points in the study area based on in-field travel time studies are summarized in Table IV-2. As indicated in Table IV-2 the proposed ramp at Interchange 15 leading onto I-89 northbound would save travelers approximately 3.6 minutes when traveling from points east of Interchange 15 to points north of Interchange 16. In the reverse path, traveling from points north of Interchange 16 to points east of Interchange 15, travelers would save approximately 4.6 minutes in travel time by using the proposed ramp at Interchange 15 from I-89 southbound. For travelers originating north of Interchange 16 and traveling to Route 15 east of I-89, the path via I-89 and the proposed ramp is approximately 3.2 minutes shorter than traveling on U.S. Route 2 & 7 and Vermont Route 15.

Figure IV-5 presents the projected year 2010 Annual Average Daily Traffic for the "no-build" condition. Figure IV-6 presents the year 2010 "no-build" peak hour traffic.
### TABLE IV-2

**WINOOSKI: INTERCHANGE IMPROVEMENTS**

**SUMMARY OF ESTIMATED TRAVEL TIME AND MILEAGE SAVINGS**

**FROM: Vermont Route 15 East of Interchange 15**

<table>
<thead>
<tr>
<th></th>
<th>Via Vt. Rt. 15</th>
<th>Via Proposed Ramp and I-89</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US 2 &amp; 7</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>East Spring St.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time(mins)</th>
<th>Miles</th>
<th>Time (mins)</th>
<th>Miles</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9</td>
<td>1.69</td>
<td>1.3</td>
<td>1.18</td>
<td>3.6</td>
</tr>
</tbody>
</table>

**TO: I-89 North of Interchange 16**

**FROM: I-89 North of Interchange 16**

<table>
<thead>
<tr>
<th></th>
<th>Via US Rt. 2 &amp; 7, Vt. Route 15</th>
<th>Via I-89 and Proposed Ramp</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Time(mins)</th>
<th>Miles</th>
<th>Time (mins)</th>
<th>Miles</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>2.14</td>
<td>1.5</td>
<td>1.29</td>
<td>4.6</td>
</tr>
</tbody>
</table>

**TO: Vermont Route 15 East of Interchange 15**

**FROM: US Route 2 & 7 North of Interchange 16**

<table>
<thead>
<tr>
<th></th>
<th>Via US Route 2 &amp; 7, and Vt. Route 15</th>
<th>Via Camp Johnson and Vt. Route 15</th>
<th>Via I-89 and Proposed Ramp</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Time(mins)</th>
<th>Miles</th>
<th>Time (mins)</th>
<th>Miles</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.9</td>
<td>2.8</td>
<td>4.7</td>
<td>2.0</td>
<td>5.6</td>
</tr>
</tbody>
</table>

**TO: Vt. Route 15 at Camp Johnson Entrance**

**FROM: I-89 North of Interchange 16**

<table>
<thead>
<tr>
<th></th>
<th>Via Exit 16 and US Route 2 &amp; 7</th>
<th>Via Proposed Ramps Exit 15 and Vt. Rt. 15</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Time(mins)</th>
<th>Miles</th>
<th>Time (mins)</th>
<th>Miles</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>1.0</td>
<td>3.0</td>
<td>1.86</td>
<td>1.0</td>
</tr>
</tbody>
</table>
NOTE: SEE APPENDIX C-1 FOR TURNING MOVEMENT DETAILS

STORCH ENGINEERS
CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION
INTERSTATE INTERCHANGE FEASIBILITY STUDY

WINOOSKI
2010 "NO-BUILD"
ANNUAL AVERAGE DAILY TRAFFIC

SCALE: 1"=800'
Figure IV-7 presents the projected year 2010 Annual Average Daily Traffic for the "build" condition. Figure IV-8 presents the year 2010 "build" condition peak hour traffic.

A total of 3,400 vehicles per day are projected to use the proposed ramps at Interchange 15 by the Year 2010. The ramp carrying traffic from I-89 southbound to Vermont Route 15 would serve an annual average of 1,700 vehicles per day (AADT) with 1,700 vehicles (AADT) utilizing the proposed ramp from Vermont Route 15 to I-89 northbound.

D. Construction Cost Estimate

The estimated cost of the proposed Winooski interchange is $2,500,000. The cost estimate is summarized in Table IV-3.

E. Benefit-Cost Analysis

Road user benefits are summarized in Table IV-4. Road user benefits have been estimated by comparing total cost of travel time, vehicle operations, and traffic accidents for the "build" and "no-build" cases for the years 1985, 1990, and 2010.

Construction of the interchange would result in annual road user benefits of about $80,000 in 1990. These would increase to about $82,000 in 2010.

In general terms, construction of the interchange would save motorists about four minutes per trip depending on their origin and destination.

A total of 3,400 vehicle trips per day are projected to use the proposed interchange by the Year 2010, resulting in an annual travel time savings of $161,000.

Based upon the estimates of construction costs and road user benefits, construction of an interchange would result in a present value cost of $2,500,000 and a present value savings of $683,000 in road user benefits. This results in a benefit-cost ratio of 0.27. The benefit-cost analysis is summarized in Table IV-5.

F. Conclusion

The proposed modification of Interchange 15 for the City of Winooski has an estimated benefit-cost ratio of 0.27. Therefore, construction of the proposed interchange cannot be economically justified.
TABLE IV-3
CONSTRUCTION COST ESTIMATE
LOCATION: WINOOSKI - COMPLETE INTERCHANGE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>QUANTITY</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing &amp; Grubbing</td>
<td>Acre</td>
<td>4.0</td>
<td>$3,500.00</td>
<td>$14,000</td>
</tr>
<tr>
<td>Earth Borrow</td>
<td>C.Y.</td>
<td>22,000</td>
<td>4.00</td>
<td>$88,000</td>
</tr>
<tr>
<td>Common Excavation</td>
<td>C.Y.</td>
<td>11,100</td>
<td>4.00</td>
<td>$44,400</td>
</tr>
<tr>
<td>Gravel Subbase</td>
<td>C.Y.</td>
<td>7,600</td>
<td>8.00</td>
<td>$60,800</td>
</tr>
<tr>
<td>Plant Mixed Bit. Base Crse</td>
<td>Ton</td>
<td>2,250</td>
<td>36.00</td>
<td>$81,000</td>
</tr>
<tr>
<td>Bit. Concrete Surface Crse.</td>
<td>Ton</td>
<td>1,425</td>
<td>34.00</td>
<td>$48,450</td>
</tr>
<tr>
<td>Guardrail, Signing, Lighting</td>
<td>L.S.</td>
<td>1</td>
<td>140,000.00</td>
<td>$140,000</td>
</tr>
<tr>
<td>Bridge Work</td>
<td>L.S.</td>
<td>1</td>
<td>470,000.00</td>
<td>$470,000</td>
</tr>
<tr>
<td>Signalization</td>
<td>L.S.</td>
<td>1</td>
<td>50,000.00</td>
<td>$50,000</td>
</tr>
</tbody>
</table>

SUBTOTAL                          |       |          |           | $996,650   |

MOBILIZATION & OTHER ITEMS (20%)   |       |          |           | $199,300   |

SUBTOTAL                          |       |          |           | $1,195,950 |

CONSTRUCTION ENGINEERING & CONTINGENCIES (10%) |       |          |           | $119,600   |

CONSTRUCTION TOTAL                |       |          |           | $1,315,550 |

PRELIMINARY ENGINEERING (15%)     |       |          |           | $197,300   |

RIGHT-OF-WAY                      |       |          |           | $945,000   |

TOTAL                             |       |          |           | $2,457,850 |

SAY                               |       |          |           | $2,500,000 |
<table>
<thead>
<tr>
<th>YEAR</th>
<th>VEH OPER COST</th>
<th>TRAVEL TIME COST</th>
<th>VEH ACC COSTS</th>
<th>VEH OPER COST</th>
<th>TRAVEL TIME COST</th>
<th>VEH ACC COSTS</th>
<th>VEH OPER COST</th>
<th>TRAVEL TIME COST</th>
<th>VEH ACC COSTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>4,360</td>
<td>4,254</td>
<td>67</td>
<td>4,426</td>
<td>4,110</td>
<td>65</td>
<td>-66</td>
<td>141</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>2010</td>
<td>6,032</td>
<td>5,870</td>
<td>88</td>
<td>6,114</td>
<td>5,709</td>
<td>85</td>
<td>-82</td>
<td>161</td>
<td>3</td>
<td>82</td>
</tr>
</tbody>
</table>
TABLE IV-5
WINOOSKI INTERCHANGE
SUMMARY OF BENEFIT-COST ANALYSIS

1. Cost (Present Value) (x $1,000).......................... $2,476
2. Net Present Value of Road User Benefits (x $1,000).......... $683
3. Benefit Cost Ratio........................................... .28
V. MILTON

A. Interchange Location and Design Criteria

1. Interchange Location.

Access to the Town of Milton from I-89 is currently provided by Interchange No. 17 located in the Town of Colchester to the south and by Interchange No. 18 located in the Town of Georgia to the north.

Interchange No. 17 is located approximately 0.5 miles south of the Milton-Colchester town line, while Interchange No. 18 is located approximately 1.5 miles north of the Milton-Georgia town line. The distance between Interchanges 17 and 18 is approximately 8.75 miles.

The location of the proposed interchange to serve the Milton area is shown in Figure V-1.

2. Interchange Design Criteria

At this location Mayo Road is carried over I-89 northbound and southbound by a two-span continuous plate girder at a 14\(^\circ\) degree skew. The minimum curb-to-curb width of Mayo Road is 22 feet and it occurs on the bridge. The remainder of Mayo Road is approximately 22 to 24 feet wide. Due to the vertical alignment of Mayo Road over I-89, the available stopping sight distance on Mayo Road as it passes over I-89 is approximately 270 feet, limiting the safe maximum speed to only 35 mph. The posted speed limit on Mayo Road is currently 35 mph.

The existing land uses in the vicinity of the proposed interchange may be seen in Figures V-2 through V-4 and are summarized below:

Land uses in both the northeast and southeast quadrants are generally residential and make up a portion of the Checkerberry Village Historic District. The southwest quadrant contains a country store located approximately 700 feet to the west of I-89. The northwest quadrant is open land with a cable television building set back 500 feet from Mayo Road. The area between I-89 and U.S. Route 7, immediately south of Mayo Road is undeveloped woodland.
Three alternatives have been developed for northbound on and off ramps at this location. These alternatives are illustrated in Figures V-2 through V-4. Alternative A, Figure V-2, is a typical diamond alignment and would require the taking of two residences. Alternative B, Figure V-3, is a loop and outer connection in the southeast quadrant, and would require the taking of one residence. Alternative C, Figure V-4, is a trumpet alignment connecting to Route 7 south of the Mayo Road area.

Three alignment options also have been developed for the southbound on and off ramps. These alignments are illustrated in Figures V-2 through V-4. Alternative A, Figure V-2, is a typical diamond alignment that would require the taking of the country store. Alternative B, Figure V-3, is a loop and outer connection in the southwest quadrant and also would require taking the country store. Alternative C, however, Figure V-4, is a loop and outer connection in the northwest quadrant.

The recommended alternative for an interchange at this location is shown in Figures V-5. This combines the northbound ramps from Alternative C and the southbound ramps from Alternative B.

The following is a summary of advantages and disadvantages of the recommended ramp locations:

**Northbound on/off ramps**

- Alternative C would result in less truck traffic on Mayo Road, destined to the Catamount Industrial Park located on Route 7.

- I-89 northbound traffic travelling to the industrial park from the south will have a shorter distance to travel than with Alternative A or B.

- No residences are within the proposed taking line of Alternative C.

- Ramp grades will be relatively low (1%±) with Alternative C.

- The majority of traffic using the proposed ramps will be coming from/going to Route 7.

V-3
TABLE V-1

LOCATION D
MILTON
SUMMARY OF DESIGN CRITERIA

Interchange Spacing

Prop. Distance to Interchange No. 17.... 3.1 miles
Prop. Distance to Interchange No. 18.... 5.5 miles

<table>
<thead>
<tr>
<th>Ramp Design</th>
<th>Ramp A</th>
<th>Ramp B</th>
<th>Ramp C</th>
<th>Ramp D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of I-89</td>
<td>600'</td>
<td>650'</td>
<td>500'</td>
<td>600'</td>
</tr>
<tr>
<td>Accel/Decel Lane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed @ Ramp</td>
<td>55 mph</td>
<td>55 mph</td>
<td>30 mph</td>
<td>50 mph</td>
</tr>
<tr>
<td>Exit/Entrance @ I-89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Ramp Length</td>
<td>1850'</td>
<td>2000'</td>
<td>850'</td>
<td>1200'</td>
</tr>
<tr>
<td>Maximum Grade (%)</td>
<td>+2%</td>
<td>-0.9%</td>
<td>+2%</td>
<td>+0.5%</td>
</tr>
<tr>
<td>(In Direction of Ramp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Stopping Sight Distance</td>
<td>830'</td>
<td>UNLIMITED</td>
<td>400'</td>
<td>3600'</td>
</tr>
<tr>
<td>on Vertical Curve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Alternative C would provide a buffer area between the industrial zone along Route 7 and the residential zone along Mayo Road.

Southbound on/off ramps

- The required right-of-way for Alternatives B and C is much less than the diamond alignment of Alternative A.

- The taking of country store is required in Alternative B. However, this additional cost is comparable to the cost that would be required for excavation in the northwest quadrant.

- The ramp grades of Alternative B would be less than 1% compared with the grades of 4 to 5% needed for Alternatives A & C.

For the projected traffic volume that would use Mayo Road, the geometry of Mayo Road as noted above, is severely deficient when compared to 1984 AASHTO standards. Therefore, it is proposed to widen Mayo Road to 40 feet curb to curb and realign it vertically to accommodate a 50 mph passing sight distance. This vertical realignment will require a significant amount of fill and the driveways of residences fronting on Mayo Road will be effected to some extent. The limits of the proposed improvements extend approximately 3,000 feet west of the "Y" intersection of Mayo Road and Route 7.

B. Existing Traffic Volumes

Existing 1985 traffic volumes in the study area were estimated from data compiled by the Vermont Agency of Transportation, the Chittenden County Regional Planning Commission and Storch Engineers. The traffic data available from the agencies was taken between 1981 and 1984 and consists of the following:

- Continuous Count Data from automatic traffic recorders stationed on I-89 and US Route 2 & 7 within the study area.

- Six hour Manual Turning Movement and Vehicle Classification Counts were recorded at the following intersections:
Supplemental traffic data was collected by Storch Engineers during the week of June 24, 1985 to June 28, 1985. This data consisted of 24 hour continuous automatic traffic counts at the following locations:

a. Interchange 18 - Ramp from US Route 7 to I-89 NB
b. Interchange 18 - Ramp from I-89 SB to US Route 7
c. US Route 2 Eastbound - East of Interchange 17
d. US Route 2 Westbound - West of ramp from I-89 NB to US Route 2 EB
e. US Route 7 - North of US Route 2
f. US Route 7 - North of TH2 (Main Street)
g. US Route 7 Northbound - North of TH31 (Park Street) and South of ramp from US Route 7 to I-89 SB
h. US Route 7 Southbound - North of Interchange 18
i. Interchange 17 - Ramp to I-89 Southbound from US Route 2 Westbound
j. Interchange 17 - Ramp from I-89 Northbound to US Route 2 Eastbound
Vehicle turning movement counts were taken by Storch Engineers at the following intersections:

a. US Route 7 (Ethan Allen Highway) and Route 104
b. US Route 7 (Ethan Allen Highway) and Lake Road (TH3)
c. US Route 7 and Railroad Street and Middle Road
d. Mayo Road (TH6) and Bartlett Road (TH45)

Traffic counts were then factored as appropriate to estimate 1985 Annual Average Daily Traffic (AADT) Volumes. Adjustment factors were based on continuous traffic data from Automatic Traffic Recorders located on I-89 and US Route 2 & 7, within the Milton study area.

Estimated 1985 AADT on the major highways, streets, and ramps in the traffic analysis study area are shown in Figure V-6.

C. Projected Traffic Volumes

Future traffic volumes were estimated by using projected population growth rates for the Town of Milton published by the Vermont Department of Health and Vermont State Planning Office.

Future traffic volumes were estimated using an increase of 5% by 1990 and 30% by 2010, compared to the 1985 population.

In projecting future traffic volumes, special attention was given to the Catamount Industrial Park located on US Route 7 north of I-89 Interchange 17 and south of the proposed ramp location. The entire park consists of 174 acres of land with available lot sizes ranging from four to ten acres. There are presently two industrial buildings within the park. The future trips generated from the industrial park have been projected assuming that the industrial park will grow to its full potential by the year 2010. Traffic generation rates were determined in accordance with the Institute of Transportation Engineer’s Trip Generation Manual. The number of trips generated were based on; 1) The gross square footage of existing buildings; and 2) the quantity of land (in acres) available for development. As Table V-2 shows, approximately 120 trips per day will be generated when the two buildings are fully occupied; an annual average of
<table>
<thead>
<tr>
<th>TABLE V-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATAMOUNT INDUSTRIAL PARK TRIP GENERATION</td>
</tr>
<tr>
<td>MILTON, VERMONT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Based on Total Building Space</th>
<th>Based on Total Land Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Space (Sq Ft)</td>
<td>Trips/1000 Sq Ft</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Adjacent Street Traffic</td>
<td></td>
</tr>
<tr>
<td>Peak AM</td>
<td>21,400</td>
</tr>
<tr>
<td>Peak PM</td>
<td>21,400</td>
</tr>
<tr>
<td>Generator Traffic</td>
<td></td>
</tr>
<tr>
<td>Peak AM</td>
<td>21,400</td>
</tr>
<tr>
<td>Peak PM</td>
<td>21,400</td>
</tr>
<tr>
<td>Average Weekday Trip Ends</td>
<td>21,400</td>
</tr>
</tbody>
</table>
approximately 10,420 trips will be generated per day if the total land area is developed. These additional generated trips have been distributed on the street network. The majority of trips are assumed to travel to and from the industrial park via Interstate 89.

The volume of traffic projected to use the Milton interchange under the "build" alternative was estimated by using a table of trip origins and destinations and projected travel times over the highway network.

Trip origins and destinations in 1985 were estimated using the results of the license plate match study. License plates were recorded over an eight hour period at the following locations:

- US Route 2 at I-89 Ramps (Interchange 17)
- US Route 2 at US Route 7
- US Route 7 at Bartlett Road (TH45)
- US Route 7 at Bombardier Road
- US Route 7 at Main Street (TH2)
- US Route 7 at I-89 Ramps (Interchange 18)

These recorded license plates were then matched at one location to another. The results of the license plate survey indicated that in 1985, an estimated 1450 vehicles per day (two-way traffic) traveled from Interchange 17 to areas north of the US Route 7 and Mayo Road (TH6) intersection. Approximately 2,600 vehicles per day were recorded traveling between US Route 7, from south of Interchange 17, and areas north of Mayo Road on US Route 7.

A total of about 800 vehicles per day (two-way traffic) traveled from Interchange 18 to areas near the US Route 7 and Mayo Road (TH6) intersection.

Special attention was focused on the proposed trips generated by the Catamount Industrial Park located on US Route 7, approximately 0.9 miles north of US Route 2 and 1.6 miles south of the US Route 7 and Mayo Road intersection. Estimated travel times were made to compare travel paths originating at the industrial park to either Interchange 17 or to the proposed interchange. The estimated travel times and mileage between points in the study area were based on in-field travel run studies, and are summarized in Table V-3.
### Table V-3

**Milton Interchange**

**Summary of Estimated Travel Time and Mileage Savings to Center of Milton (US 7 at Middle Road and Railroad Street)**

<table>
<thead>
<tr>
<th>From</th>
<th>To I-89 Northbound (at location of proposed interchange)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I-89 South of Interchange 17</td>
<td>6.7 4.63</td>
<td>5.9 4.57</td>
<td>-</td>
<td>-</td>
<td>0.8</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-89 North of Interchange 18</td>
<td>-</td>
<td>-</td>
<td>8.7 7.29</td>
<td>8.3 5.67</td>
<td>0.4</td>
<td>1.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Park</td>
<td>4.7 4.1</td>
<td>3.6 2.1</td>
<td>1.1</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- I-89 North of Interchange 18 is not directly connected to the proposed interchange.
- Time and mileage savings for specific points are calculated based on the proposed interchange and compared to current routes.
Vehicles traveling on I-89 in the southbound direction can reach the center of Milton in a shorter distance and time by using Interchange 18 instead of using the proposed interchange. The proposed interchange would benefit those traveling to and from the industrial park located on US Route 7 to I-89 northbound with approximately a 1.08 minutes time saving and a 2.0 mile savings. The significance of these savings depends on the extent of future development within the industrial park.

Figures V-7 and V-8 present projected year 2010 Annual Average Daily Traffic for the "no-build" and "build" conditions.

Based upon the origin-destination studies and estimates of future population growth, a total of 7,400 vehicles per day would be projected to use a Milton interchange by the year 2010. Ramps A and B, and also Ramps C and D are estimated to carry Annual Average Daily Traffic (AADT) volumes of 3,700.

D. Construction Cost Estimates

The estimated cost of the recommended Milton interchange is $3,411,000. The cost estimate is summarized in Table V-4.

E. Benefit-Cost Analysis

Road user benefits are summarized in Table V-5. Road user benefits have been estimated by comparing total cost of travel time, vehicle operations, and traffic accidents for the "build" and "no-build" cases for the years 1990 and 2010. Road user benefits were evaluated assuming first that there was no development of Catamount Industrial Park and then assuming that there was full development of the industrial park.

With no development at the industrial park, construction of the interchange would result in annual road user benefits of about $12,000 in 1990, increasing to approximately $14,000 by the year 2010. Therefore, without any development at the industrial park, the Milton interchange would not prove significantly beneficial by the year 2010 regardless of construction costs.
TABLE V-4
CONSTRUCTION COST ESTIMATE
LOCATION: MILTON - COMPLETE INTERCHANGE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>QUANTITY</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing &amp; Grubbing</td>
<td>Acre</td>
<td>17.5</td>
<td>$2,600.00</td>
<td>$45,500</td>
</tr>
<tr>
<td>Earth Borrow</td>
<td>C.Y.</td>
<td>0</td>
<td>4.00</td>
<td>0</td>
</tr>
<tr>
<td>Common Excavation</td>
<td>C.Y.</td>
<td>49,800</td>
<td>4.00</td>
<td>$199,200</td>
</tr>
<tr>
<td>Gravel Subbase</td>
<td>C.Y.</td>
<td>20,600</td>
<td>8.00</td>
<td>$164,800</td>
</tr>
<tr>
<td>Plant Mixed Bit. Base Crse</td>
<td>Ton</td>
<td>8,550</td>
<td>44.00</td>
<td>$376,200</td>
</tr>
<tr>
<td>Bit. Concrete Surface Crse.</td>
<td>Ton</td>
<td>5,250</td>
<td>36.00</td>
<td>$189,000</td>
</tr>
<tr>
<td>Guardrail, Signing, Lighting</td>
<td>L.S.</td>
<td>1</td>
<td>97,500.00</td>
<td>$97,500</td>
</tr>
<tr>
<td>Bridge Work</td>
<td>L.S.</td>
<td>1</td>
<td>590,000.00</td>
<td>$590,000</td>
</tr>
<tr>
<td>Upgrade of Rt. 7</td>
<td>L.S.</td>
<td>1</td>
<td>450,000.00</td>
<td>$450,000</td>
</tr>
</tbody>
</table>

SUBTOTAL $2,112,200

MOBILIZATION & OTHER ITEMS (20%) $422,400

SUBTOTAL $2,534,600

CONSTRUCTION ENGINEERING & CONTINGENCIES (10%) $253,500

CONSTRUCTION TOTAL $2,788,100

PRELIMINARY ENGINEERING (15%) $418,200

RIGHT-OF-WAY $205,000

TOTAL $3,411,300
SAY $3,411,000
### TABLE V-5
SUMMARY OF ROAD USER BENEFITS (IN $1000)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EXISTING HIGHWAY NETWORK</th>
<th>WITH MILTON INTERCHANGE</th>
<th>NET BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VEH OPER COST</td>
<td>TRAVEL TIME COST</td>
<td>VEH ACC COST</td>
</tr>
<tr>
<td>1990*</td>
<td>10,939</td>
<td>8,836</td>
<td>168</td>
</tr>
<tr>
<td>1990</td>
<td>12,498</td>
<td>9,974</td>
<td>193</td>
</tr>
<tr>
<td>2010*</td>
<td>13,544</td>
<td>10,974</td>
<td>208</td>
</tr>
<tr>
<td>2010</td>
<td>16,550</td>
<td>13,152</td>
<td>257</td>
</tr>
</tbody>
</table>

*With no development at Industrial Park
Assuming full development at the Catamount Industrial Park, construction of the interchange would result in annual road user benefits of approximately $311,000 in 1990. These would increase to about $554,000 in the year 2010.

In general terms, construction of the interchange would save motorists on the average, one minute per trip depending on their origin and destination. A total of 7,400 vehicle trips are projected to use the proposed interchange by the year 2010, assuming full development of the industrial park, resulting in an annual time savings of $77,000.

Because travel on the interstate highway results in lower vehicle operating costs per mile and that some trips are shortened in length, the proposed interchange would result in a savings of about $151,000 per year in vehicle operating costs by the year 2010.

The proposed interchange would also result in an annual savings in accident costs of about $3,000 and annual travel time costs of about $400,000 by the year 2010.

Based on the estimates of construction cost and road user benefits, construction of the interchange would result in annual cost of $3,411,000 and an annual savings in road user benefits of $3,271,000. This results in a benefit-cost ratio of 0.96. The benefit-cost analysis is summarized in Table V-6.

F. Conclusion

The proposed interchange would have an estimated benefit-cost ratio of 0.96 if full development of Catamount Industrial Park were to occur by the 1990. However, given other assumptions based on phased development of the industrial park, lower benefit-cost ratios would result. Given the assumption that full development of the industrial park is not likely to occur by 1990, the construction of the proposed interchange cannot be considered economically feasible at this time.
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Net Present Value of Road User Benefits (x $1,000)</th>
<th>Benefit Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. No Development at Catamount Industrial Park</td>
<td>$33</td>
<td>0.01</td>
</tr>
<tr>
<td>b. 100% Development at Catamount Industrial Park by 1990 and Full Development by 2010</td>
<td>$3,271</td>
<td>0.96</td>
</tr>
</tbody>
</table>
REFERENCES


Vermont Standard Drawings, Vermont Agency of Transportation.


See Volume II For Technical Appendices