TRAFFIC ENGINEERING

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THE USE OF C.B. RADIO IN TRAFFIC MANAGEMENT

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PREFACE

This report presents an evaluation of the use of citizen's band (C.B.) radio in the I-35W traffic management system. The I-35W system, which extends along a 17 mile section of freeway south of downtown Minneapolis, has been in operation since April, 1974. This system includes ramp control signals, bypass ramps for high occupancy vehicles, a closed circuit television (CCTV) network, a motorist information program, and an incident detection and response program. Operation of the system is computer coordinated from the Traffic Management Center (T.M.C.) near downtown Minneapolis. A listing of reports which document the design details, system hardware and software, and system evaluation is presented in the Appendix.

Citizen's band radio equipment was added in December, 1977 to allow traffic management system operators to monitor emergency calls on C.B. channel nine. This provides additional information concerning I-35W, and informs operators of conditions beyond the limits of the area monitored by CCTV. With C.B. radio monitoring, traffic management personnel have the benefit of a twenty-four hour a day volunteer force of traffic observers providing information at their own expense. Compared to other means of incident detection, C.B. radio monitoring is simple and low in cost.

Because the daily variation in C.B. radio use was great, a one year period from September 1, 1978 to August 31, 1979 was used for the evaluation study. During this time period a total of 665 C.B. calls were logged, an average of 2.5 per work day. In addition to evaluating the use of C.B. radio, a secondary objective of the study was to gather information needed to establish guidelines for more uniform use of C.B. equipment by system operators.

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SYSTEM DESCRIPTION

The I-35W citizens' band radio system consists of a base transmitter-receiver located in the Traffic Management Center operations room, and two remote base receivers which extend the reception range to approximately 15 miles south of the Traffic Management Center (see Figure 1).

The transmitter-receiver base is equipped with a "Super Scanner" (selectable directionality) antenna, and the two remote receivers are equipped with beam antennas. The remote receivers are located in field cabinets and hard wired back to individual desk top speakers in the operations room. All three receivers are Motorola Series 4000, 40 channel units, but only the unit located in the Traffic Management Center has transmission capability.

Traffic management system operators primarily use the C.B. equipment for traffic surveillance by monitoring emergency calls on channel nine. Operator use of C.B. radio is coordinated with REACT, a citizen volunteer monitoring organization, and the State Patrol. In some cases REACT contacts the T.M.C. to relay or request information over channel nine, and the same is true for the State Patrol who are also equipped with C.B. radios. T.M.C. system operators make some transmissions over C.B. radio, but in general REACT responds to motorist calls while the T.M.C. operator monitors calls and takes appropriate traffic management actions.

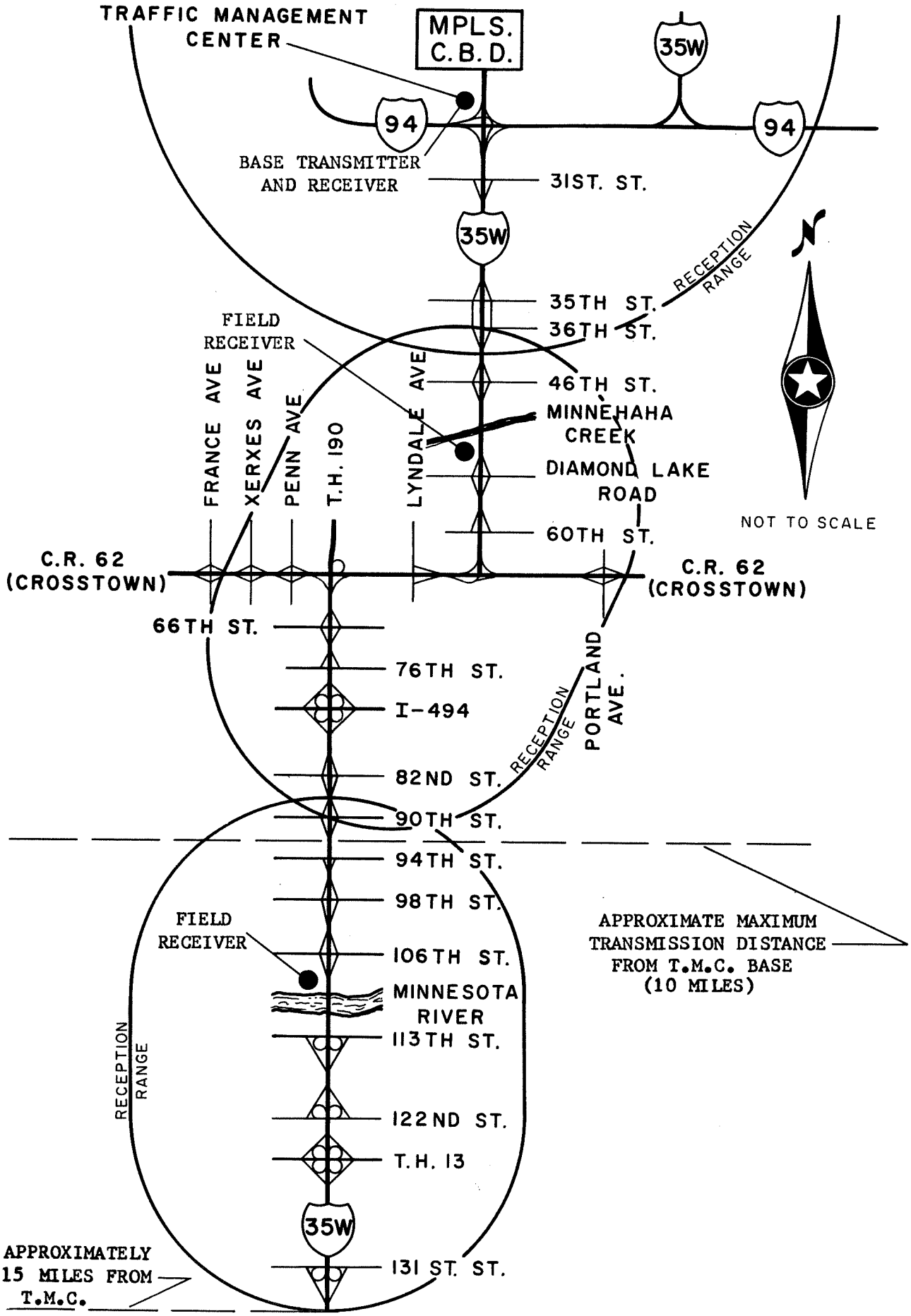

Figure 1: MAP OF C.B. RADIO SYSTEM

STUDY METHODOLOGY

The use of citizens' band radio at the Traffic Management Center was studied from September 1, 1978 to August 31, 1979. To evaluate the effectiveness of the C.B. equipment, data was collected from the following sources:

1) A driver survey questionnaire study conducted earlier for the evaluation of highway advisory radio, but containing information about motorist use of C.B. radio.

2) Incident logs kept in the operations room on which information on all incidents (accidents, stalls and other) is recorded by operators. A copy of this log is presented in the Appendix.

3) A special C.B. log created for the purpose of this study, on which operators logged information about C.B. calls by motorists over channel nine. A copy of this log is presented in the Appendix.

4) Interviews with operators. These were used primarily to determine the operators use of C.B. and the C.B. log, and to moderate the conclusions of this report appropriately.

5) Maintenance and cost accounting records kept by the Electrical Services Unit and the Radio Maintenance Section of Mn/DOT.

In addition to analysis of this data, the evaluation included a review of C.B. equipment use with the Traffic Systems Engineer and the System Operations Engineer.

STUDY RESULTS

MOTORIST USE OF C.B.

A questionnaire created to evaluate drivers' response to highway advisory radio was sent to 1,200 I-35W drivers in October, 1978. Over 900 of these were returned to the Traffic Management Center and analyzed. Answers to the questionnaire revealed that approximately 14 percent of all cars on I-35W are equipped with C.B. radio. The survey also showed that people who own C.B. radio equipment find it to be the most useful source of traffic information available (the other sources rated by drivers were: traffic grade signs, changeable message signs, highway advisory radio, and commercial radio).

With the percentage of C.B. equipped vehicles being quite substantial, there is virtually no time lapse between the time of an accident or other incident and the time the incident is observed by a motorist in a C.B. equipped vehicle. During the day, all points along the roadway are virtually under continual observation. For example, in a three lane section with a volume of only 3,000 cars per hour, a C.B. equipped car passes any point about every eight seconds. Since sight distance does not require a driver to be at the exact site of an incident in order to observe it, a section of roadway with a volume as described would be under constant surveillance by CBers. Actual I-35W volumes, especially during critical periods, are much higher, about twice that described above. C.B. detection is thus even more likely than described. Even in the lowest volume areas, in the middle of the night, detection would be likely in under two minutes. Motorist use of C.B. radio is common enough to make C.B. very useful as a traffic management device.

TRAFFIC MANAGEMENT CENTER USE OF C.B.

Study results from the incident logs are shown in Table 1. The data shows that during the study year ending August 31, 1979, twelve percent of all incidents logged by system operators were initially detected by C.B. radio.

Table 1: SOURCE OF INCIDENT DETECTION

(A.M. & P.M. Peak Periods - September 1, 1978 to August 31, 1979)

NUMBER & PERCENT OF INCIDENTS DETECTED BY TYPE OF INCIDENT

	Accidents		Stalls		Other		Total	
SURVEILLANCE ELEMENT	#	%	#	%	#	%	#	%
Map Display	123	21	278	10	22	16	423	12
CCTV	194	33	1659	61	68	49	1921	56
Police Radio Scanner	112	19	355	13	14	10	481	14
C.B. Radio	129	22	271	10	23	17	423	12
Maintenance Radio	18	3	75	3	11	8	104	3
Other	12	2	92	3	0	0	104	3
TOTALS	588	100	2730	100	138	100	3456	100

This amounted to 423 incidents out of a total of 3,456. More importantly, C.B. radio accounted for the initial detection of 22 percent of all accidents detected. C.B. also accounted for the initial detection of 17 percent of "other" incidents (these include spilled loads and pedestrians on the freeway), but only 10 percent of the stalled vehicles. There are two reasons for this higher efficacy of C.B. radio in detecting more serious incidents such as accidents and spilled loads. The first is that C.B. users often do not report simple stalls, particularly if the stalled vehicle is unoccupied, whereas T.M.C. system operators tend to record all incidents regardless of type. The second is that C.B. equipped motorists provide continual surveillance of the roadway during peak periods, and thus C.B. detection of a significant incident often occurs faster than detection by other means.

The data shows that CCTV is the only surveillance element more effective than C.B. radio at detecting accidents. Monitoring of CCTV accounted for the initial detection of 33 percent of the accidents, and 56 percent of all incidents. Closely following C.B. radio in effectiveness were the computerized map display panel, which summarizes data from the vehicle detectors, and the scanner used to monitor State Patrol and police radio frequencies.

Without C.B. radio monitoring, a substantial percentage of incidents would have been detected later, and some may not have been detected at all. Results of the interviews with system operators also affirmed the importance of C.B. radio. Without exception they found C.B. radio to be a "valuable tool" in traffic management.

Following is a description of the types of calls logged on the special C.B. log sheets.

1) Calls regarding events that were in the range of monitors were generally logged, but not uniformly.

2) In every case where the operator transmitted over C.B., the original motorist C.B. call was logged.

3) Calls that constituted the first detection of an incident were nearly always logged, even though they did not require a transmission by the operator.

4) Calls that neither required a transmission nor constituted the first detection of an incident were only occasionally logged.

5) Calls regarding events not within range of CCTV monitoring were not logged.

Study results from the C.B. log sheets are presented in Table 2. Because of the non-uniformity in logging, the data reflects nearly all transmissions and primary detections, but only a random sample of other C.B. activity. The data shows that of the incidents reported on C.B. channel nine during the study year, 28 percent were accidents, 60 percent were stalled vehicles, and twelve percent were other types. By comparison, for all incidents recorded (regardless of whether or not they were reported over C.B.), 17 percent were accidents, 80 percent were stalled vehicles, and three percent were other types. This data confirms the results from the incident log, providing further documentation that C.B. radio users report serious incidents more quickly.

REACT and State Patrol Response to C.B. Calls:

REACT (Radio Emergency Associated Citizen Teams) is a voluntary organization which monitors C.B. calls over emergency channel nine. The REACT group is quite efficient, so system operators at the T.M.C. are careful not to usurp their position as a motorist aid. Not usurping REACT consists primarily of simply monitoring channel nine, and transmitting only when a repeated call is unanswered by REACT. In addition, system operators work with REACT in that the volunteer organization is acquainted with T.M.C. work and occasionally contacts operators by C.B. or conventional telephone. Conversely, operators occasionally contact REACT concerning the status of incidents within the range of TV monitoring. The relationship between REACT and the T.M.C. has been basically one of non-interference and frequent mutual aid.

The study results show that REACT responded to motorist C.B. calls 63 percent of the time. Since operators generally transmit only when REACT

Table 2: INFORMATION ON C.B. REPORTED INCIDENTS

(A.M. & P.M. Peak Periods - September 1, 1978 to August 31, 1979)

		Number	Percent
Type of incident reported via C.B.?	Accident	184	28
	Stall	394	60
	Other	78	12
	Totals	656	100
Did REACT respond?	Yes	410	63
	No	243	37
	Totals	653	100
Did the State Patrol respond?	Yes	68	10
	No	594	90
	Totals	662	100
Did the T.M.C. respond via C.B. transmission?	Yes	208	31
	No	457	69
	Totals	665	100
Was the incident verified with CCTV?	Yes	376	57
	No	288	43
	Totals	664	100
Did the incident require T.M.C. action?	Yes	289	44
	No	375	56
	Totals	664	100
What T.M.C. action was taken?	State Patrol notified	257	84
	Commercial radio notified	23	7
	Lane control signal use	4	1
	Changeable message sign use	2	1
	Highway advisory radio use	6	2
	Ramp control override	2	1
	Other	13	4
	Totals	307	100

does not respond to a call, and the logs represented all transmissions but not all calls, this percentage is a conservative estimate.

Occasionally the State Patrol, who are equipped with C.B., will directly answer a call by a motorist over channel nine. This occurred in 68 total instances (ten percent of the logged calls) during the study year. Because the State Patrol C.B.'s are mobile units, and the troopers are busy with numerous other tasks, they can not be depended upon by motorists to answer calls.

Traffic Management Center Response by C.B.:

The data shows that the T.M.C. operator responded to a C.B. call by transmitting over C.B. in 208 instances during the study year, an average of one transmission every 1.2 working days. As noted earlier, this represents virtually every transmission made by T.M.C. staff, but the number of cases where the T.M.C. did not transmit (457) is only partial. Therefore the percentage (31%) of calls to which the T.M.C. responded by transmitting is considerably exaggerated.

Most of the transmissions by T.M.C. operators were either in response to a request for information from REACT, or made directly to motorists whose C.B. calls were not answered by REACT or the State Patrol. The use of C.B. equipment to transmit varied widely among operators, with some never transmitting, while others transmitted 50 or more times during the study year. The reasons for this variation are each operators individual style, familiarity with C.B. equipment, frequency of assignment to the operations room, and priority placed on C.B. compared with other tasks. Up to this time there has been no objective information upon which to base the priority of C.B. radio, and operators have been free to establish their own priorities. The independent judgement exercised by operators should become more uniform with the additional input of data from this study. If general guidelines are stressed, individual operators will find the question "to transmit or not to transmit?" easier to answer quickly, and traffic management will proceed as smoothly as possible.

Locating C.B. Reported Incidents With CCTV:

The data shows that over half (57 percent) of the incidents reportedly within the T.M.C. monitoring area were verified by CCTV. Operators were concerned that many C.B. calls would be "false alarms", and that C.B. would therefore be an unreliable source of traffic information. The number of C.B. reported incidents which are later verified by CCTV shows this concern to be largely unfounded, and that C.B. is quite reliable.

Some valid incidents were not later verified by CCTV for the following reasons:

1) They were of short duration - clearing before CCTV verification was possible.

2) They were not verifiable by CCTV. Although all incidents logged were within the range of T.M.C. monitoring, some were located in blind spots such as under bridges, or occurred after dark or under poor visibility conditions making verification by CCTV impossible.

3) They were not actively searched for by the system operator. Occasionally other tasks would preempt the verification of a C.B. reported incident.

Because of this, the percentage of verified incidents (57 percent) does not indicate that the other 43 percent were false calls. The percent of theoretically verifiable incidents would be higher than the percent of those incidents actually verified.

Traffic Management Center Action Taken:

Study results indicate that T.M.C. system operators responded to C.B. reported incidents with some action other than transmission over C.B. somewhat less than half of the time (44 percent). The most common action taken in response to a C.B. reported incident was to report the incident to the

State Patrol. This occurred 257 times during the study year, an average of over once a day. The second but considerably less common action taken was to report the incident or traffic condition to the commercial radio stations (the T.M.C. maintains a "hotline" to several local stations). This occurred 23 times during the year. Other categories of action include the activation of lane control signals, operation of changeable message signs, airing of traffic information over highway advisory radio, and regulation of freeway access by altering ramp metering rates. Each of these last categories were logged quite infrequently as responses to C.B. reported incidents.

SYSTEM COSTS

The total cost of the C.B. system design, equipment, and installation was $1,671, excluding the cabinets housing the remote receivers and wiring to the T.M.C. which were inplace. The only maintenance cost during the one year study period was approximately $30 for a minor adjustment to one of the field receivers. Listed below is a summary of these costs.

		Cost
1)	Base stations (3)	$ 422
2)	Antennas (1-Super Scanner, 2-beam)	$ 216
3)	Labor and material	$ 793
4)	Consultant liaison	$ 240
5)	Maintenance for one year	$ 30
	Total	$1,701

The cost of the C.B. equipment represents less than 0.1 percent of the I-35W traffic management system capital cost ($2.25 million), and the cost of C.B. maintenance represents less than 0.05 percent of the average yearly system maintenance cost ($72,000).

SUMMARY OF FINDINGS AND CONCLUSIONS

Listed below is a summary of the key findings for the C.B. radio study.

1) Fourteen percent of the peak period vehicles in the study area were equipped with C.B. radio.

2) During the study year a total of 665 C.B. calls were logged during peak periods, an average of 2.5 per working day.

3) Twelve percent of all incidents, and 22 percent of all accidents recorded by control room operators were first detected by C.B. radio.

4) Of all the incidents reported via C.B. in the Traffic Management Center's monitoring area, 57 percent were verified by CCTV.

5) REACT, a voluntary organization, responded to motorist C.B. calls 63 percent of the time, and the State Patrol directly answered a motorist call ten percent of the time.

6) System operators found C.B. radio to be a useful tool. They reported C.B. detected incidents to the State Patrol on an average of about once a day, transmitted over C.B. approximately once every 1.2 days, and less frequently notified commercial radio stations or took other action.

7) C.B. radio was not used uniformly by system operators.

8) The C.B. radio equipment had a relatively low initial cost, and required little maintenance.

Analysis of these study results, and experience with the C.B. radio system installation, operation, and maintenance leads to the following conclusions.

1) C.B. radio is an effective traffic management tool, greatly enhancing the incident detection capability. The Traffic Management Center staff has reached a decision to make the system permanent, and to give future consideration to installing C.B. equipment on additional freeway sections.

2) Coordination of the use of C.B. radio with the State Patrol and the REACT group of citizen volunteers has been adequate, and must be continued in order to make the most effective use of C.B. radio.

3) The results from this study should be used to establish guidelines for more uniform use of C.B. equipment by system operators.

APPENDIX: PROJECT REFERENCES

Project Planning and Design:

1. "Ramp Metering" Report No. 07-110, September 1969, Office of Traffic Engineering, Minnesota Highway Department.

2. "Prospectus for a Metropolitan Area Freeway Surveillance and Control System" November 1970, Office of Traffic Engineering, Minnesota Highway Department.

3. "I-35W Ramp Metering" Report No. 07-118, January 1971, Office of Traffic Engineering, Minnesota Highway Department.

4. Final Report, Planning for "I-35W Urban Corridor Demonstration Project - Bus-On-Metered Freeway System", Minnesota Highway Department, Metropolitan Transit Commission, Bather-Ringrose-Wolsfeld Inc., September 1971.

5. "Design Study Report" I-35W U.C.D.P. Surveillance and Control System, Mar 1972, Minnesota Highway Department.

6. "MHD Traffic Management Center - Design & Function" Report No. 07-043-04, May 1973, Office of Traffic Engineering, Minnesota Highway Department.

7. "Moving People In the I-35W Corridor" Wolsfeld, R. P., Carlson, G. C., Benke, R. J. for I.T.E. Traffic Engineering, Aug. 1973.

System Hardware and Software:

8. "Surveillance & Control System Overview" I-35W U.C.D.P., Minnesota Highway Department, #MNITE 73-1, May 1973.

9. "Operational Experience With a Freeway Traffic Management System" July 1975, Office of Traffic Engineering, Minnesota Highway Department.

10. "I-35W Surveillance and Control System Operational Software" December 1975, Office of Traffic Engineering, Minnesota Highway Department.

11. "I-35W Traffic Management - An Operational Review" May 1976, Office of Traffic Engineering, Minnesota Highway Department.

System Evaluation:

12. "I-35W Urban Corridor Demonstration Project - Inventory of the Transportation Condition of the I-35W Corridor" February 1971, Bather-Ringrose-Wolsfeld, Minnesota Highway Depart, et al, for the Metropolitan Council.

13. "I-35W Ramp Metering" Report No. 07-118-S1, January 1973, Office of Traffic Engineering, Minnesota Highway Department.

14. "I-35W U.C.D.P. - Evaluation Operations Manual" October 1973, Bather-Ringrose-Wolsfeld, Minnesota Highway Department, et al.

15. "I-35W U.C.D.P. - Phase I Data Summary Memorandum" December 1973, Bather-Ringrose-Wolsfeld, Minnesota Highway Department, and Metropolitan Transit Commission.

16. "I-35W U.C.D.P. - Phase II Evaluation Results" November 1974, Bather-Ringrose-Wolsfeld, Minnesota Highway Department, and Metropolitan Transit Commission.

17. "I-35W U.C.D.P." Final Report, August 1975, by the Minnesota Highway Department, Bather-Ringrose-Wolsfeld et al, for the Urban Mass Transportation Administration, U.S. Department of Transportation.

18. "Ramp Meter Bypass for Carpools" Report No. FHWA-RD-76-189, October 1976, Office of Traffic Engineering, Minnesota Department of Transportation.

19. "I-35W Traffic Management System Operations - 1976 Report" March 1977, Office of Traffic Engineering, Minnesota Department of Transportation.

20. "I-35W Traffic Management System Operations - 1977 Update "January 1978, Traffic Engineering Section, Minnesota Department of Transportation.

21. "Evaluation of Highway Advisory Radio in the I-35W Traffic Management Network" Report No. FHWA-RD-79-33, March 1979, Traffic Engineering Section, Minnesota Department of Transportation.

General Information:

22. "Preferential Treatment for Car Pools on I-35W" Study No. 07-135, July 1975, Office of Traffic Engineering, Minnesota Highway Department.

23. "Minnesota Traffic Engineering Manual" January 1977, Traffic Engineering Section, Minnesota Department of Transportation.

24. "Freeway Traffic Management Plan - Twin Cities Metropolitan Area" August 1979, Traffic Engineering Section, Minnesota Department of Transportation.

25. "I-35W Traffic Management System: Summary of Operating Experience 1974-1978" November, 1979, Office of Traffic Engineering, Minnesota Department of Transportation.

Mn/DOT 29036 (4-78)

	OPERATOR	TEMPERATURE	SKY	PAVEMENT
A.M.				
P.M.				

T.M.C. INCIDENT LOG

YEAR		MONTH		DATE		DAY
1	2	3	4	5	6	7

DAY (COLUMN 7)	INCIDENT TYPE (COLUMN 9)	ROAD (COLUMNS 11-13)	LANE CODE (COLUMN 20)	DETECTION & VERIFICATION CODE (COLUMNS 26 & 31)	ASSISTANCE CODE (COLUMNS 44 & 49)	RESULT (COLUMN 58)
1 - SUNDAY	A - ACCIDENT	35W	1-LANE 1	1 - MAP DISPLAY	1 - SELF HELP	A - ADDED TO EXISTING PROBLEM
2 - MONDAY	B - STALL	012	2-LANE 2	2 - C.R.T.	2 - STATE TROOPER	N - RESULTED IN NO CONGESTION
3 - TUESDAY	C - OTHER	062	3-LANE 3	3 - T.V.	3 - TOW TRUCK	Y - RESULTED IN SOME CONGESTION
4 - WEDNESDAY		065	4-LANE 4	4 - SCANNER	4 - AMBULANCE	S - RESULTED IN SEVERE CONGESTION
5 - THURSDAY		094	5-LEFT SHOULDER	5 - CITIZENS BAND RADIO	5 - ANOTHER MOTORIST	
6 - FRIDAY		169	6-MEDIAN	6 - T.M.C. MAINTENANCE RADIO	6 - SERVICE PATROL	
7 - SATURDAY		494	7-RIGHT SHOULDER	7 - OTHER	7 - OTHER	
		694	8-WEAVING AREA			
			A-ENTRANCE RAMP			
			B-EXIT RAMP			
			C-ENTRANCE LOOP			
			D-EXIT LOOP			

OPERATOR	INCIDENT TYPE	LOCATION: ROAD	LOCATION: STATION	LOCATION: DIRECTION	LOCATION: LANE CODE	LOCATION: NO. OF VEHICLES	DETECTION: TIME	DETECTION: CODE	VERIFICATION: TIME	VERIFICATION: CODE	NOTIFICATION: STATE PATROL TIME	NOTIFICATION: RADIO TIME	ARRIVAL OF ASSISTANCE FIRST: TIME	ARRIVAL OF ASSISTANCE FIRST: CODE	ARRIVAL OF ASSISTANCE SECOND: TIME	ARRIVAL OF ASSISTANCE SECOND: CODE	REMOVAL: MOVED TO SHOULDER	REMOVAL: CLEAR TIME	RESULT			COMMENTS

6 9 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 ...

C.B. EVALUATION

	TIME(S) REPORTED		INCIDENT TYPE A, B OR C	REACT RESPONDED Y=YES, N=NO	PATROL RESPONDED Y=YES, N=NO	T.M.C. RESPONDED Y=YES, N=NO	LOCATED BY C.C.T.V. Y=YES, N=NO	REQUIRES ACTION BY T.M.C. Y=YES, N=NO	ACTION TAKEN METER, LCS, CMS, HAR, H.P., RADIO, ETC.	REMARKS
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