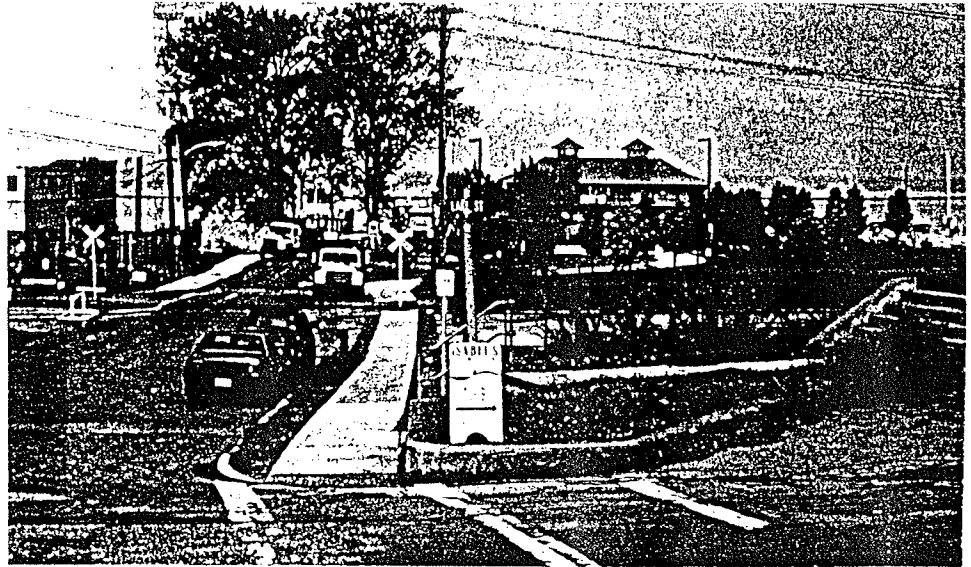

BURLINGTON WATERFRONT PARK TRAFFIC STUDY

*Final
DRAFT*



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INTRODUCTION

The Act 250 permit approval for the Burlington Waterfront Park requires that a traffic study be completed to assess the conditions at the College Street railroad crossing. This study documents the summer 1993 pedestrian and vehicular traffic counts as well as a five year projection of pedestrian and vehicular volumes at the crossing locations. The focus of the study is to evaluate the safety of the College Street railroad crossing.

EXISTING CONDITIONS

College Street in the vicinity of the railroad crossing is a 30-32 foot wide roadway accommodating one travel lane per direction with parallel parking located east of the crossing on the north side of the roadway. A sidewalk exists on the north side of the roadway east of the railroad crossing and on both sides of the roadway west of the railroad crossing. At the railroad crossing, railroad crossing (crossbuck) signs are located on both approaches. Based on discussions with Vermont Railways, there are currently approximately five rail operations per day (8:00 AM-8:00 PM) crossing College Street. Rail speed through this area is approximately 5 mph.

Pedestrian crossing counts were conducted during a Waterfront Park event and a non-event period. Counts were conducted on Saturday, August 7, 1993 between the hours of 1:00 PM and 3:00 PM during the Champlain Valley Folk Festival and on Saturday, August 28, 1993, between the hours of 12:00 noon and 3:00 PM during the Fool's Afloat event. Pedestrian counts were also conducted on Thursday, August 19, 1993 between the hours 11:30 AM - 1:30 PM for a non-event period. These pedestrian counts included bicyclists, roller-bladers as well as pedestrians. The results are summarized below:

PEDESTRIAN COUNT SUMMARY

<u>Date</u>	<u>1:00 - 2:00 PM</u>	<u>2:00 - 3:00 PM</u>		
Saturday August 7, 1993				
Folk Festival				
eastbound	331		303	
westbound	<u>504</u>		<u>488</u>	
Total	835		791	
	<u>11:30 - 12:30 PM</u>	<u>12:30 - 1:30 PM</u>		
Thursday, August 19, 1993				
(non-event)				
eastbound	70		89	
westbound	<u>149</u>		<u>118</u>	
Total	219		207	
	<u>12:00 noon - 1:00 PM</u>	<u>1:00 PM - 2:00 PM</u>	<u>2:00 PM - 3:00 PM</u>	
Saturday, August 28, 1993				
(Fool's Afloat)				
eastbound	942	356		317
westbound	<u>705</u>	<u>473</u>		<u>438</u>
Total	1,647	829		755

As shown, the peak period for pedestrian traffic is during a typical Saturday midday. The highest pedestrian counts were observed during the Fool's Afloat event where approximately 1,647 pedestrians were observed with 705 pedestrians traveling towards the waterfront and 942 pedestrian traveling from the waterfront.

During a non-event day, the peak pedestrian period is anticipated to also be during the midday. The peak period was observed between 11:30 AM - 12:30 PM when 219 pedestrians were observed.

General observations reveal that typical pedestrian traffic can be accommodated on the sidewalk while during the peak Saturday event conditions, pedestrian traffic overflows onto the roadway.

Traffic counts were conducted over the 7-day period between Monday, August 23, 1993 and Sunday August 29, 1993. A summary of the traffic count is presented below.

VEHICULAR TRAFFIC VOLUME SUMMARY

	Daily Traffic VPD	Midday Peak Hour	"K"* Factor	D** Factor	Evening Peak Hour	"K" Factor	D Factor
College Street west of the railroad crossing							
Weekday	1,700+	158	9.3	51% EB	158	9.3	56% EB
Saturday	1,950	184	9.4	52% WB	159	8.2	58% EB

* "K" factor - Peak hour volume percent of Daily Traffic

** "D" factor - Directional split of peak hour traffic

+ Monday, August 23 to Tuesday, August 24, 1993

As shown, College Street accommodates on a typical day approximately 1700 vehicles. During the midday peak hour 158 vehicles are accommodated with 51 percent traveling eastbound. During the evening peak hour, 158 vehicles are accommodated with 56 percent traveling eastbound. During a typical Saturday event, College Street accommodates approximately 1,950 vehicles with 184 vehicles accommodated during the midday peak hour and 159 vehicles accommodated during the evening peak hour.

In addition, based upon our discussion with the Burlington Police Department there have been no accidents in the rail crossing area involving rail operations with pedestrians or vehicles between January 1991 to the present.

FUTURE CONDITIONS

The future increase in vehicular and pedestrian traffic is primarily a function of the existing Waterfront Park, Community Boathouse and the proposed mixed use project at the Naval Reserve Site. This project is anticipated to accommodate a research center, museum, retail space and a restaurant. Since no parking will be provided at the site, it is assumed that little or no vehicular traffic will be generated. Additional pedestrian traffic was based upon the ITE Trip Generation Manual¹ and an assumed auto occupancy ratio of 2.5 persons per vehicle. A summary of the increase in pedestrian traffic is shown below:

¹ Trip Generation, Institute of Transportation Engineers, 5th Edition 1991.

**FUTURE PEDESTRIAN TRAFFIC INCREASE
NAVAL RESERVE SITE**

**Saturday Midday
Peak hour**

Entering	70
Exiting	<u>70</u>
Total	140

As shown, it is anticipated that the mixed use project at the Naval Reserve Site will generate an additional 140 new pedestrian trips traveling to/from the Central Business District and these pedestrians are anticipated to utilize College Street.

Future pedestrian and vehicular traffic was estimated by applying a 5.0 percent growth over the current peak levels to accommodate increased patronage in the area as well as adding the projected pedestrian traffic from the Naval Reserve Site. A summary of the 5-year projected levels are shown below.

**PEDESTRIAN AND VEHICULAR TRAFFIC VOLUMES
5-YEAR PROJECTION**

<u>Pedestrian Traffic</u>	1993 <u>Existing</u>	1998 <u>Projection</u>
Saturday		
Eastbound	942	1,059
Westbound	<u>705</u>	<u>810</u>
Total	1,647	1,869
 <u>Vehicular Traffic</u>		
Weekday Evening		
Eastbound	89	94
Westbound	<u>69</u>	<u>72</u>
Total	158	166
 Saturday Midday		
Eastbound	89	93
Westbound	<u>95</u>	<u>100</u>
Total	184	193

As shown by 1998, the projected pedestrian levels during the peak Saturday period are anticipated to increase from approximately 1,647 to 1,869 pedestrians.

Traffic volumes on a weekday and Saturday will remain relatively low with approximately 166 and 193 peak hour vehicles anticipated, respectively.

RECOMMENDATIONS

It is recommended that the existing traffic control at the rail crossing be upgraded to increase safety conditions for the vehicular and pedestrian traffic. The upgrade should include the following:

- Install railroad advance warning signs (W10-1) a minimum of 100 feet in advance of the railroad crossing on both approaches.
- Install pavement markings in advance of the track crossing with an X and the Letters RR on both approaches.

In addition, with the significant pedestrian traffic present during peak summer event periods, additional traffic/pedestrian control is recommended. This control could be in the form of crossing guard control for all train crossings during the summer season which could be provided by the railroad with a flagman or the installation of flashing light signals with or without automatic gates. The order of magnitude cost estimate for flashing lights are \$100,000 and \$125,000 including automatic gates. It is further recommended that the city of Burlington in a letter to the Secretary of the Agency of Transportation request a review of these options at the College Street rail crossing location as well as possible funding sources. The state would appoint a diagnostic team made up of officials from the City, Federal Highway Administration, Railroad and State to further evaluate the crossing and also identify potential funding sources such as ISTEA funds to implement any improvements.

APPENDIX A: Traffic Counts, College Street

Location : College Rd W of Lake ST
 Weather : in Burlington N.H.
 Operator : RFA

FILE: burvt2
 DATE: 8/23/93

TIME BEGIN	MONDAY 23		TUESDAY 24		WEDNESDAY 25		THURSDAY 26		FRIDAY 27		SATURDAY 28		SUNDAY 29		WEEK AVERAGE	
	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2	WB 1	EB 2
12:00 AM	*	*	*	*	7	10	3	4	12	13	5	9	8	7	7	8
1:00	*	*	*	*	3	3	7	6	5	6	5	7	9	9	5	6
2:00	*	*	*	*	1	2	3	2	3	3	4	5	4	6	3	3
3:00	*	*	*	*	4	3	1	3	2	2	4	4	3	2	2	2
4:00	*	*	*	*	1	2	3	4	3	4	0	0	0	2	1	2
5:00	*	*	*	*	0	0	1	3	1	1	5	4	0	1	1	1
6:00	*	*	*	*	3	1	5	7	4	6	3	3	1	1	3	3
7:00	*	*	*	*	14	9	20	13	19	9	12	5	8	4	14	7
8:00	*	*	*	*	17	16	18	14	27	22	11	13	16	17	17	16
9:00	*	*	*	*	50	40	49	41	51	42	20	21	50	44	44	37
10:00	*	*	*	*	39	29	50	48	52	50	34	30	59	60	46	43
11:00	*	*	*	*	52	48	78	65	99	75	70	62	55	42	68	58
12:00 PM	*	*	*	*	61	61	76	71	64	66	68	73	33	41	60	62
1:00	*	*	*	*	80	82	88	85	70	86	95	89	72	90	81	86
2:00	*	*	*	*	70	74	72	70	61	68	92	90	87	91	76	78
3:00	*	*	*	*	76	73	83	92	88	102	102	114	63	88	82	93
4:00	*	*	74	76	69	85	60	83	67	74	57	65	68	83	65	77
5:00	*	*	56	80	56	59	53	74	67	72	66	93	64	93	50	78
6:00	*	*	32	28	52	49	60	65	71	59	80	79	70	78	60	59
7:00	*	*	41	56	74	73	61	70	77	84	64	78	59	77	62	73
8:00	*	*	33	35	62	111	37	61	72	100	46	75	40	62	48	74
9:00	*	*	15	17	35	48	26	38	41	50	30	58	7	32	25	40
10:00	*	*	7	11	28	32	25	24	33	51	20	32	7	7	20	26
11:00	*	*	9	6	13	15	9	10	22	37	18	24	11	13	13	17
TOTALS	*	*	267	309	867	924	888	953	1001	1081	911	1033	734	950	863	949

COMBINED TOTALS

12:00 AM	*	*			17		7		25		14		15		15	
1:00	*	*			6		13		11		12		18		11	
2:00	*	*			3		5		6		9		10		6	
3:00	*	*			7		4		4		8		5		4	
4:00	*	*			3		7		7		0		2		3	
5:00	*	*			0		4		2		9		1		2	
6:00	*	*			4		12		10		6		2		6	
7:00	*	*			22		33		27		17		12		21	
8:00	*	*			33		32		49		24		33		33	
9:00	*	*			90		90		93		41		94		81	
10:00	*	*			68		98		102		64		119		89	
11:00	*	*			100		143		164		132		97		126	
12:00 PM	*	*			122		147		130		141		74		122	
1:00	*	*			162		173		156		184		162		167	
2:00	*	*			144		142		129		182		178		154	
3:00	*	*			149		175		190		216		151		175	
4:00	*	*			150		143		141		122		151		142	
5:00	*	*			136		127		139		159		157		138	
6:00	*	*			60		101		125		130		148		119	
7:00	*	*			97		147		131		142		136		135	
8:00	*	*			68		173		98		121		102		122	
9:00	*	*			32		83		64		88		39		65	
10:00	*	*			18		60		50		52		14		46	
11:00	*	*			15		29		18		42		24		30	
TOTALS	*	*			576		1791		1841		2082		1744		1812	

APPENDIX B: College Street Pedestrian Counts



COLLEGE STREET PEDESTRIAN COUNT		SATURDAY AUGUST 28, 1993				
	PEDS		BICYCLES		WB	TRAINS
	EB	WB	EB	WB		
12:00-12:15	81	281	16	33		411
12:15-12:30	571	122	59	29		781
12:30-12:45	92	90	19	41		242
12:45-1:00	74	78	30	31		213
1:00-1:15	55	58	28	37	1	179
1:15-1:30	57	125	21	26		229
1:30-1:45	96	89	18	20		223
1:45-2:00	55	85	26	33	1	200
2:00-2:15	54	70	14	55		193
2:15-2:30	87	91	23	50		251
2:30-2:45	57	43	21	39		160
2:45-3:00	37	59	24	31		151
PEAK HOUR						
12:00-12:15	81	281	16	33		411
12:15-12:30	571	122	59	29		781
12:30-12:45	92	90	19	41		242
12:45-1:00	74	78	30	31		213
	818	571	124	134		1647
1:00-1:15	55	58	28	37	1	179
1:15-1:30	57	125	21	26		229
1:30-1:45	96	89	18	20		223
1:45-2:00	55	85	26	33	1	200
	263	357	93	116	2	
2:00-2:15	54	70	14	55		193
2:15-2:30	87	91	23	50		251
2:30-2:45	57	43	21	39		160
2:45-3:00	37	59	24	31		151
	235	263	82	175		

APPENDIX C: Signals and Gates Details

C. SIGNALS AND GATES

8C-1 Purpose and Meaning

Active traffic control systems inform motorists and pedestrians of the approach or presence of trains, locomotives, or railroad cars on grade crossings. The meaning of flashing light signals and gates shall be as defined in the Uniform Vehicle Code (secs. 11-701 & 11-703, Revised 1968). *

When tracks are not in service, the gate arms shall be removed. The signal heads shall be hooded, turned or removed to clearly indicate that they are not in operation.

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Rev. 5

8C-2 Flashing Light Signal—Post Mounted

When indicating the approach or presence of a train, the flashing light signal, illustrated in figure 8-3, shall display toward approaching highway traffic the aspect of two red lights in a horizontal line flashing alternately. As shown in figure 8-3, the typical flashing light signal assembly on a side of the roadway location includes a standard crossbuck sign and, where there is more than one track, an auxiliary "number of tracks" sign, all of which indicate to vehicle operators and pedestrians at all times the location of a grade crossing. A bell may be included in the assembly and operated in conjunction with the flashing lights. Bells are a particularly suitable warning for pedestrians and bicyclists.

The flashing light signals should normally be placed to the right of approaching highway traffic on all roadway approaches to a crossing. They should be located laterally with respect to the highway in conformance with figure 8-6, (page 8C-5) except where such location would compromise signal display effectiveness. As stated in section 8A-3, if it is practical, equipment housings (controller cabinets) should have a lateral clearance of 30 feet from the roadway and adequate clearance from the tracks. Where conditions warrant, escape areas, attenuators, or guardrails should be provided.

Additional pairs of lights may be mounted on the same supporting post and directed toward vehicular traffic approaching the crossing from other than the principal highway route. Such may well be the case where there are approaching routes on roadways closely adjacent to and parallel to the railroad. At crossings of a highway with traffic in both directions, back-to-back pairs of lights shall be placed on each side of the tracks. On one way streets and divided highways, signals shall be placed on the approach

* Available from Northwestern University, P.O. Box 1409, Evanston, IL 60204.

side of the crossing normally on both sides of the roadway and may be equipped with back lights. Typical location plans for signals are shown in figure 8-7, (page 8C-6).

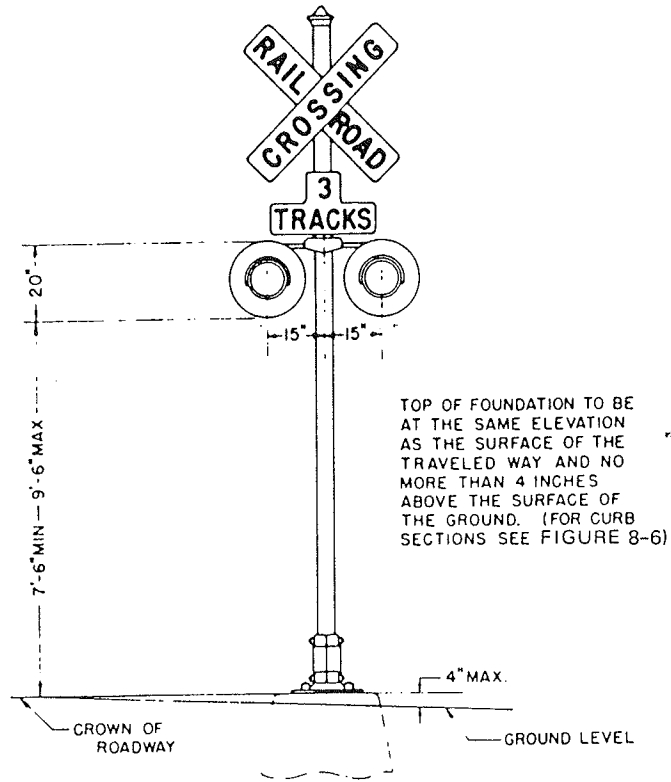


Figure 8-3. Typical flashing light signal—post mounted.

8C-3 Flashing Light Signal—Cantilever Supported

Where required for better visibility to approaching traffic, particularly on multi-lane approaches, cantilevered flashing light signals are used in the manner shown in figure 8-4. In addition to the flashing lights cantilevered over the roadways, flashing lights should usually be placed on the supporting post.

Although cantilever signals are more commonly used on multi-lane highways, they are also suitable for other locations where additional emphasis is needed. These locations may include high speed rural highways, high volume two-lane highways, or specific locations where there are distractions. If one pair of cantilever flashing lights would be visible to drivers in all approaching lanes, except the right lane which has a

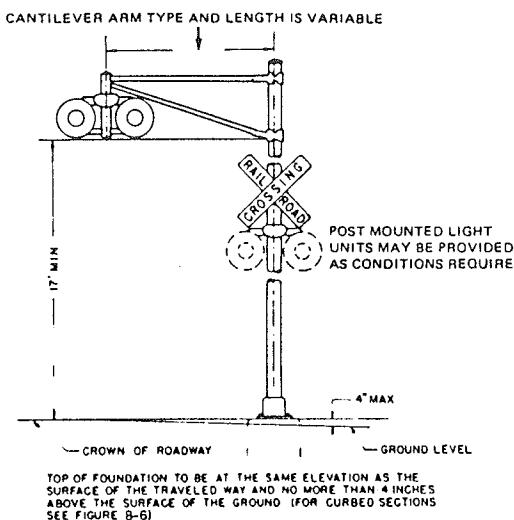


Figure 8-4. Typical flashing light signal—cantilever supported.

view of the post mounted signals, other flashing lights are not required on the cantilever arm. A pair of lights overhead for each approaching lane is not required, inasmuch as the warning aspect is at all times identical for all.

Breakaway or frangible bases shall not be used for cantilever signal supports. Where conditions warrant, escape area, attenuators, or properly designed guardrails should be provided.

8C-4 Automatic Gate

An automatic gate is a traffic control device used as an adjunct to flashing lights. The device consists of a drive mechanism and a fully reflectorized red and white striped gate arm with lights, and which in the down position extends across the approaching lanes of highway traffic about 4 feet above the top of the pavement. The flashing light signal may be supported on the same post with the gate mechanism or separately mounted. A schematic view of the gate arm in the down position is shown in figure 8-5. This view does not show any of the several mechanisms used to raise and lower the arm.

In its normal upright position, when no train is approaching or occupying the crossing, the gate arm should be either vertical or nearly so (fig. 8-6). Typical minimum clearance is 2 feet from face of vertical curb to closest part of signal or gate arm in its upright position for a distance of 17 feet above the crown of the roadway. Where there is no curb, a minimum horizontal clearance of 2 feet from edge of a paved or surfaced shoulder shall be provided with a minimum clearance of 6 feet from the

NOTE: Gate arm supports and operating mechanism not shown

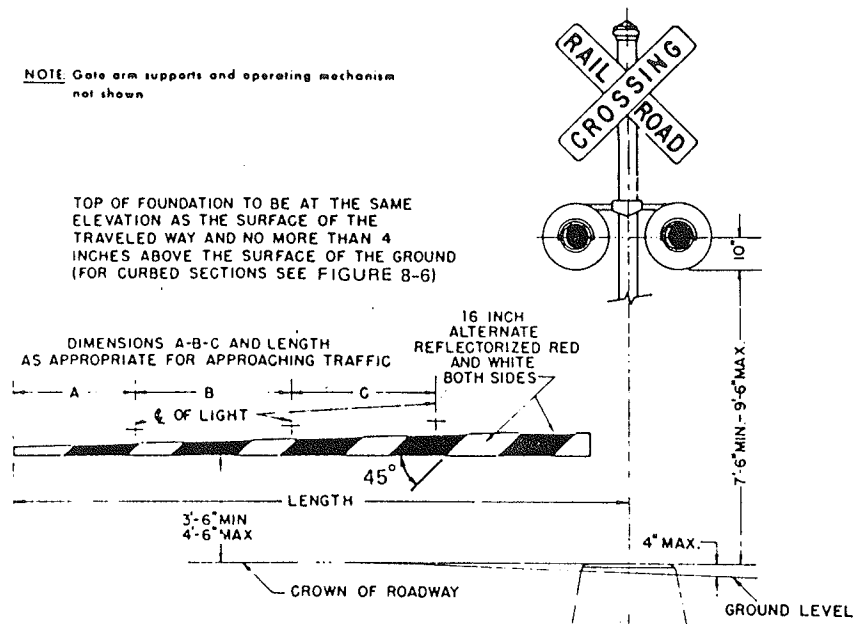


Figure 8-5. Schematic view of automatic gate.

edge of the traveled roadway. Where gates are located in the median, additional width may be required to provide the minimum clearance for the counterweight supports. Where conditions warrant, escape routes, attenuators, or guardrails should be provided.

In a normal sequence of operation the flashing light signals and the lights on the gate arm in its normal upright position are activated immediately upon detection of the approach of a train. The gate arm shall start its downward motion not less than 3 seconds after the signal lights start to operate, shall reach its horizontal position before the arrival of any train, and shall remain in that position as long as the train occupies the crossing. When the train clears the crossing, and no other train is approaching, the gate arm shall ascend to its upright position normally in not more than 12 seconds, following which the flashing lights and the lights on the gate arm shall cease operation. In the design of individual installations, consideration should be given to timing the operation of the gate arm to accommodate slow moving trucks. Timing the operation of the gate arm shall be coordinated with the pre-emption sequence of adjacent traffic control signals.

Typical location plans for automatic gates at crossings are shown in figure 8-7. Component details are described in section 8C-7.

8B-3 Railroad Advance Warning Signs (W10-1, 2, 3, 4)

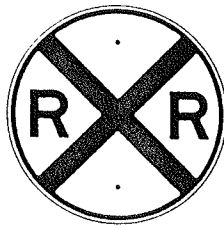
A Railroad Advance Warning (W10-1) sign shall be used on each roadway in advance of every grade crossing except:

1. On low-volume, low-speed roadways crossing minor spurs or other tracks that are infrequently used and which are flagged by train crews.
2. In the business districts of urban areas where active grade crossing traffic control devices are in use.
3. Where physical conditions do not permit even a partially effective display of the sign.

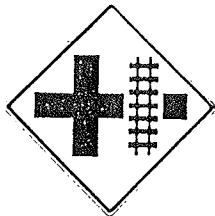
Placement of the sign shall be in accordance with Table II-1, Section 2C-3 and Sections 2A-21 to 2A-27, except in residential or business districts where low speeds are prevalent, the signs may be placed a minimum distance of 100 feet from the crossing. On divided highways and one-way roads, it is desirable to erect an additional sign on the left side of the roadway.

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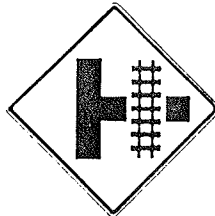
The W10-2, 3, and 4 signs may be installed on highways that are parallel to railroads. The purpose of these signs is to warn a motorist making a turn that a railroad crossing is ahead. Where there is 100 feet or more between the railroad and the parallel highway, a W10-1 sign should be installed in advance of the railroad crossing and the W10-2, 3, or 4 signs on the parallel highway would not be necessary.



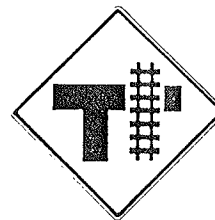
W10-1
36" Diameter



W10-2
30" x 30"

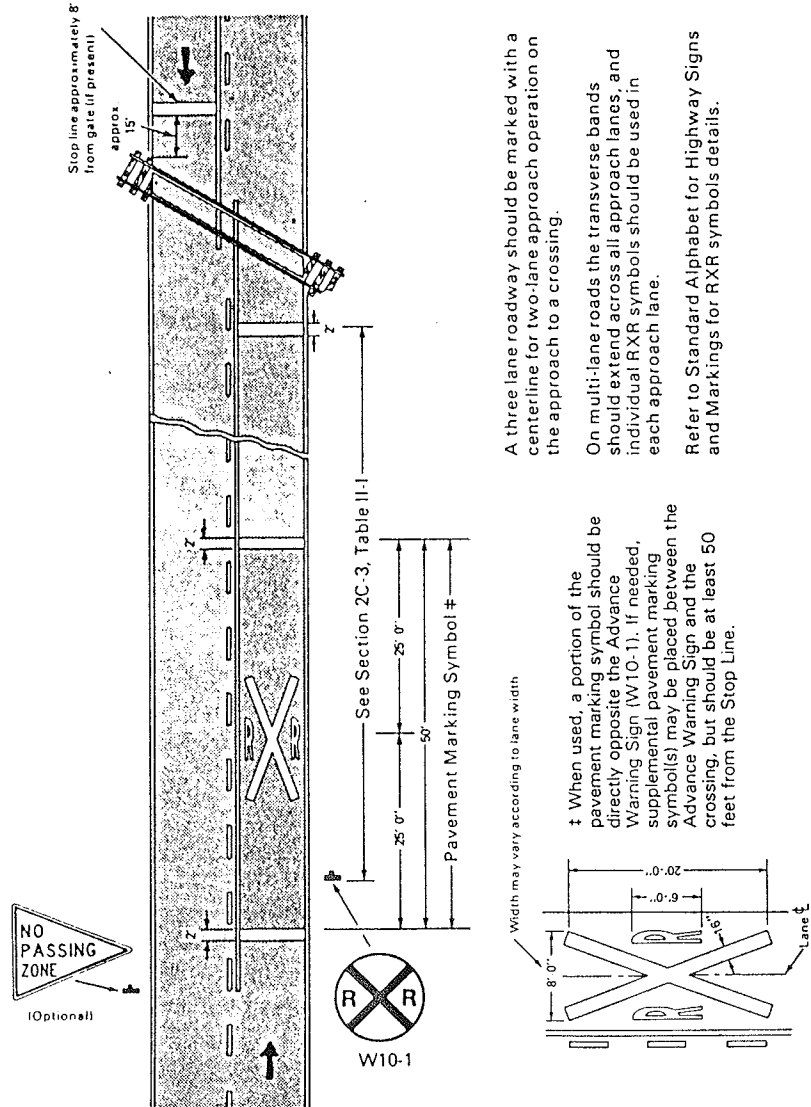


W10-3
30" x 30"



W10-4
30" x 30"

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A three lane roadway should be marked with a centerline for two-lane approach operation on the approach to a crossing.

On multi-lane roads the transverse bands should extend across all approach lanes, and individual RXR symbols should be used in each approach lane.

Refer to Standard Alphabet for Highway Signs and Markings for RXR symbols details.

† When used, a portion of the pavement marking symbol should be directly opposite the Advance Warning Sign (W10-1). If needed, supplemental pavement marking symbol(s) may be placed between the Advance Warning Sign and the crossing, but should be at least 50 feet from the Stop Line.

Figure 8-2. Typical placement of warning signs and pavement markings at railroad-highway grade crossings.

8B-4 Pavement Markings

Pavement markings in advance of a grade crossing shall consist of an X, the letters RR, a no passing marking (2-lane roads), and certain transverse lines. Identical markings shall be placed in each approach lane on all paved approaches to grade crossings where grade crossing signals or automatic gates are located, and at all other grade crossings where the prevailing speed of highway traffic is 40 mph or greater. When used, a portion of the pavement marking symbol should be directly opposite the advance warning sign. If needed, supplemental pavement marking symbol(s) may be placed between the advance warning sign and the crossing.

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The markings shall also be placed at crossings where the engineering studies indicate there is a significant potential conflict between vehicles and trains. At minor crossings or in urban areas, these markings may be omitted if engineering study indicates that other devices installed provide suitable control.

The design of railroad crossing pavement markings shall be essentially as illustrated in figure 8-2. The symbols and letters are elongated to allow for the low angle at which they are viewed. All markings shall be reflectorized white except for the no-passing markings which shall be reflectorized yellow.

8B-5 Illumination at Grade Crossings

At grade crossings where a substantial amount of railroad operation is conducted at night, particularly where train speeds are low, where crossings are blocked for long periods, or accident history indicates that motorists experience difficulty in seeing trains or control devices during the hours of darkness, illumination at and adjacent to the crossing may be installed to supplement other traffic control devices where an engineering analysis determines that better visibility of the train is needed. Regardless of the presence of other control devices, illumination will aid the motorist in observing the presence of railroad cars on a crossing where the gradient of the vehicular approaches is such that the headlights of an oncoming vehicle shine under or over the cars.

Recommended types and location of luminaires for grade crossing illumination are contained in the American National Standard Practice for Roadway Lighting, RP8.* In any event, luminaires shall be so located and light therefrom so directed as to not interfere with aspects of the railroad signal system and not interfere with the field of view of members of the locomotive crew.

8B-6 Exempt Crossing Signs (R15-3, W10-1a)

When authorized by law or regulation a supplemental sign (R15-3) bearing the word EXEMPT may be used below the Crossbuck and Track

* Available from the Illuminating Engineering Society, New York, N.Y. 10017.

