658-5588

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Chittenden County Regional
Planning Commission

INTERSTATE 89

EXIT 14W SOUTHBOUND

RAMP CONGESTION STUDY

September 20, 1993

prepared for

CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION

DRAFT

prepared by

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Burlington, VT 05401

P•E•A

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Engineers ❖ Planners ❖ Landscape Architects ❖ Surveyors

Interstate 89

Exit 14W Southbound

Ramp Congestion Study

Narrative Description of Proposed Immediate Improvements

November 29, 1993

Morning traffic entering Burlington at the referenced location is often backed up onto the main line due to hold-up created by vehicles attempting to enter Williston Road westbound from the I 89 ramp. To facilitate vehicular movement, minor maintenance type improvements are proposed described as follows:

Ramp at Williston Road near Sheraton: Remove existing Yield signs on the ramp at Williston Road. Install a W4-3 Warning Merge Sign on the ramp approximately 185 feet back from Williston Road, and on Williston Road approximately 175 feet back from the ramp intersection north side. Restripe with solid white from the point of ramp and Williston Road intersection 130 feet westerly along Williston Road, to differentiate the lane use and discourage the attempt at immediate merge, tending to cause traffic backup.

East Avenue at Williston Road: On the inside corner widen the pavement (set back the curb) up to a maximum of 5 feet and tapering over a 180 foot distance, to accommodate two 11 foot right turn lanes from Williston Road to East Avenue. Restripe Williston Road and East Avenue to Carrigan Drive accordingly to allow two travel lanes. Include pavement markings, arrows and re-signing as appropriate to accommodate improved traffic movement from Williston Road onto East Avenue.

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To Vail Leach	From Art Hogan
Co. Vt. AOT.	Co. CCRPC
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and fax transmittal memo 7671 | # of pages ▸ 1

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Williston Road/Ramp	1
Williston Road/Sheraton-Staples	2
Williston Road/East Avenue	3
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I. INTRODUCTION

This project consists of a study of the exit 14W southbound ramp for I-89. The impetus for initiating this project is due to an unsafe condition which has developed during the morning peak hour traffic period between approximately 7:30 a.m. and 8:30 a.m. at this I-89 Interchange ramp west bound towards Burlington (Ramp C). This study is to determine the causes of, and possible solutions to the long queue that develops, creating a back-up in the travel lanes on I-89. This condition is very unsafe and potentially very dangerous. Additionally, this gridlock of vehicles has been a problem for emergency vehicles trying to reach the Medical Center Hospital of Vermont (MCHV). The study of this situation includes a review of the problems with the discharge of the vehicles from the ramp, as well as observations and study of the three downstream signalized intersections.

The upper Main Street widening project has several improvements which include the long-term resolutions to this current problem. Using existing traffic study data, PEA is to develop possible interim solutions which can be immediately implemented. Among those alternatives is the "no build" scenario with signal phasing/timing changes or other traffic flow enhancements in the area. Several other changes or alternate solutions including physical improvements have been investigated.

Many studies have been conducted on this section of Williston Rd./Main Street. PEA will review and gather pertinent parts of the existing traffic data and studies for use in its work. Additionally the proposed Main Street plans will be reviewed for compatibility with any proposed solutions. The existing data and plans were supplemented with additional traffic counting and observation by PEA staff.

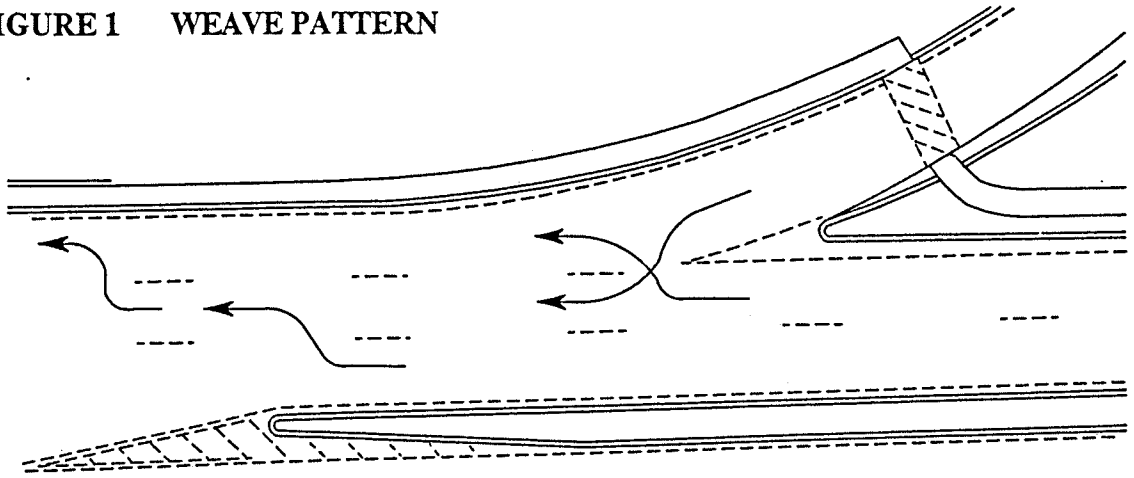
All studies and evaluations were reviewed with the involved parties consisting of the Chittenden Regional Planning Commission (CCRPC), the Vermont Department of Transportation (VAOT); the Cities of Burlington and South Burlington, Campus Area Transportation Management Association (CATMA), and the Sheraton. The observations, concerns and suggestions were included in the development of the alternatives.

II. EXISTING CONDITIONS:

Weave Pattern

Presently, morning traffic through the Exit 14W interchange is extremely heavy westward (Level of Service F)[1] from the I-89 exit ramps (both north- and southbound), as well as Williston Road and Dorset Streets east of the interchange. Although it is acknowledged that peak morning traffic is heavy on all ramps of the interchange, this report focuses on the problem area that is the unsafe condition that occurs on the exit 14W southbound towards Burlington (Ramp C).

FIGURE 1 WEAVE PATTERN



Actual US-2 (Williston Road) westbound traffic movements from the bridge over I-89 to the intersection of East Avenue and Carrigan Drive, including Ramp C and the "Jug Handle" intersection of US-2, East Ave. and Spear St., were observed over the peak period from approximately 7:30 to 8:30 a.m. for the entire week September 13-18, 1993.

The problem backups onto Ramp C have been observed to be the result of the following occurrences:

1. The generally abundant flow of traffic westbound from both north and southbound I-89, as well as Williston Rd. and Dorset St. east of Interchange 14, during the peak weekday morning period.

2. The yield directive at the intersection of Ramp C (southbound off) at US-2.

[1] *Traffic Impact Review, UVM Housing/Parking Study*; Resource Systems Group, February 1990.

3. The abundant traffic flowing from US-2 to East Ave. competing to weave with Ramp C traffic entering US-2 bound for East Ave. or Main St. in Burlington.

Observations have identified the primary problem movement occurring at the point where Ramp C intersects with US-2. At this intersection, US-2 westbound is three lanes wide with the left and center lanes carrying traffic from the east. The right lane, which originates at Ramp C, extends through the signal at the intersection of US-2 and Sheraton Hotel to East Ave. (additionally, a Left-Turn-Only lane originating just past the US-2/Ramp C intersection and terminating at the Sheraton/Staples signal).

General traffic flow at the I-89 interchange is heavy due to rush-hour morning traffic from the outlying suburban areas in Chittenden County to the University of Vermont, MCHV and the downtown Burlington business district. Figure 2 following shows 1993 morning peak hour traffic.

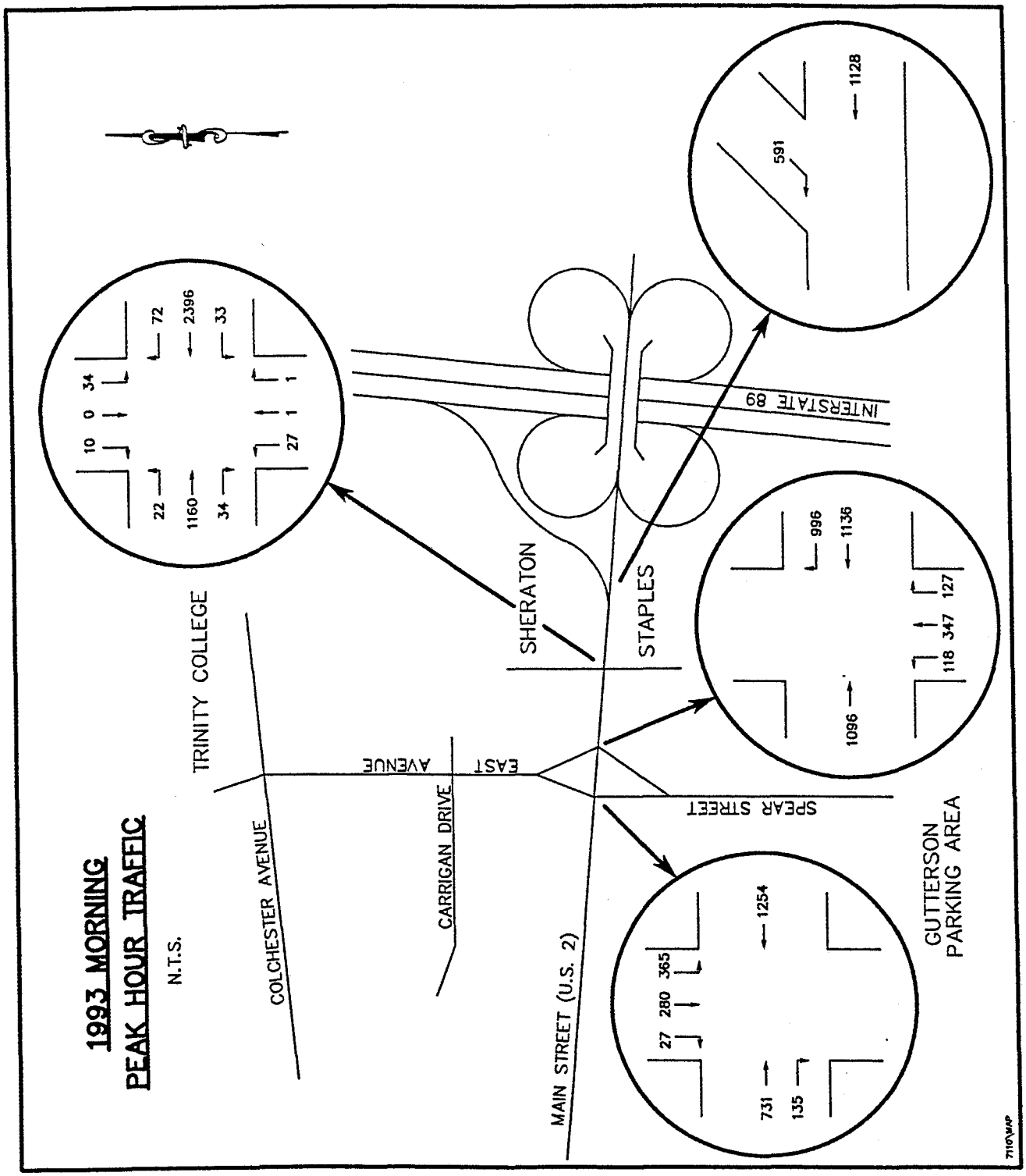
Presently Ramp C, which enters the US-2 traffic flow with its own lane, is signed to direct traffic to yield to the US-2 traffic. A driver properly obeying the yield directive (stopping to wait for an opportunity to safely enter the traffic stream) during periods of peak traffic flow, typically is faced with delays waiting for a gap in the traffic in which to safely merge/weave. While the courteous/safe driver is properly yielding, traffic will back up onto Ramp C behind. Frequently it was observed that the yielding drivers would be looking over their shoulder waiting for a gap in traffic, while the lane directly in front of them was empty. During the peak morning period, gaps in the US-2 westbound traffic are infrequent and this "yielding driver scenario" contributes to the dangerous backups onto the I-89 Ramp C deceleration lane and shoulder. As noted in the Resource Systems Group report, 68% of the ramp traffic weaves left and 45% of the Williston Rd. traffic weaves left.

An observed alternative (and more frequent scenario) to the properly yielding driver are those drivers that maintain speed and merge with the US-2 traffic. It is obvious that these drivers are well aware of the fact that, regardless of the instruction to yield, there is a full lane that Ramp C empties into. They approach the traffic aggressively and either occupy their space in the right lane or merge into moving traffic in the center lane. This scenario results in better traffic flow and less backup; however, it was also observed that many vehicles stopped in an attempt to yield to oncoming traffic, would be passed by the more aggressive drivers driving around them to merge. Several erratic moves and "close calls" were observed due to this movement.

Merging of the US-2 and Ramp C traffic, which is able to take place for the entire length of the right lane from Ramp C to East Ave., usually only occurs in the length east of the Sheraton intersection.

This backup is further compounded by the numerous US-2 westbound vehicles heading toward East Ave. that are required to merge with the right lane to do so. These vehicles, given the right-of-way by the Ramp C yield directive, tend to monopolize the right lane immediately after the intersection with Ramp C. Although there is substantial additional distance to complete this merge between the Sheraton intersection and East Ave., very little merging was seen taking place here.

FIGURE 2 MORNING PEAK TRAFFIC



Accidents

Accident data from State Highway Sorted Accident File (VT A.O.T.) was reviewed for the years 1986 to 1991 on US-2 for the section between Dorset St. and East Avenue. Thirteen weaving type accidents were identified. All were located in the westbound direction between Ramp C and East Ave. Of these, only one was located between the Sheraton entrance and East Ave.

The potential for this type of accident is indicated by the number of weaving maneuvers observed. On September 14, a one-hour period starting at 7:25 a.m. found 609 left-to-right lane changes, and 284 right-to-left hand changes, a total of 893 weaves. A similar time period observed on September 13 noted 66 erratic or aggressive movements taking place in this same weaving area.

Traffic Back-ups

Video recordings by the CCRPC, taken September 1 & 2, 1993, document the traffic back-up regularly encountered by southbound I-89 vehicles on weekday mornings. For example, September 1 from 7:41 to 7:51 a.m., queues extending from 3 to 6-or-more vehicles were observed from the ramp nose northerly. (The position of the camera on September 1 was such that a physical obstruction prevented the visual observation of the number of queued vehicles beyond six.) September 2, from 7:40 to 8:22 a.m., queue lengths of 1 to 12 vehicles were noted beyond the ramp gore, with only four one minute intervals when the waiting line was contained within the ramp. The September video filmed by the CCRPC showed one unsafe maneuver consisting of a vehicle in the ramp queue pulling back into the travel lane into oncoming traffic.

Occasional short back-ups were noted during a similar time period September 13 & 15 on East Ave. and Spear St., occurring between green signal phases at the jug-handle. Fourteen back-ups, more than 1 signal cycle, were observed during a one-hour period on Williston Rd., most occurring from Sheraton/Stables east, with a few east of the jug-handle.

III. ALTERNATIVES

Discussion

We perceive that the main contributor to the back-up of the ramp is the weave pattern at the end of the ramp. Vehicles leaving the ramp tend to stop and wait for gaps in vehicles traveling along Williston Road. This right-to-left weave is further complicated by the unpredictability of the Williston Road vehicles as about half of these vehicles are intending to weave left-to-right immediately upon reaching the start of the right hand lane (the ramp lane). As observed by PEA and as noted in the Resource Systems Group report the signalization at the jug-handle for right turns onto East Avenue do not cause queues to the Sheraton/Staples intersection and thus do not appear to contribute to the back-up on the ramp. Consequently the the ability to weave smoothly and quickly is the main thrust of our analysis of alternatives.

Alternative I - No Build

The "no build" alternative considers altering the existing signalization to expedite the movement of traffic away from the ramp. The existing signalization patterns of green time for

mainline and side streets were analyzed using existing traffic information to determine if the signals are optimally timed to allow maximum flow. We have concluded that minor adjustments could be made to balance green signal time through the intersections, but this would not significantly alleviate the ramp backup problem.

One signalization change for the a.m. peak period would be to increase the green time on the mainline at the more easterly jug-handle. To compensate for this change for cross traffic from Spear Street, the lane markings would be changed so that the left lane would serve as straight through or left turn (currently the lane is left only). To accompany this change, East Ave. will need to be marked as two lanes from Williston Road to the signal at Carrigan Drive. Our review shows that East Ave. has sufficient width to handle the two lanes.

Pavement markings can be improved to encourage right (curb) lane utilization by the Sheraton, accomplished by extending the solid white line further towards the signal. This would remind off-ramp weaving drivers that they can proceed in their own exclusive lane, and do not have to weave left before the signal.

Additional signing, to supplement the overhead guide sign east of the jug-handle, could perhaps help the stranger into his correct lane; however, the need is not compelling when assuming most vehicles in the rush hour are repeat (commuter) drivers.

Alternative II - Physical Improvements

Signalization - Ramp Improvements

The main cause of the back-up problem is the inability of the traffic to leave the exit ramp in a timely, orderly fashion. Educating the Burlington-bound ramp driver to utilize the open lane, to maintain speed equal to the existing Williston Road traffic and then to merge left cannot be effectively done by signing and striping alone. The driver needs to feel secure in having the right-of-way when entering Williston Road in order to maintain a free flow. Traffic control signals are the most effective means to control traffic on Williston Road (and consequently the ramp) to give the ramp driver the security to enter Williston Road without hesitation.

The signalization of the ramp allows for platooning of the vehicles which decreases waste of time for each Burlington-bound vehicle to stop, look, and wait for an appropriate gap in the lane prior to making a lane change. To best utilize signalization, double lanes are proposed on the ramp to allow a double row of platooned vehicles to enter Williston Road with the left lane signed for downtown Burlington and the right lane signed for East Avenue. Having three receiving lanes downstream, it would very inefficient to hold Williston Rd. while a single-lane ramp empties.

Signalizing will also allow nonconflicting flow along Williston Road; the vehicles destined for East Ave. will also have a protected lane change and the hesitations, erratic speed changes and erratic lane changes are essentially eliminated.

To best control the green time split between Williston Road and the ramp, advance loop detectors will be placed in each roadway. When the loop detects a stopped vehicle, an extended green for the backed up lane is actuated. To prevent short cycling of the signals, Williston Road will have a minimum of 18 seconds of green time and the ramp will have a minimum of 12 seconds of green time.

Jug-Handle - East Avenue Improvements

The signalization at the ramp/Williston Road junction will slightly increase traffic flow to the downstream intersections. To assure continued free flow for the right turn movements at East Ave., the creation of double right turn lanes can be easily created. The curve on the north side of the lane can be pulled back to allow width for the creation of two right turn lanes. With creation of two right turn lanes, East Avenue would need to be striped for two lanes from the jug-handle through to Carrigan Drive. As noted in Alternative I, our review shows that East Ave. has sufficient width to handle the two lanes, with full width lanes to be constructed as part of the upper Main Street project. This East Avenue scenario is as planned and intended by the Burlington Main Street project.

Other Considerations

The improvements being proposed are considered operational improvements and not major alterations to the transportation network of the area. The improvements are in and along existing roadways with negligible impacts on surrounding areas. The limited scope of the improvements will not cause any adverse environmental impacts.

Similarly, the magnitude of the work is so small that very little change in the aesthetics of the area will be observed and no change in the existing landscaping is proposed.

IV. COSTS

The costs for the improvements have been tabulated and categorized in accordance with VAOT Item numbering system and preliminary values. These costs include the ramp widening with signalization, signing, striping and the East Avenue double right turn improvements to include curb relocation and striping.

PRELIMINARY CONSTRUCTION ESTIMATE

VAOT ITEM NO.	PAY ITEM	UNIT	UNIT PRICE	QUANTITY	TOTAL PRICE
203.28	EXCAVATION OF SURFACES & PAVEMENTS	CUBIC YARD	14.00	60.00	840.00
203.32	GRANULAR BORROW	CUBIC YARD	10.00	750.00	7500.00
203.40	FINE GRADING - SUBGRADE	SQUARE YARD	1.50	500.00	750.00
204.20	TRENCH EXCAVATION OF EARTH	CUBIC YARD	12.00	570.00	6840.00
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CUBIC YARD	20.00	480.00	9600.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	60.00	270.00	16200.00
601.20	PRECAST REINFORCED CONC. CB W/C.I. GRATE	EACH	2000.00	1.00	2000.00
630.10	UNIFORM TRAFFIC OFFICERS	HOUR	20.00	240.00	4800.00
631.10	FIELD OFFICE - ENGINEERS	LUMP SUM	10000.00	1.00	10000.00
631.17	TESTING EQUIPMENT - BITUMINOUS	LUMP SUM	500.00	1.00	500.00
635.10	MOBILIZATION, INCL. STRIP. TOPSOIL & EROSN. CONTR.	LUMP SUM	10%	1.00	19428.03
646.40	DURABLE 4" WHITE LINE	LINEAR FOOT	0.40	1200.00	480.00
646.43	DURABLE 8" YELLOW LINE	LINEAR FOOT	0.40	200.00	80.00
646.46	DURABLE 24" STOP BAR	LINEAR FOOT	5.00	38.00	190.00
646.50	DURABLE LETTER OR SYMBOL	EACH	50.00	14.00	700.00
646.51	DURABLE CROSSWALK MARKING W/ DIAGONAL LINE	LINEAR FOOT	7.00	38.00	266.00
651.15	SEED	POUND	5.00	5.00	25.00
651.18	FERTILIZER	POUND	1.00	5.00	5.00
651.20	AGRICULTURAL LIMESTONE	TON	100.00	0.10	10.00
651.25	MULCH (HAY)	TON	220.00	0.10	22.00
651.35	TOPSOIL	CUBIC YARD	30.00	40.00	1200.00
675.20	TRAFFIC SIGNS, TYPE A	SQUARE FOOT	18.00	18.00	324.00
675.21	TRAFFIC SIGNS, TYPE B	SQUARE FOOT	25.00	108.00	2700.00
675.30	FLANGED CHANNEL SIGN POSTS	POUND	2.50	80.00	200.00
675.50	REMOVING SIGNS	EACH	8.25	1.00	8.25
675.33	SIGN POSTS	POUND	3.00	8.00	24.00
675.43	SIGN POST FOUNDATIONS	EACH	450.00	2.00	900.00
677.12	OVERHEAD TRAFFIC SIGN SUPPORT	EACH	2400.00	1.00	2400.00
678.15	SIGNALS	LUMP SUM	42000.00	1.00	42000.00
678.21	ELECTRICAL CONDUIT	LINEAR FOOT	8.00	1800.00	14400.00
678.22	VEHICLE LOOP DETECTOR	LINEAR FOOT	6.50	1240.00	8060.00
678.24	ELECTRICAL WIRING	LINEAR FOOT	8.00	1800.00	14400.00
678.25	SINGLE PULL BOX	EACH	800.00	10.00	8000.00
			SUBTOTAL		$ 194280.31
			CONTINGENCY 10%		19428.03
			ENGINEERING 10%		19428.03
			TOTAL COST		$ 233136.37

V. COST BENEFIT DETERMINATION

A simple method for making a practical analysis of the proposed improvements to relieve the ramp congestions is based on a determination of the benefits to road users. Unit road user operating costs are given, prepared to be representative on a national basis. The method of analysis is applied as a "Build-No Build" alternate, being a comparison of the annual road user savings to the annual capital costs for building the recommended improvements. The method results in a benefit ratio or factor.

The annual vehicle operating and time cost is calculated by:

Annual cost = 260 x A x L x U

where:

260 is the number of work days in a year (Monday - Friday)
A is average daily peak hour traffic
L is length of delay per vehicle (seconds)
U is cost per second of delay

The net costs to the public is the cost difference in delays between the build and the no-build scenario.

"No Build" conditions:

A_w = 1187 vehicles per peak hour (Williston Road)[2]
A_r = 662 vehicles per peak hour (Ramp)[2]
L_w = 5 sec (Williston Road)
L_r = 20 sec (Ramp)
U = $ 0.078/sec[3]

Annual Operating costs = "No Build" Cost to public
= $(260 \times A_w \times L_w \times U) + (260 \times A_r \times L_r \times U)$
= $(260 \times 1187 \times 5 \times \$0.078) + (260 \times 662 \times 20 \times \$0.078)$
= $388,869 per year

"Build" conditions:

A_w = 1187 vehicles per peak hour (Williston Road)
A_r = 662 vehicles per peak hour (Ramp)
L_w = 8.3 sec (Williston Road)
L_r = 9.8 sec (Ramp)
U = $ 0.078/sec

Annual Operating costs = "Build" Cost to public
= $(260 \times A_w \times L_w \times U) + (260 \times A_r \times L_r \times U)$
= $(260 \times 1187 \times 8.3 \times \$0.078) + (260 \times 662 \times 9.8 \times \$0.078)$
= $131,568 per year

[2] Agency of Transportation Traffic Data
[3] *Road Users Benefit Analysis for Highway Improvements, 1960*

Net Operating Costs = "No Build" - "Build" Operating Costs
= $388,869 - $131,556
= $257,313 per year

Assuming this interim solution is for three years; then the total cost saving to the public is $771,939.

The total costs of the improvements has been determined to be approximately $233,500 for a benefit cost ratio of: $\frac{\$771,939}{\$233,500} = 3.3$

This is a very strong ratio supporting the improvements.

The costs to the driving public are a conservative value as it does not factor in increase in traffic nor escalation of costs over the three year period. The analysis also does not include the costs associated with any possible accidents which could occur on I-89 should the back-up be allowed to continue. Thus, the benefit cost ratio could be greater.

VI. CONCLUSIONS

This study has identified a traffic engineering measure which is considered feasible and can be implemented in a short time frame. The proposed work should essentially eliminate the weekday morning bottleneck for in-bound US-2 traffic which has begun to interfere with traffic on the southbound lanes of I-89.

The major cause of the bottleneck is the weave from Ramp "C" westerly, rather than the infrequent back-up from a downstream intersection. This is an operational conflict which will be partially addressed by the upper Main Street project; however, the benefits of this short-term improvement will extend to that already planned capacity improvement, which is sorely needed.

A lot of the weaving conflict west of the Sheraton-Staples signal can be reduced by having two northbound right turn lanes toward East Avenue (as proposed by the Main Street project). While the new turning radius shown herein allows this movement, the rather narrow section from there to Carrigan Drive should still undergo the minor widening included in the Main Street project.

While emphasis has been on the Ramp "C" back-up, it should be noted that upstream US-2 traffic will be improved. The reduction in weave problems after the ramp junction will encourage use of the right lane much more efficiently.

The ramp signals are a reverse twist on the increasingly used ramp "metering" concept, wherein the mainline is overloaded and ramp traffic is added in increments by the signal. The proposed system does not add traffic, but rather assigns a positive right-of-way to allow all available lanes to be fully utilized.

The improvements proposed should be considered interim measures only, until the Main Street project is completed (if within 3 years). It seems as though long term planning should be looking at more positive solutions such as the addition of a supplementary westbound ramp.

VII. RESOURCE MATERIAL

1. Resource Systems Group *Traffic Impact Review of Housing and Parking Relocation* prepared for University of Vermont, February 1990

2. Topographic Maps provided by University of Vermont

3. *Highway Design and Operational Practices Related to Highway Safety* second edition, 1974, published by American Association of State Highway & Transportation Officials.

4. Rowan, N.J., Woods, D.L., Stover, V.G., Anderson, D.A., & Dozier, J.H.; edited by Johnson, J.H. *Safety Design and Operational Practices for Streets and Highways*; Texas A & M University for the United States Department of Transportation.

5. *Road Users Benefit Analysis for Highway Improvements*; American Association of State Highway Officials, 1960

1985 HCM: SIGNALIZED INTERSECTIONS
SUMMARY REPORT

****

INTERSECTION..Williston Rd. US-2/I-89 S'bnd OFF Ramp C
AREA TYPE.....OTHER
ANALYST.....PINKHAM ENGRG. - R.Alexander
DATE.....9-19-93
TIME.....'93 AM peak hour
COMMENT.....CCRPC project, South Burlington

	VOLUMES					GEOMETRY							
	EB	WB	NB	SB		EB		WB		NB		SB	
LT	0	0	0	0	:	12.0	T	12.0		12.0	T	12.0	
TH	0	1128	0	591	:	12.0	T	12.0		12.0	T	12.0	
RT	0	0	0	0	:	12.0		12.0		12.0		12.0	
RR	0	0	0	0	:	12.0		12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	

ADJUSTMENT FACTORS

	GRADE (%)	HV (%)	ADJ Y/N	PKG Nm	BUSES Nb	PHF	PEDS	PED. Y/N	BUT. min T	ARR. TYPE
EB	0.00	2.00	N	0	0	0.90	0	N	8.5	3
WB	0.00	2.00	N	0	3	0.90	0	N	8.5	3
NB	0.00	2.00	N	0	0	0.90	0	N	8.5	3
SB	0.00	2.00	N	0	0	0.90	10	N	8.5	3

SIGNAL SETTINGS — CYCLE LENGTH = 50.0

		PH-1	PH-2	PH-3	PH-4			PH-1	PH-2	PH-3	PH-4
EB	LT					NB	LT				
	TH						TH				
	RT						RT				
	PD						PD				
WB	LT					SB	LT				
	TH		X				TH		X		
	RT						RT				
	PD						PD				

LEVEL OF SERVICE

	LANE GRP.	V/C	G/C	DELAY	LOS	APP. DELAY	APP. LOS
WB	T	0.774	0.480	6.3	B	8.3	B
SB	T	0.605	0.320	9.8	B	9.8	B

INTERSECTION: Delay = 8.8 (sec/veh) V/C = 0.706 LOS = B

1985 HCM: SIGNALIZED INTERSECTIONS
SUMMARY REPORT

****

INTERSECTION..Williston Rd. US-2/Sheraton / Staples
AREA TYPE.....OTHER
ANALYST.......PINKHAM ENGRG. - R.Alexander
DATE..........9-19-93
TIME..........'93 AM peak hour
COMMENT.......CCRPC proj. I-89 OFF-ramp, So.Burl.

	VOLUMES					GEOMETRY							
	EB	WB	NB	SB		EB		WB		NB		SB	
LT	22	33	27	10	L	12.0	L	12.0	L	12.0	LT	12.0	
TH	1160	2396	1	0	T	12.0	T	12.0	T	12.0	R	12.0	
RT	34	72	1	34	T	12.0	T	12.0	R	12.0		12.0	
RR	0	0	0	0	R	12.0	TR	12.0		12.0		12.0	
						12.0		12.0		12.0		12.0	
						12.0		12.0		12.0		12.0	

ADJUSTMENT FACTORS

	GRADE (%)	HV (%)	ADJ Y/N	PKB Nm	BUSES Nb	PHF	PEDS	PED. Y/N	BUT. min T	ARR. TYPE
EB	0.00	2.00	N	0	0	0.87	0	N	0.0	3
WB	0.00	2.00	N	0	0	0.87	0	N	0.0	3
NB	0.00	2.00	N	0	0	0.87	0	N	0.0	3
SB	0.00	2.00	N	0	0	0.87	0	N	0.0	3

SIGNAL SETTINGS — CYCLE LENGTH = 107.0

		PH-1	PH-2	PH-3	PH-4			PH-1	PH-2	PH-3	PH-4
EB	LT	X				NB	LT	X			
	TH		X				TH	X			
	RT		X				RT	X			
	PD						PD				
WB	LT	X				SB	LT	X			
	TH		X				TH	X			
	RT		X				RT	X			
	PD						PD				
GREEN		8.0	76.0	0.0	0.0	GREEN		10.0	0.0	0.0	0.0
YELLOW		4.0	5.0	0.0	0.0	YELLOW		4.0	0.0	0.0	0.0

LEVEL OF SERVICE

	LANE GRP.	V/C	G/C	DELAY	LOS	APP. DELAY	APP. LOS
EB	L	0.200	0.075	35.4	D	5.9	B
	T	0.546	0.720	5.5	B		
	R	0.036	0.720	3.3	A		
WB	L	0.300	0.075	36.0	D	9.1	B
	TR	0.815	0.720	8.8	B		
NB	L	0.201	0.093	34.1	D	34.1	D
	T	0.007	0.093	33.4	D		
	R	0.008	0.093	33.4	D		
SB	LT	0.069	0.093	33.6	D	34.4	D
	R	0.276	0.093	34.6	D		

INTERSECTION: Delay = 8.5 (sec/veh) V/C = 0.715 LOS = B

1985 HCM: SIGNALIZED INTERSECTIONS
SUMMARY REPORT

****

INTERSECTION.. Williston Rd. US-2/East Ave.north jghndl
AREA TYPE.....OTHER
ANALYST.....PINKHAM ENGRG. - R.Alexander
DATE.....9-19-93
TIME.....'93 AM peak hour
COMMENT.....CCRPC proj. I-89 OFF-ramp, Burl.

	VOLUMES					GEOMETRY							
	EB	WB	NB	SB		EB		WB		NB		SB	
LT	0	0	118	0	: T	12.0	T	12.0	LT	12.0		12.0	
TH	1096	1136	347	0	: T	12.0	T	12.0	T	12.0		12.0	
RT	0	995	127	0	: T	12.0	R	12.0	R	12.0		12.0	
RR	0	0	0	0	:	12.0	R	12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	

ADJUSTMENT FACTORS

	GRADE (%)	HV (%)	ADJ Y/N	PKG Nm	BUSES Nb	PHF	PEDS	PED. Y/N	BUT. min T	ARR. TYPE
EB	0.00	2.00	N	0	0	0.90	0	N	11.5	3
WB	0.00	2.00	N	0	0	0.90	0	N	11.5	3
NB	0.00	2.00	N	0	0	0.90	0	N	23.5	3
SB	0.00	2.00	N	0	0	0.90	0	N	23.5	3

SIGNAL SETTINGS — CYCLE LENGTH = 119.0

		PH-1	PH-2	PH-3	PH-4			PH-1	PH-2	PH-3	PH-4
EB	LT					NB	LT	X			
	TH	X					TH	X			
	RT						RT	X			
	PD						PD				
WB	LT					SB	LT				
	TH	X					TH				
	RT	X					RT				
	PD						PD				
GREEN		74.0	0.0	0.0	0.0	GREEN		36.0	0.0	0.0	0.0
YELLOW		5.0	0.0	0.0	0.0	YELLOW		4.0	0.0	0.0	0.0

LEVEL OF SERVICE

	LANE GRP.	V/C	G/C	DELAY	LOS	APP. DELAY	APP. LOS
EB	T	0.398	0.630	8.3	B	8.3	B
WB	T	0.590	0.630	10.1	B	10.9	B
	R	0.689	0.630	11.8	B		
NB	LT	0.523	0.303	26.5	D	26.1	D
	R	0.308	0.303	24.4	C		

INTERSECTION: Delay = 12.4 (sec/veh) V/C = 0.635 LOS = B

1985 HCM: SIGNALIZED INTERSECTIONS
SUMMARY REPORT

****

INTERSECTION..Williston Rd. US-2/Spear St. south jghndl
AREA TYPE.....OTHER
ANALYST.....PINKHAM ENGRG. - R.Alexander
DATE.....9-19-93 .
TIME.....'93 PM peak hour
COMMENT.....CCRPC proj. I-89 OFF-ramp, Burl.

	VOLUMES					GEOMETRY							
	EB	WB	NB	SB		EB		WB		NB		SB	
LT	0	0	0	365	: T	12.0	T	12.0		12.0	L	12.0	
TH	731	1254	0	290	: T	12.0	T	12.0		12.0	LT	12.0	
RT	135	0	0	27	: R	12.0		12.0		12.0	TR	12.0	
RR	0	0	0	0	:	12.0		12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	
					:	12.0		12.0		12.0		12.0	

ADJUSTMENT FACTORS

	GRADE (%)	HV (%)	ADJ Y/N	PKG Nm	PUSES Nb	PHF	PEDS	PED. Y/N	BUT. min T	ARR. TYPE
EB	0.00	2.00	N	0	0	0.90	0	N	0.0	3
WB	0.00	2.00	N	0	0	0.90	0	N	0.0	3
NB	0.00	2.00	N	0	0	0.90	0	N	0.0	3
SB	0.00	2.00	N	0	0	0.90	0	N	0.0	3

SIGNAL SETTINGS CYCLE LENGTH = 119.0

		PH-1	PH-2	PH-3	PH-4			PH-1	PH-2	PH-3	PH-4
EB	LT					NB	LT				
	TH	X					TH				
	RT	X					RT				
	PD						PD				
WB	LT					SB	LT	X			
	TH	X					TH	X			
	RT						RT	X			
	PD						PD				
GREEN		74.0	0.0	0.0	0.0	GREEN		36.0	0.0	0.0	0.0
YELLOW		5.0	0.0	0.0	0.0	YELLOW		4.0	0.0	0.0	0.0

LEVEL OF SERVICE

	LANE GRP.	V/C	G/C	DELAY	LOS	APP. DELAY	APP. LOS
EB	T	0.380	0.630	8.2	B	8.0	B
	R	0.157	0.630	6.9	B		
WB	T	0.651	0.630	11.0	B	11.0	B
SB	L	0.510	0.303	26.8	D	26.7	D
	LTR	0.531	0.303	26.6	D		

INTERSECTION: Delay = 13.9 (sec/veh) V/C = 0.612 LOS = B