METROLINK.

SCRRA HIGHWAY - RAIL GRADE CROSSING MANUAL

FINAL

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1.0 INTRODUCTION

1.1 BACKGROUND

Southern California Regional Rail Authority (SCRRA) is a five-county joint powers authority, created pursuant to California Public Utilities Code Section 130255 and California Government Code Section 6500 et seq., to plan, design, construct, and then maintain and administer the operation of the Metrolink regional commuter train system serving the counties of Los Angeles, Orange, Riverside, San Bernardino, and Ventura.

The five-county SCRRA member agencies are comprised of the following: Los Angeles County Metropolitan Transportation Authority (“METRO”); Ventura County Transportation Commission (“VCTC”); Orange County Transportation Authority (“OCTA”); San Bernardino County Transportation Authority (“SBCTA”); and Riverside County Transportation Commission (“RCTC”). SCRRA plans, designs, builds, operates, and maintains the Metrolink regional commuter rail system in the five-county area on rail rights-of-way owned by the member agencies. Two major freight rail carriers, BNSF and UPRR, and the inter-city passenger carrier Amtrak, operate on SCRRA tracks through Shared-Use agreements; SCRRA in turn operates on tracks owned by BNSF, UPRR, and North County Transit District (NCTD).

SCRRA’s service territory is located in the Southern California metropolitan region. The operating environment can be typically categorized as urban and suburban, with some limited rural or undeveloped regions. As of 2018, SCRRA trains operate over 456 highway-rail grade crossings; of these, SCRRA is jointly responsible, with the applicable highway agency, for managing the design, construction, operation, and maintenance of over 352 highway-rail grade and pedestrian-rail grade crossings.

Initial design, changes and/or modifications to SCRRA’s existing and any proposed new highway-rail grade crossings are subject to the regulations and approval of the California Public Utilities Commission (CPUC) and also certain provisions of Federal Railroad Administration (FRA) regulations. Most SCRRA highway-rail grade crossings are operated under relatively dense (> 50 daily) mixed commuter, freight, and inter-city passenger train traffic, with relatively high levels of motor vehicle, pedestrian, and bicycle traffic.

A large proportion of SCRRA highway-rail grade crossings feature multiple tracks and vehicle lanes. Table 1-1 summarizes the categories of highway-rail grade crossings over which SCRRA operates and maintains. The latest crossing summary and more detailed information regarding the characteristics of SCRRA’s service patterns and service territory can be found in SCRRA’s Quarterly Fact Sheets on SCRRA’s website:

https://www.metrolinktrains.com/about/agency/facts--numbers/

TABLE 1-1 Summary of SCRRA Highway-Rail Grade Crossings

Crossing Type	Owner and/or Operator/Maintenance Responsibility			
	Metrolink	BNSF	UPRR	NCTD
Public Highway	281	38	47	2
Public Pedestrian	11	0	4	0
Private Highway	31	2	9	1
Private Pedestrian	0	0	0	0
Station Pedestrian	29	1	0	0
Total	**352**	**41**	**60**	**3**

1.2 PURPOSE AND USE OF THE MANUAL

This Manual was developed in 2009 and issued as a Recommended Design Practices and Standards Manual. With nearly 10 years of experience and over 100 crossings built or rebuilt and placed in service utilizing the requirements in the Recommended Manual – SCRRA has experienced very favorable operational performance with these enhanced crossings, most notably reduced accidents and close calls, and where applicable less train horn noise due to quiet zones. Given the favorable experience over time and many crossings, SCRRA has incorporated revisions to the Manual, removed the recommended provision and issued it in November 2018 as a Design Standards and Criteria Manual.

The large number of SCRRA highway-rail grade crossings, combined with high and increasing levels of train, motorized vehicle, and pedestrian traffic, has driven the need for SCRRA to develop a comprehensive single document that incorporates current and applicable highway-rail and pedestrian-rail grade crossing design standards and criteria. This document has been titled the “SCRRA Highway-Rail Grade Crossing Design Standards Manual”, or the “Manual” for short. This Manual addresses many of the unique and complex planning, design, construction, maintenance and operational challenges associated with highway-rail grade crossings located on the Metrolink regional commuter rail network.

In this Manual, the following terms shall be defined as:

- Highway-Rail Grade Crossing – Rail-Grade Crossing, Rail Crossing, At-Grade Crossings, Pedestrian-Rail Grade Crossing, or Crossing
- Highway – Roadway, Road, Street, or Approach Road, including medians, lighting, fencing, landscaping, sidewalks, traffic signs, traffic signals, traffic striping and all other highway improvements
- Highway Agency – Owner or Owners of the Highway including the property, easements, licenses, and all highway improvements. The “Highway Agency” will typically be a local municipality (a City), a County, the State, or in the case of a private crossing, a private party that is responsible for traffic control and law enforcement of the highway crossing the tracks.
- Railroad – shall be referred to as SCRRA

One challenging aspect of highway-rail grade crossing design, particularly in urban metropolitan areas, is that highway-rail grade crossings must typically be designed to allow for the safe and efficient mobility of three entirely different and conflicting modes of mobility: 1) the train; 2) the motor vehicle; and 3) non-motor vehicle; pedestrians and bicycles. Adding to the uniqueness and complexity associated with highway-rail grade crossings is that the jurisdiction for the planning, design, maintenance and operations of highway-rail grade crossings is jointly controlled by at least two, and in some cases as many as four or five, owner/operators, and many other stakeholders.

Another contributing factor of complexity is that most of SCRRA's highway-rail grade crossings have experienced significant train, motor vehicle and pedestrian traffic growth, especially in the last two decades, and have high levels of traffic for all modes of mobility. National and regional Southern California studies have indicated that the combined vehicle and train use of most highway-rail grade crossings has increased by a factor of 2.5 over the past two decades, and this growth is anticipated to continue.

A final factor contributing to the challenges associated with operating highway-rail grade crossings is that a significant number of highway-rail grade crossings, as well as highway and pedestrian approaches, are due, or will soon be due, for a cycle of major rehabilitation and renewal (R&R). These R&R programs typically occur every 15 to 30 years and keep highway-rail grade crossings current with traffic growth, design practices, technological improvements, and changes in regulations. For all the reasons stated above, this Manual was developed and will continually be refined as needed to meet the latest changes in Federal and State regulations as well as current industry best practices.

The primary purpose of the Manual is to provide SCRRA standards, criteria, practices, procedures, and policies that reflect current regulations, proven and accepted technological developments, and best available highway and rail industry design practices. This Manual provides users with the safest and most efficient standard design requirements and practices when improving or modifying highway-rail grade crossings. The Manual user will apply these standards and criteria to SCRRA's highway-rail grade crossings.

Applying the design standards, procedures, and criteria in this Manual will enhance the safety and efficiency of the highway-rail grade crossing and result in a highway-rail crossing that reflects "best practices" on a national basis. When considering the standards and criteria in this Manual, all design teams must exercise sound judgment and take into consideration the unique conditions that may exist at each highway-rail crossing.

For example (and as stated above), many highway-rail grade crossings and the associated highway and pedestrian approaches have not been significantly rehabilitated or renewed for two or three decades and often include design, right-of-way and operational characteristics that exist from previous freight railroad owners or have evolved throughout the years since SCRRA has taken ownership. Such highway-rail crossings and both roadway and train approaches to these grade crossings may not conform fully to current practices and standards as a result. This Manual provides procedures and criteria on how to enhance the safety and operations of a highway-rail grade crossing, in a relatively cost-effective manner and with minimal right-of-way impact, while providing a design team the flexibility necessary to meet site-specific and special "legacy" circumstances found at many crossings.

This Manual will be used when:

1. Significant changes and modifications are proposed to any existing SCRRA highway-rail grade crossings and the approaches thereto. Significant modifications to existing highway-rail grade crossings would include changes in the number of tracks, width, or length of the grade crossing, volume of rail, vehicular or pedestrian traffic, or the type of traffic.

2. Metrolink service is proposed in a new corridor (or extension of an existing corridor).

3. New joint use of existing Metrolink corridors are proposed, such as Light Rail, Freight Rail, and other Rail or Bus Modes .

4. Temporary (36 months or less) or permanent relocations are required of existing SCRRA highway-rail grade crossings. These relocations are most often associated with the construction of a new grade separation, railroad line change, or other similar major construction project.

5. New highway-rail grade crossings along an existing corridor. Installing any new highway-rail grade crossings anywhere on the Metrolink System is strongly discouraged by not only SCRRA but by the CPUC and FRA and other State and Federal Agencies. Adding new grade crossings typically require the closure of one or more nearby existing and in-service highway-rail grade crossings and will require extensive studies to determine the benefits and impacts to motorist and pedestrians before approval is granted (refer to Section 1.7).

In conjunction with developing this Manual and compiling design practices and standards, a thorough review was made of current standards, manuals, regulations, handbooks and other documents available from other highway agencies and private sector railroads. A nation-wide literature search was made of highway-rail grade crossing design practices, and site inspections were conducted of pubic agency and private railroads in both Southern and Northern California and on several large Northeastern Commuter Railroads to establish SCRRA design standards and criteria and application of new but proven technologies.

The costs of implementing highway-rail grade crossing improvements included within this Manual may be considerably higher than other crossing improvement projects completed in the past, due in part to implementation of added safety features such as Exit and Pedestrian Gates, and the accompanying pedestrian channelization railings. Also adding to the cost of crossing improvement projects is increasing demands for substantially higher Advance Preemption requirements from the Highway Agency and the need to incorporate Positive Train Control (PTC) commissioning practices into the implementation process (refer to Section 8.9). The significant increase in costs are due, in part, to the application of more costly and complex design standards such as:

1. Extended and widened center medians

2. Adding new and improving existing sidewalk

3. Improved highway approach geometry

4. Four-quadrant pedestrian gates and flashers
5. Exit gates
6. Pre-signals and queue-cutter signals
7. Vehicle traffic signal system interconnections with simultaneous and advance preemption
8. Reconstructed and lengthened highway-rail grade crossing surfaces
9. Modifying Positive Train Control (PTC) database and operating files to reflect changes to PTC critical features

In some cases, minor right–of-way acquisitions (sliver or small takes less than 1,000 square feet) were also required for the improvements, which contributes to the increase of cost.

As a benefit of meeting or exceeding the standards and criteria of this Manual, most crossings will be “quiet zone” ready should the highway agency desire to apply for a Quiet Zone. In some instances, some additional improvements beyond the standards and criteria of this Manual may be required to meet Federal Quiet Zone regulations.

1.3 MANUAL LIMITATIONS AND DISCLAIMERS

This Manual is not a textbook, nor a substitute for engineering knowledge, experience, or judgment. This Manual provides specialized criteria, standard drawings, design practices, procedures, and policies including graphs, tables, flowcharts, and associated “design aids” not ordinarily contained in many reference documents or textbooks. Some of these “design aids” are provided to facilitate solutions to a particular aspect of highway-rail grade crossing design. Sound judgment by experienced highway-rail grade crossing engineers working as part of a multi-disciplinary and multi-agency design team must be exercised in the application of the Manual provisions to specific circumstances.

This Manual details SCRRA design practices, standards, criteria, procedures, and policies that have been developed to increase highway-rail grade crossing safety through treatments that generally reduce hazards and risks, while still maintaining sufficient functionality for the motorized vehicle, non-motorized pedestrian and bicycle, and train operations. These standards and criteria have been adopted to facilitate and promote uniformity and consistency to the design of new or modified SCRRA highway-rail grade crossings. SCRRA assumes no liability for the use of information contained in this Manual. It is not intended that any standard of conduct or duty toward the public shall be created or imposed by the use of the Manual. SCRRA does not warrant the accuracy or completeness of this Manual or that the Manual does not contain errors and omissions. The Manual user shall independently validate and verify the information in the Manual and promptly notify SCRRA of any discrepancies or inconsistencies discovered in the course of utilizing this Manual.

Except for new developments, no attempt is made to detail basic engineering techniques; for these, existing design manuals (as provided in the Reference Standards list) and applicable engineering textbooks should be used. For routine design processes and procedures, the Manual's design standards and criteria should be intuitive. The contents of this Manual do not preclude use of different methods when special or highly atypical conditions arise, and when approval (through the special design consideration process) is requested and approved. In any event, all highway-rail grade crossing designs under the jurisdiction of SCRRA must be approved by SCRRA and any other rail owner at the crossing, as well as the highway agency owner of the highway-rail grade crossing and highway approaches. Additionally, all highway-rail grade crossing designs must comply with all applicable CPUC, FRA, and California Manual on Uniform Traffic Control Devices (CA MUTCD) regulatory requirements.

It is not intended that all the standards and criteria included in this Manual be applied retroactively to minor physical or operational changes or to routine maintenance upgrades to existing crossings and highway approaches, as this would not be warranted or economically feasible.

It is intended that the standards and criteria in this Manual be applied when significant physical or operational changes have occurred or are proposed, applicable regulatory approval has been received, realistic scopes and estimates have been developed, the required funding has been obtained, and there is an agreement on the scope, cost, schedule, responsibility and delivery of the proposed changes with the principal highway-rail grade crossing stakeholders.

In most cases, the primary responsibility for funding highway-rail grade crossing safety and operational changes does not reside with SCRRA, but with the highway agency that owns and maintains the approach highways and pedestrian paths. In many cases, grade crossing safety enhancements are funded by applicable State and Federal grants. SCRRA or SCRRA's member agencies may elect to participate in funding improvements for a highway-rail grade crossing on a case-by-case basis or as part of a corridor-wide program.

The designs applied to any proposed highway-rail grade crossing modification or new highway-rail grade crossing should, to the maximum extent feasible, equal or exceed the standards and criteria provided in the Manual. When considering changes and modifications to existing highway-rail grade crossings or if a new grade highway-rail grade crossing is proposed, the highest priority should be given first to treatments resulting in safety improvements and hazard reduction. After safety enhancements and hazard reductions are prioritized, appropriate consideration should then be equally given to: 1) availability of funding; 2) project costs—both the initial and the recurring operation and maintenance costs; 3) vehicular/pedestrian and train throughput, capacity, and operation; 4) short, mid-term, and long term maintenance impacts; 5) socio-economic and environmental impacts, especially those associated with noise (primarily locomotive horn blowing, but also warning bells) and the implementation of "quiet zones" by highway agencies; and 6) right-of-way acquisitions.

In some cases, the standards and criteria are subject to amendment as conditions and experience seems to warrant. Special situations may call for variation from the standards, criteria, policies, and procedures, subject to SCRRA and CPUC or FRA approval, or such other approval as may be specifically provided for in the Manual. A process for requesting special design considerations from the standards and criteria has been provided.

SCRRA advises the user to completely review the entire Manual and develop a thorough level of understanding prior to beginning a project or study involving the design, assessment, or diagnostic evaluation of a SCRRA highway-rail grade crossing.

Due to the complexity of intersecting train, vehicle, and pedestrian traffic, combined with relatively high traffic and train volumes and the multi-jurisdictional ownership associated with most SCRRA highway-rail grade crossings, SCRRA requires that a “lead Engineer” be designated and placed in “responsible charge” of the inter-disciplinary team involved with any highway-rail grade crossing modification. The lead Engineer shall be a registered California Civil Engineer and have at least five (5) years of recent experience associated with highway-rail grade crossings.

The lead Engineer, supported by the interdisciplinary and inter-agency design team, shall have a good understanding of, and significant experience with, all aspects of the design, construction, operation, and maintenance of highways and streets, traffic signals, railroad track, and railroad active warning devices, as well as being very familiar with applicable CPUC, CA MUTCD and FRA regulations. Additionally, the lead Engineer’s experience should include significant expertise with the diagnostic processes, safety certification and hazard analyses, inter-disciplinary track and highway geometric design, and rail and traffic signal system design.

1.4 SYSTEM SAFETY PROGRAM PLAN AND SCRRA GENERAL POLICIES

The Manual supports the goals and objectives included within SCRRA’s System Safety Program Plan (SSPP). The goal of SCRRA’s SSPP is the facilitation of a safe work environment through the integration of Standard Operating Procedures (SOPs), System Safety Standards (such as this Manual) and FRA/APTA (American Public Transportation Association) Audit recommendations. Consideration will be given to incorporating critical safety elements of this Manual into the SOP’s within the SSPP.

SCRRA Board Resolutions 91-3 and 98-21 in Appendix G provide SCRRA’s high level Board Policies regarding highway-rail grade crossings. Aside from section and paragraph headings and table and figure descriptions within the Manual, SCRRA general policy statements supporting the intent of Board Resolutions appear as *italicized dark blue* text. These policies should be adhered to during the design of highway-rail and pedestrian-rail grade crossings.

1.5 ESSENTIAL DESIGN STANDARDS, CRITERIA, AND SPECIAL DESIGN CONSIDERATIONS

SCRRA intends to apply the standards and criteria provided in this Manual when a significant physical change or traffic volume increase (rail, vehicle, pedestrian) is proposed, or occurs, to an existing highway-rail grade crossing, including motor vehicle highway and non-motor vehicle pedestrian and bicycle approaches.

In addition, SCRRA will apply the standards and criteria included in this Manual when a significant change in use is proposed, or occurs, to the highway-rail grade crossing; especially changes in use resulting in significant increases in vehicle, pedestrian, bicycle, and train traffic, or changes in traffic patterns.

Examples of changes in traffic patterns would include:

- Installation of a new left-turn lane near the highway-rail grade crossing approach
- Installation of new traffic signals on an adjacent intersection
- Opening of a new passenger rail station near an existing highway-rail grade crossing

It is not intended that the requirements in the Manual be applied retroactively to existing highway-rail grade crossings absent any proposed major physical or use changes, nor should they in the absence of an appropriate level of funding.

Standards, criteria, and procedures established in the Manual, and listed in Table 1-2, are those considered <u>most essential</u> to enhancing and reducing the hazards at highway-rail grade crossings. Aside from section and paragraph headings, and table and figure descriptions, these **essential standards, criteria, practices, and policies** are called out in the Manual in **Boldface** type.

Any deviation from the standards and criteria listed in this Manual will require a special design consideration and the approval of a Change Review Committee, designated by the Director of Engineering and Construction or Director of Communication and Signals, as appropriate. The Change Review Committee will typically include the Directors and a cross section of senior managers representing SCRRA Civil, Signal, Safety and Rail Crossings groups.

It is important to note that any deviation requested from the standards and criteria of this Manual must be formally approved and officially documented through an executed Request for Special Design Consideration form. Informal agreements of any kind, including but not limited to; verbal or email communications; will not be considered official and may be rejected. This is to ensure that a proper review of the requested deviation is performed by all relevant parties that may be affected by the non-standard design.

The current procedure for requesting a special design consideration from the Manual is to prepare and then request the necessary approvals by completing SCRRA's Request for Special Design Consideration form. This form is included in the Manual as Appendix E. The request should be signed and sealed by a registered engineer, preferably the lead Engineer for the highway-rail grade crossing design.

Table 1-2. SCRRA Essential Design Standards, Criteria, and Policies

Section	List of Essential Design Standards, Criteria, and Policies
2.5.1	Maintenance costs for exit gate systems, if used solely for establishing a quiet zone, shall be addressed in the C&M Agreement and shall not be funded by SCRRA.
3.2.2	All private highway-rail grade crossings shall be subject to the standards and criteria that are applied to permanent highway-rail grade crossings in this Manual.
3.2.4	Relocated or temporary highway-rail grade crossings shall be subject to the standards and criteria that are applied to permanent highway-rail grade crossings in this Manual.
3.4.1.1	Active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast, at new or existing highway-rail grade crossings. A Special Design Consideration may be requested for active warning devices installed less than 15 feet from the centerline of track, but in no case shall an active warning device be installed less than 12 feet from the centerline of the track.
3.4.1.2	For skewed crossings, highway active warning devices shall be installed perpendicular to the highway and 15 feet from the centerline of the track, as measured from either the center of gate mast or tip of the gate (whichever is closer). If the geometry of the highway-rail grade crossing precludes installing the gates at 15 feet from the centerline of the track, then a Special Design Consideration shall be requested to place the device closer to the crossing, but in no case less than 12 feet from the centerline of the track.
3.4.1.2	When a right-angle highway-rail grade crossing cannot be achieved due to physical constraints, the interior angle shall be designed as close to 90 degrees as practical but shall not be less than 75 degrees.
3.4.4	The AASHTO WB-65 semi-tractor-trailer shall be the highway “design vehicle” used for horizontal highway geometry design at highway-rail grade crossings and grade crossing approaches.
3.4.5	The horizontal and vertical geometry of the highway approaches and adjacent intersections (immediately upstream and downstream of the highway-rail grade crossing) shall safely accommodate all anticipated traffic movements and required clearances of the highway “design vehicle”.
3.4.10	Vertical curves within the highway at a highway-rail grade crossing shall not be allowed.
3.4.10	At highway-rail grade crossings with multiple tracks, the tops of the rails for all tracks shall be in the same plane.
3.4.10	The highway vertical profile grade at lip of gutter pan should be 0% within 10 feet of the centerline of the nearest track and the grade can be increased to 1.11% up to 37.50 feet from the centerline of the nearest track. Beyond 37.50 feet from the centerline of the nearest track, the grade on the approach to the highway-rail grade crossing shall be minimized, with due respect for low-ground-clearance vehicles, to allow maximum acceleration by heavy trucks.

Section	List of Essential Design Standards, Criteria, and Policies (cont.)
3.4.10	Highway-rail grade crossing vertical profiles shall be analyzed with the Low-Ground Clearance Vehicle template, to determine the clearance for this vehicle type. The Low–Ground Clearance vehicle template has a nominal six (6) inch ground clearance. Highway-rail grade crossings should provide a minimum clearance of three (3) inches between the street surface and the lowest point on the Low-Ground Clearance vehicle template.
3.4.10	In the event site conditions do not allow for the design to meet the Low-Ground Clearance vehicle template, a special design consideration may be requested to allow a W10-5 low-ground-clearance sign (as specified in the CA MUTCD) to be installed on each approach to the highway-rail grade crossing sufficiently in advance to allow the vehicles to turn around or navigate an alternate route in advance of the highway-rail grade crossing.
3.4.12	If the railroad geometry and facilities in the vicinity of the highway-rail grade crossing do not meet current SCRRA standards, or the railroad facilities are not in acceptable condition, the railroad facilities shall be reconstructed to correct any deficiencies.
3.4.14.1	Highway-rail grade crossings shall be of a width not less than the traveled approach portions of the adjacent sections of road, highway or street, including usable shoulders and sidewalks [pedestrian pathways].
3.4.14.1	Highway-rail grade crossings shall not be less than 24 feet wide in effective roadway width measured at right angles with the centerline of the roadway.
3.4.14.1	A vehicle entering the footprint of the highway-rail grade crossing shall have an unimpeded means of clearing the crossing.
3.4.14.2	Sidewalks and pavement approaches to the highway-rail grade crossing shall be constructed using hot mix asphalt concrete between the crossing panels and a distance of ten (10) feet from the centerline of the track.
3.5.2	Raised median islands shall be used on both approaches to the highway-rail grade crossing to constrain undesirable traffic movements, such as driving around the automatic crossing gates or making U-turns in the vicinity of the highway-rail grade crossing.
3.5.2	On each approach to the highway-rail grade crossing, the raised median shall begin 10 feet from the centerline of the nearest track. The end of the median adjacent to the highway-rail grade crossing shall be square, with a six (6) inch radius on the corners.
3.5.2	The minimum length of the median as measured from the highway-rail grade crossing gate shall be 100 feet. A Special Design Consideration will be required where the 100 feet is unobtainable, but in no case shall the median be less than 60 feet. The width of the median shall be ten (10) feet if a warning device is installed in the median and four (4) feet if no warning device is installed in the median. The minimum width of the median may be two (2) feet with the approval of SCRRA and the highway agency. Raised median curbs shall be eight (8) inches.
3.5.4	Trees, shrubbery, and similar view obstructing landscaping are not allowed on highway approaches within 150 feet of a highway-rail grade crossing. Low maintenance stamped concrete, pavers, or other hardscape materials shall be the standard landscape treatment for median islands and sidewalk approaches.

Section	List of Essential Design Standards, Criteria, and Policies (cont.)
3.6	New driveways (private or public) shall not be located within 100 feet of the nearest highway-rail grade crossing active warning gate. Existing driveways within 100 feet of the nearest highway-rail grade crossing active warning gate shall be removed or appropriately reconfigured to achieve safety objectives.
3.6	Driveways adjacent to a highway-rail grade crossing which require vehicle reversing (backing) movements shall not be allowed and the highway agency shall prohibit the reversing movements.
3.6	The design and actual usage of the driveway shall not allow the reverse movement of vehicles through and over the highway-rail grade crossing while entering or exiting the driveway.
3.6	Special traffic signage shall be installed to control undesirable traffic movements, especially reverse or slow movements into or out of driveways near tracks.
3.7	Vehicle parking within 100 feet of the highway-rail grade crossing, as measured from the furthest automatic warning device from the tracks, shall be prohibited.
3.10.3.2	Exit gates shall only be used as a last resort, when all other options to mitigate gate circumvention have been exhausted and an exit gate system is the only feasible option. With the exception noted in Section 3.10.4.1, a Special Design Consideration and approval from SCRRA is required for all applications of exit gates.
3.10.4.1	For highway intersections within 100 feet of a highway-rail grade crossing with multiple main tracks, an exit gate system shall be installed to prevent any vehicular movements from accessing the track area.
3.11	Any new proposed crosswalks that are adjacent to a highway-rail grade crossing will require that a Special Design Consideration be submitted to SCRRA for review and approval.
3.13.4	During the preemption hold interval, the traffic signal indications shall prevent vehicles from moving toward the track area while displaying a green protected movement signal for through/turning movements to allow traffic to move off the tracks and away from the crossing.
3.13.4	A blank-out, changeable message sign, appropriate highway signal indication, or other similar control shall be used to prohibit turning movements toward the highway-rail grade crossing during preemption.
3.13.5	In cases where there is an existing left-turn lane not provided with a signal head equipped with a protected left-turn arrow, the traffic signal shall be modified to provide a protected left-turn arrow or a blank-out sign restricting the left-turn movement towards the track.
3.13.5	A left-turn lane pocket configuration extending across the tracks shall be avoided.
3.13.6.1	A Standard No. 9-A cantilever shall not be used as or used to mount a pre-signal.
3.13.6.2	In all cases, pre-signal poles shall be positioned to maintain visibility of the railroad flashing lights.
3.13.6.2.1	The far-side intersection signal heads shall be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to drivers at the pre-signal stop line.

Section	List of Essential Design Standards, Criteria, and Policies (cont.)
3.13.9	Backup or standby power systems shall be required at all traffic signals interconnected with railroad signals.
3.14.4.2.2	Limited Service shall be used for traffic signals interconnected to SCRRA active warning devices.
3.14.5.3	The Los Angeles Department of Transportation "(LADOT) Railroad Preemption Form" shall be used to calculate the duration of the queue clearance time. The Texas Department of Transportation Traffic Signal Preemption at Highway-Rail Grade Crossings form may also be used.
3.14.10	Total Approach Time for highway-rail grade crossing warning systems shall not exceed 50 seconds.
4.1	The design of pedestrian-rail grade crossings and installation of pedestrian treatments shall be in accordance with the process in Section 4.8 and the Pedestrian-Rail Grade Crossing Design Consideration Flowchart in Figure 4-4.
4.2.3	Station pedestrian-rail grade crossings shall provide "full pedestrian treatments" (signage, channelization, active pedestrian warning devices with gates, and swing gates) and fencing, and shall not cross more than two (2) tracks.
4.2.3	New pedestrian-rail grade crossings at any location on platforms shall not be allowed.
4.2.3	New station pedestrian-rail grade crossings shall be constructed approximately 60 feet from the ends of the platform and include full pedestrian treatments.
4.2.4	New pedestrian-rail grade crossings shall not be allowed unless one or more existing pedestrian-rail or highway-rail grade crossings are closed.
4.4	ADA Accessibility Guidelines must be incorporated into the overall design for pedestrian-rail grade crossings.
4.6.1	Active warning devices for pedestrian-rail grade crossings shall be installed 15 feet from the centerline of the track, as measured from the center of the mast at new or existing crossings. A Special Design Consideration may be requested for active warning devices installed less than 15 feet from the centerline of the track, but in no case, shall an active warning device be installed less than 12 feet from the centerline of the track.
4.7.3	At stations, track centers shall be a minimum of 19 feet-6 inches but not more than 25 feet to accommodate an inter-track fence.
4.8	"Full pedestrian treatments" shall include signage, markings, channelization, fencing, active warning devices with gates, and swing gates.
5.1	All projects that propose an additional track (of any type and operation including, but not limited to, Commuter, Freight, Light Rail Transit, High Speed Rail, and Diesel Multiple Units), that increases the track count of a highway-rail grade crossing to three (3) or more main line tracks, will require a comprehensive analysis as detailed in the Section 5.1 and shall involve the full and joint participation of all key grade crossing stakeholders (SCRRA, Highway Agency or Agencies, CPUC, FRA, etc.) in all phases of the analysis.
7.1	Modifications of all highway-rail grade crossings or proposals for new highway-rail grade crossings shall be subject to the CPUC approval process.

Section	List of Essential Design Standards, Criteria, and Policies (cont,)
8.6	The height of the fence within 150 feet of highway-rail grade crossings shall be four (4) feet. The height of the fence in the balance of the right-of-way shall be at least six (6) feet.
9.1	Highway agency and its contractors shall comply with the rules and regulations contained in the current editions of SCRRA's documents during construction of the project.
9.4	When a highway-rail grade crossing exists either within, or in the vicinity of, a temporary traffic control zone; lane restrictions, flagging, or other operations shall not be performed in a manner that would cause vehicles to stop on the railroad tracks unless a law enforcement officer or qualified flagger is provided at the highway-rail grade crossing to minimize the possibility of vehicles stopping on the tracks.
10.1	Highway agency shall independently inspect the preempted traffic signals intersection a minimum of every three (3) months and shall report the results of this inspection to the SCRRA Signal Maintenance Department. If the crossing is a joint crossing, the highway agency shall also report the results to the other owner(s) of the joint crossing.
10.2	Highway-rail grade crossings with preempted traffic signals shall be jointly inspected on an annual basis with SCRRA. If the crossing is a joint crossing, the joint inspection will also include all other owner(s) of the joint crossing.
10.3	Any changes to railroad or highway traffic conditions discovered during routine inspection and tests shall be reported to each party.

1.6 MANUAL CHANGES, UPDATES, AND THE MANUAL EFFECTIVE DATE

The various sections of the Manual, as dated in the lower right-hand footer of each page, supersede all prior dated sections, Office Standards, Special Orders, and other directives relating to material covered. Revisions and updates to the Manual will be posted on the Metrolink website. Manual users shall be solely responsible for frequently checking for updates to ensure the latest version is being used when performing design or related work on SCRRA highway-rail grade crossings. The Manual is available on SCRRA's Website: www.metrolinktrains.com. The user shall ensure the latest version of the Manual, inclusive of any and all changes and updates, is being utilized. **The effective date of this Manual is January 2021.**

1.7 SCRRA POLICY ON NEW HIGHWAY-RAIL GRADE CROSSINGS

SCRRA's Board (Board) has passed Resolution 91-3 and Resolution 98-21 pertaining to the establishment of a new highway-rail grade crossing on SCRRA's system. *SCRRA's policy, as well as State and National policy, strongly discourages the construction of new highway-rail grade crossings and seeks to reduce the number of active highway-rail grade crossing by promoting grade separation or closure of existing highway-rail grade crossings.* In accordance with Resolution 98-21, a new, additional highway-rail grade crossing is not allowed unless the member agency of SCRRA sponsors the request to construct it and the Board approves the request. This resolution also requires the member agency to sponsor the closure of a nearby existing and in-service highway-rail grade crossing(s) in order to open a new highway-rail grade crossing, so there will be no net increase in the number of highway-rail grade crossings on SCRRA's commuter rail system. These resolutions are attached as Appendix G. Any new highway-rail grade crossings shall be consistent with the standards and criteria in this Manual and are subject to CPUC approval.

1.8 REFERENCE STANDARDS

The most current editions of the following standards, codes, specifications, and guidelines shall be consulted in the design of highway-rail grade crossings:

Primary References:

- California Manual on Uniform Traffic Control Devices (CA MUTCD), issued by the California Department of Transportation (Caltrans)
- California Public Utilities Commission General Orders (CPUC GO)
- California Public Utilities Code (PU Codes)
- Code of Federal Regulations (CFR), Title 23 and Title 49
- SCRRA Documents:
    - Design Criteria Manual
    - Design Procedures Manual
    - Engineering Standard Drawings
    - Standard Specifications
    - Right-of-Way Encroachment Process
    - Track Maintenance Manual
    - CADD Manual

Secondary References:

- The Communications & Signals Manual issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- The Document for Railway Engineering issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- The Portfolio of Track Work Plans (companion volume to the Railway Engineering Manual), issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- Green Book Standard Specifications for Public Works Construction by the Green Book Committee, BNI Building News.
- Railroad-Highway Grade Crossing Handbook, U.S. Department of Transportation, Federal Highway Administration.
- The California Highway Design Manual published by the California Department of Transportation (Caltrans).
- Caltrans Standard Plans.
- Caltrans Standard Interconnection for Traffic Signal Preemption at Railroad

Crossings.

- A Policy on Geometric Design of Highways and Streets, published by the American Association of State Highway and Transportation Officials (AASHTO).
- Highway agency's standards and design criteria for traffic signals.
- Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 4th edition, 2006 Interim, published by the American Association of State Highway and Transportation Officials (AASHTO).
- National Electrical Code.
- Preemption of Traffic Signals near Railroad Crossings, Institute of Transportation Engineers (ITE).
- Standard Plans for Public Works Construction, American Public Works Association.
- WATCH-Work Area Traffic Control Handbook.
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
- Highway-Railroad Crossings: A Guide to Crossing Consolidation and Closure, FRA/FHWA Joint Publication.
- Highway-Rail Crossing Elimination and Consolidation, published by the American Association of State Highway and Transportation Officials (AASHTO).

Detailed drawings related to highway-rail grade crossings, pedestrian crossings and signal system automatic warning devices are included in SCRRA Engineering Standards and are available on SCRRA's website:

https://www.metrolinktrains.com/about/agency/engineering--construction.

These standards are not intended to replace existing regulatory standards or to be a substitute for engineering knowledge, experience and judgment, but are requirements, which are most important for safe construction, maintenance and operation of highway-rail grade crossings. Since the actual design will typically be site specific, information shown on these standard drawings will be modified as necessary in close collaboration with SCRRA and as per the diagnostic process described in Section 7.3. SCRRA requires the highway agencies to prepare drawings and cost estimates showing highway, rail, traffic signal, pedestrian, signal and other details similar to the one shown on the sample drawings. Table 1-3 shows the list of SCRRA's Engineering Standards related to highway-rail grade crossing.

Table 1-3. List of Highway-Rail Grade Crossing Engineering Standards

STANDARD NO.	TITLE
ES 4001	Highway-Rail Grade Crossing - Typical Sections
ES 4002	Pedestrian Swing Gate Details
ES 4003	Pedestrian Gate Layout, Signal Foundation and ADA Ramp Details
ES 4004	Pedestrian Crossing Design Consideration Table
ES 4005	Pedestrian Barricade and Metal Hand Railing Details
ES 4006	Grade Crossing Marking and Signage
ES 4010	Grade Crossing Notes and Legend
ES 4011	Pedestrian Facilities at Vehicle Crossing - Entrance Gates Only
ES 4012	Pedestrian Facilities at Vehicle Crossing - Entrance/Exit Gates
ES 4013	Pedestrian Facilities at Acute Angle Vehicle Crossing - Entrance Gates Only
ES 4014	Pedestrian Facilities at Acute Angle Vehicle Crossing - Entrance/Exit Gates
ES 4015	Pedestrian Facilities at Obtuse Angle Vehicle Crossing - Entrance Gates Only
ES 4016	Pedestrian Facilities at Obtuse Angle Vehicle Crossing - Entrance/Exit Gates
ES 4017	Typical Pedestrian Treatment Details
ES 4018	Pedestrian Crossing Only
ES 4020	Pedestrian/Vehicle Crossing Adjacent to Station
ES 4021	Pedestrian Crossing Adjacent to Station
ES 4201	Precast Concrete Panels for Highway-Rail Crossing
ES 8270	Emergency Notification Sign for Highway-Rail Grade Crossings
ES 8300	Flashing Light Signal Assembly With or Without Gate
ES 8305	Flashing Light Signals Configuration (CPUC #8)
ES 8306	Flashing Light Signals with Gate Configurations (CPUC No. 9, 9-A and 9-E)
ES 8308	Typical Gate Assemblies for Pedestrian Treatments at Vehicle Crossings
ES 8309	Typical Gate Assemblies for Pedestrian and Bicycle Only Crossings
ES 8320	Single Mast Crossing Cantilever Assembly 10’ Thru 30’ Arm Length
ES 8325	Double Mast Crossing Cantilever Assembly 30’ Thru 40’ Arm Length
ES 8350-02	Location Plan Flashing Light Signals with Entrance Gates, Gates, Exit Gates, Ped Gates, Instrument Enclosure, Pull Box & Conduit Layout
ES 8355	Typical Location Plan - Flashing Light Signals with Entrance and Exit Gates

STANDARD NO.	TITLE
ES 8360	Typical Location Plan - Cantilever Flashers with Entrance Gates
ES 8365	Typical Location Plan - Cantilever Flashers with Entrance and Exit Gates
ES 8370	Typical Location Plan - Flashing Light Signals with Entrance Gates and Median
ES 8375	Typical Location Plan - Flashing Light Signals with Entrance and Exit Gates and Median
ES 8380	Typical Location Plan - Cantilever Flashers with Entrance Gates and Median
ES 8385	Typical Location Plan - Cantilever Flashers with Entrance and Exit Gates and Median
ES 8390	Typical Location Plan - Pedestrian Flashing Light Signals with Pathways Crossing Configuration
ES 8395	Typical Location Plan - Pedestrian Flashing Light Signals with Vehicle Crossing Configuration
ES 8400	Typical Light Unit Alignment for Flashing Light Signals at Grade Crossing
ES 8405	Installation and Placement of Vital Inductive Loops used with Exit Gates

1.9 RECOMMENDATIONS OF SCRRA SAFETY PEER REVIEW PANEL

In January 2009, SCRRA received a report authored by the Metrolink Commuter Rail Safety Peer Review panel entitled *Metrolink Commuter Rail Safety Peer Review Panel: Final Report*. The subject and purpose of the report was to discuss the observations and recommendations made by this Panel.

The Panel was appointed by a SCRRA Board Ad Hoc Subcommittee and consisted of experts and professionals from across the nation having diverse backgrounds and experience from commuter rail and passenger agencies, private companies, and members of academic society.

The report recommended the implementation of an "Enhanced Safety Action Plan", which included short, medium, and long-term safety and operational enhancements to the Metrolink System. This plan was organized into eight (8) key issues, the fifth being Infrastructure Maintenance. The importance of this report to the Manual is that Grade Crossing Safety Enhancements and Sealed Corridors were included in the recommendations for Infrastructure Safety Improvements. Recognizing the importance of grade crossing to overall system safety, the Panel report recommended that SCRRA continue with its programs to enhance safety at highway-rail grade crossings and continue programs to either close or grade separate existing grade crossings. Any subsequent changes to the report that change the requirements of the Enhanced Safety Action Plan will be required to be complied with, until this Manual is formally updated to include the new requirements.

2.0 FEDERAL, STATE, AND LOCAL REGULATIONS AND SCRRA AGREEMENTS

2.1 INTRODUCTION

Regulatory agencies include those agencies with jurisdiction for modifications to existing public and private highway-rail grade crossings, as well as any proposed new highway-rail grade crossings. Highway-rail grade crossing closures, quiet zones, and grade separation are issues that may arise and need to be addressed in detail in conjunction with the modification of an existing or proposed new highway-rail grade crossing.

With regard to modifications and changes to existing SCRRA highway-rail grade crossings, the primary regulatory agency and point of contact will always be the California Public Utilities Commission (CPUC). Federal Railroad Administration (FRA) applicable regulations will also apply, especially in those instances when a quiet zone may be under consideration. The principal CPUC General Orders (GO) associated with highway-rail grade crossings are GO 72, 75 and GO 88.

In accordance with CPUC and Federal Highways Administration (FHWA) guidelines, representatives from both railroad and highway agencies are required to participate with the regulatory authorities in all activities that involve the analysis and design of proposed changes to a highway-rail grade crossing. SCRRA will be the regulatory point of contact, in the lead railroad role for highway-rail grade crossings it maintains and operates. The most likely other agency to be involved with highway-rail grade crossings will be the highway owner, which in most cases is the local City who owns and maintains the grade highway-rail grade crossing highway approaches. In some cases, the highway owner is the County, or the State of California (Caltrans). Other stakeholders in the process of modifying, closing an existing highway-rail grade crossing or proposing a new highway-rail grade crossing may include passenger and freight railroads that operate at the crossing location, local emergency services (fire and police), school districts, neighborhood associations, and nearby businesses. Technical, funding, or planning representatives from SCRRA's member agencies (METRO, OCTA, VCTC, SBCTA, and RCTC) will often participate in the grade crossing planning, design, and funding process, and will also participate in discussions with the regulatory agencies.

2.2 FEDERAL

SCRRA's rail network is regulated by the FRA. FRA regulations are included in Title 49, Parts 200 to 299 of the Code of Federal Regulations (CFR). The purpose of the FRA is to: enforce rail safety regulations; administer railroad assistance programs; conduct research and development in support of improved railroad safety and national rail transportation policy; and consolidate government support of rail transportation activities.

The FRA maintains the federal database of highway-rail grade crossings in the United States. A US DOT crossing number identifies each public highway-rail grade crossing in the United States. This crossing number is issued by the FRA to the operating railroad. The number consists of seven characters: six numerical characters, followed by one letter (e.g. 123456A). The US DOT and the FRA use this number to maintain the federal crossing inventory. The available statistics applicable to a particular crossing can be found by using its number to search the federal database for accident, traffic, and basic inventory information. The user should verify this information with the railroad and the highway agency. The operating railroad is responsible for supplying current information regarding the highway-rail grade crossing to the FRA. Information regarding a particular highway-rail grade crossing can be found on the FRA website at http://www.fra.dot.gov.

The "Safety" page on the FRA website includes information regarding the regulation of highway-rail grade crossings, as well as important database information. To access the desired information, the user is able to search using a number of different queries.

The principal FRA regulations associated with highway-rail grade crossings in CFR Title 49 are Parts 222 (*"locomotive hours at public highway-rail grade crossings")* and Part 234 ("*grade crossing signal system safety*"). Other Parts in CFR 49 also apply.

In October 2008, the Rail Safety Improvement Act of 2008 was passed and includes new provisions addressing grade crossing safety. The FRA also sponsors a number of programs promoting safety, inspection, highway-rail grade crossing safety, and trespass prevention. Additional details regarding FRA programs involving safety can be found on the FRA website.

2.3 STATE

In the State of California, the CPUC has regulations and standards governing many aspects of highway-rail grade crossings design, construction, maintenance and operation. The Rail Crossings and Engineering Branch (RCEB) of the CPUC is the primary point of contact within the CPUC for issues involving highway-rail grade crossings. General Orders (GO) of the CPUC, combined with regulations contained in the California Manual on Uniform Traffic Control Devices (CA MUTCD), defines the requirements for application of warning devices and traffic control. In most cases, the highway agency has jurisdiction on the highway and pedestrian approaches outside of the crossing, in accordance with the standards of the agency and the CA MUTCD.

The criteria established within the GOs are developed through a formal rule-making process to become part of the standards. Each GO has a revision letter appended to the end of its number. For example, GO 88-B refers to revision B of GO 88. In the Manual, revision letters that apply to each referenced GO have been omitted, with the understanding that the user will refer to the latest version.

The construction or modification of any new highway-rail grade crossing must comply with regulatory process defined in Sections 1201–1205 of the Public Utilities Code. Construction of improvements cannot begin until authorization is received from the CPUC.

In most cases, the modification of an existing highway-rail grade crossing shall be applied for through the CPUC GO 88 process.

Each highway-rail grade crossing in California has a CPUC-issued identification number. The CPUC numbers identify the railroad, branch or subdivision, milepost, and nature of the track (main or branch track, pedestrian crossing, etc.).

By way of example, 101VY-123.40-A is a typical CPUC highway-rail grade crossing number array. That number is obtained as follows:

101 = Railroad company/authority
VY = Subdivision and branch/line (see Table 2-1)
123.40 = Railroad milepost (to the nearest hundredth of a mile)
A, B, C, D = Type of crossing (see Table 2-2)

Each SCRRA highway-rail grade crossing CPUC number uses “101” as a prefix, assigned by CPUC on behalf of SCRRA.

The following tables list some of the more commonly used highway-rail grade crossing identifiers:

Table 2-1. SCRRA Subdivision Identifiers

Subdivision	Identifier
River	RI
Valley	VY
Ventura	VE
Orange	OR
Olive	OL
Montalvo	MO
San Gabriel	SG
Short Way	SW
Perris Valley	PV
Pasadena	PA

Table 2-2. Highway-Rail Grade Crossing Type Identifiers

Overhead (RR under), grade-separated highway over railroad	A
Underpass (RR over), grade-separated highway under railroad	B
Spur Track (Industry Track) crossing	C
Pedestrian crossing	D
Railroad-railroad crossing (track over track)	T
Private crossing	X
Overhead pedestrian crossing	AD*
Underpass pedestrian crossing	BD*
Pedestrian private crossing	DX*
Overhead pedestrian private crossing	ADX*
Underpass pedestrian private crossing	BDX*

*Note: these are combinations of the above identifiers

As another example of how these identifiers are generated, crossing number 101VY–10.95-A is the Magnolia Blvd overhead highway crossing on SCRRA’s Valley Subdivision at mile post 10.95.

2.4 LOCAL

A highway agency or municipality has ownership and jurisdiction over the highway and highway approaches on which the highway-rail grade crossing is located. While agreements between the railroad and the agency define the physical limits of the highway-rail grade crossing, the approach highways and sidewalks outside of those defined limits falls under the jurisdiction of the highway agency. (The lead Engineer is referred to CPUC GO 72 for a description of these limits).

In carrying out this responsibility, the highway agency will define the engineering standards, criteria, and design practices to be used in the development of designs for the highway-rail grade crossing's approaches. These standards must be minimally compliant with CA MUTCD and should be consistent with the standards and criteria in this Manual.

Highway-rail grade crossing and the associated highway and sidewalk approaches typically involve the intersection of three transportation modes (rail, motor vehicles, and non-motor vehicle pedestrian and bicycles) and include overlapping ownership, design, construction, maintenance, operation and funding responsibilities. SCRRA, the highway agency, CPUC, and other stakeholders should develop highly-collaborative approaches when planning and designing highway-rail grade crossing modifications or new crossings.

The highway agency responsible for the highway approach shall follow the standards and criteria included within this Manual when planning and designing physical or use changes to the highway-rail grade crossing and highway approaches.

2.5 SCRRA

2.5.1 Construction and Maintenance Agreements

The construction or modification of a highway-rail grade crossing within SCRRA's system shall be defined in one or two agreements, ultimately culminating in a Construction and Maintenance (C&M) Agreement. In many cases, the C&M Agreement will be preceded by simple letter agreements to initiate the review of the conceptual plans, followed by more detailed agreements addressing complicated design services support, including scope development, full design, cost estimates and schedules, construction, and construction management of the railroad improvements.

Typical changes and modifications that require SCRRA review and approval to highway-rail grade crossings include, but are not limited to:

1) Interconnections with traffic signals and traffic signal preemption
2) Making enhancements to the railroad warning devices or traffic controls associated with the highway-rail grade crossing
3) Performing significant highway or pedestrian pathway work on the approaches and within the limits of the crossing
4) Adding pedestrian or bicycle paths parallel and intersecting grade crossings
5) Creating significant changes in the use of the highway approaches

6) Implementing other projects that may have a significant effect on the traffic patterns over the crossing

Before any designs can be finalized and before any construction work can begin, an agreement that includes a detailed work description must be executed between SCRRA and the highway agency and any other outside parties participating in the funding. This agreement specifies the method of payment; assigns responsibility for design, construction, funding, and maintenance; provide cost estimates of SCRRA work; and specifies the form, duration, and amount of insurance and liability. The CPUC must also approve the final design of changes and modifications to existing crossings before any construction can begin.

It is important that the development of documents outlining the responsibilities of the parties and SCRRA begin early, as the design is established in order to properly define the scope of work and the project cost. A new C&M Agreement will typically supersede any existing railroad/highway agency agreement. SCRRA will require that the funding for SCRRA services associated with highway-rail grade crossing agreements (including “Letter Agreements”, “Design Service Agreements” or “Design Scoping and Cost Estimating Agreements” as well as C&M Agreements) be deposited with SCRRA upon execution of the Agreement and in advance of SCRRA incurring any costs.

The maintenance costs associated with automatic warning devices is partially reimbursed by the CPUC for highway agencies and shall be in accordance with CPUC Code Section 1202.2**. Maintenance costs for exit gate systems, if used solely for establishing a quiet zone, shall be addressed in the C&M agreement and shall not be funded by SCRRA.**

SCRRA has developed standard specifications that define the responsibilities of contractors working within rights-of-way operated and maintained by SCRRA. The highway agency should be familiar with these specifications and include these specifications with any bid documents associated with the work at the crossing. The list of these specifications and the latest electronic version of these specifications is available on SCRRA’s website:

https://www.metrolinktrains.com/about/agency/engineering--construction

All project maintenance shall be conducted in accordance with the C&M Agreement. The highway agency shall maintain and keep in a state of good repair the traveled way, fences, gates, signs, traffic signals, landscaping, and any other improvements within the jurisdiction and ownership (or easement, or licensed traveled-way) of the highway agency.

As part of the C&M Agreement, the highway agency shall notify SCRRA within five (5) working days in advance of any maintenance activity, and within thirty (30) days in advance of any construction activity to occur within the right-of-way or as specified in the C&M Agreement with regards to work windows and construction that will require modifications to PTC databases and operating files. The highway agency shall be required to reimburse SCRRA the actual cost and expense incurred by SCRRA for all services and work performed in connection with the project, including a computed surcharge representing SCRRA’s costs for administration and management.

2.5.2 Right-of-Entry Agreements

In order for any work to be performed on any right-of-way operated and maintained by SCRRA, Right-of-Entry Agreements are required. Parties that need to access SCRRA's right-of-way shall follow SCRRA's Right-of-Way Encroachment Process to obtain the proper agreement that is needed, which is dependent on the type of work to be performed on SCRRA's right-of-way. The various types of agreements and associated SCRRA forms are as follows and can be found under the "Right-of-Way Encroachments" tab on SCRRA's website:

https://www.metrolinktrains.com/about/agency/engineering--construction.

- Form 4 – Agreement for Moving Oversized Loads Over Highway-Rail Grade Crossings
  - Required for movement of oversize vehicles over SCRRA-maintained and operated crossings.
- Form 5 – Indemnification and Assumption of Liability Agreement
  - Required for temporary or short-term uses of rights of way (such as surveying activities and shallow geotechnical investigations).
- Form 6 – Temporary Right-of-Entry Agreement
  - Required for projects involving construction on SCRRA's rights-of-way.
  - Defines the nature of the work, the flagging requirements, and the appropriate safety measures that must be in place during the work.
  - This includes all work within the right-of-way, from initial design through the completion of construction.
  - Construction on and over SCRRA's right-of-way shall meet the latest SCRRA's Standards and Criteria

2.5.3 Rights-of-Way

In many cases, railroad right-of-way on the Metrolink System is maintained by SCRRA and owned in fee by the member agencies. Highway agency or third-party projects that affect the railroad right-of-way must be coordinated with SCRRA's Engineering & Construction Department.

The modification of highway-rail grade crossings often has an effect on the existing right-of-way defining the crossing. At the earliest stages of the project, the highway agency shall determine the status of the right-of-way within the limits of the project in order to properly identify the encumbrances and issues related to the crossing.

In cases where additional right-of-way is required, the lead Engineer shall develop the appropriate mapping and right-of-way definitions in accordance with SCRRA and highway agency standards for the proper definition of the right-of-way. The application of SCRRA's standards and criteria in this Manual to a highway-rail grade crossing will likely result in the need for additional right-of-way for sidewalks, highways, or other civil features related to safety enhancements.

In most cases, the highway agency takes the lead for land acquisition. The lead Engineer shall properly define the necessary right-of-way, provide legal descriptions, and work with SCRRA's Right-of-Way Coordinator and the member agency's real estate department, as needed, to advance the process of property acquisition, easement, or preparing a license agreement.

In some cases, SCRRA also shares the right-of-way with the Burlington Northern Santa Fe Railway Company (BNSF) and the Union Pacific (UPRR) railroads. In order for work to be perform on their rights-of-way, approval shall be obtained from BNSF and UPRR.

The procedures for applying for right-of-way encroachment may be found on SCRRA's website at:

https://www.metrolinktrains.com/globalassets/about/engineering/right_of_way_encroachment_process.pdf

The SCRRA ROE Schedule of Fees can be found on SCRRA's website at:

https://www.metrolinktrains.com/globalassets/about/engineering/scrra_schedule_of_fees_for_third_party_construction.pdf

3.0 HIGHWAY-RAIL GRADE CROSSINGS

3.1 GENERAL

Highway-rail grade crossings are the level intersection of the railroad and highway, which also include the pedestrian and bicycle paths located at the edges and parallel to the highway. This chapter of the Manual provides the design standards and criteria for modifying and enhancing existing highway-rail grade crossings or constructing new highway-rail grade crossings.

3.2 HIGHWAY-RAIL GRADE CROSSING TYPES

3.2.1 Public Highway-Rail Grade Crossings

A “public highway-rail grade crossing” is a highway-rail grade crossing where the highway is owned or controlled by a highway agency; typically a city, in some cases a county, and less frequently, the state. “At-grade” public highway-rail grade crossings, also known as “level” crossings or highway-rail crossings, are locations where trains intersect with other modes of transportation, including motor vehicles, pedestrians, and bicycles.

In this Manual, the term “highway-rail grade crossing” will be used to mean rail-grade crossing, rail crossing, at-grade crossings, or crossing. The term “highway” will be used to mean highway, road, or approach road. A large majority of SCRRA’s highway-rail grade crossings are categorized as public highway-rail grade crossings. The chance for conflict at public highway-rail grade crossings increases whenever other modes of transportation are introduced which cross the traveled path of a train, and when the quantity or volume of modal traffic increases. To reduce the chance of such a conflict, appropriate warning treatments are applied to warn motorists and pedestrians of oncoming trains. Highway-rail grade crossing conflicts at public highways are exacerbated by the fact that highway agencies have a very limited ability to control the public’s access to highway-rail grade crossings; additionally, the nature of railroad operating mode does not permit trains to stop in same relative distances as vehicles.

In order to provide a consistent level of safety at the highway-rail grade crossing, warning devices such as vehicle gates, flashing lights, bells, signage, and pavement markings are incorporated to warn users of the highway-rail grade crossing of approaching trains.

3.2.2 Private Highway-Rail Grade Crossings

A “private crossing” is a highway-rail grade crossing in which the highway is owned or controlled by a private party, and not a highway agency. Private highway-rail grade crossings are generally on highways or at driveways to private property, and in many cases, are used by the private party essentially in the same manner as a public crossing. A private party normally owns the highway on at least one side.

In many cases, SCRRA, or the member agency, provides access to private property under an agreement between the property owner and SCRRA or SCRRA member agency. These highway-rail grade crossings are prevalent where a highway or driveway is used as the means of accessing private property that would otherwise be landlocked.

A private highway-rail grade crossing might also be used in cases where the railroad intersects private property and the private crossing allows necessary access between sections of the private property divided by the railroad (e.g., farmland). **All private highway-rail grade crossings shall be subject to the standards and criteria that are applied to permanent highway-rail grade crossings in this Manual.**

3.2.3 Temporary Construction Crossings (Not Used by the Public)

Temporary construction crossings shall be approved by SCRRA. Temporary construction crossings will only be considered by SCRRA where it is shown that extreme hardship and/or unusual conditions exist that justifies the crossing.

Temporary construction crossings shall not be open to the public and shall be designed and constructed in accordance with SCRRA ES 4302.

Temporary construction crossings shall be secured, gated, and locked with an SCRRA lock to ensure no access is possible when not in use. Access across temporary construction crossings shall be controlled by an SCRRA Employee-in-Charge (EIC) and shall only be used when an SCRRA EIC is present at the worksite.

Whistling point signs per SCRRA ES 5216 shall be installed 1,320’ (1/4 mile) from the centerline of the temporary construction crossing in each direction along the track and shall remain in place for the duration that the temporary construction crossing is in place. Whistling point signs shall be removed once the temporary construction crossing is removed.

Temporary construction crossings in place for 6 months or more will require a Department of Transportation (DOT) number assigned to the crossing. SCRRA will provide the DOT number upon request. Emergency Notification System (ENS) Signs per SCRRA ES 8270 shall be posted at the temporary construction crossing for the duration the crossing is in place.

3.2.4 Temporary Highway-Rail Grade Crossings (Used by the Public)

A temporary highway-rail grade crossing occurs when the highway, railroad, or both is temporarily relocated to a new location. The temporary relocations can be due to the construction of a grade separation, a railroad line change, or some other major construction project that requires the relocation of road or track. **Relocated or temporary highway-rail grade crossings shall be subject to the standards and criteria that are applied to permanent highway-rail grade crossings in this Manual.**

3.3 HIGHWAY

The overall design and requirements of the highway is set forth in the standards and criteria of the highway agency, AASHTO Publications, CA MUTCD, and Caltrans Standards, and shall be consistent with the requirements of this Manual. In most cases, the highway agency has jurisdiction over the highway, outside of the immediate area of the crossing. SCRRA and highway agency jurisdictional limits are generally defined by CPUC GO 72 and covered in more detail in the C&M Agreement, which may include project plans as an attachment, between SCRRA and the highway agency.

The overall quality of the constructed highway, including approaches to the highway-rail grade crossing and the crossing itself, shall be sufficient to:

- Provide for a smooth ride for motor vehicles at the posted speed limit.
- Provide a smooth ride for train traffic at the designated operating speeds.
- Provide safe stopping sight distances (in accordance with the posted speed limit).
- Provide adequate highway and adjacent intersection capacity so motor vehicles do not queue on the tracks.
- Include the display of appropriate signing and pavement markings.
- Provide for ADA compliance for pedestrians through the crossing.
- Minimize sight restrictions for highway users and train operations.
- Allow highway users to make clear and informed decisions that will minimize traffic congestion and the potential for conflict.
- Comply with the standards and criteria in this Manual.

On the approaches to a crossing, the characteristics of the approach highway, traffic signals, and approach sidewalks are an extremely important factor in developing an effective design of the highway-rail grade crossing.

3.4 HIGHWAY AND RAILROAD GEOMETRY

As applied to highways and railroads, geometry defines the horizontal and vertical curvature. “Crossing geometry” refers to the geometrical relationship between the alignment of the crossing highway and the railroad. This horizontal relationship may be perpendicular or skewed. The vertical relationship may include “humps” or vertical curves. These geometric features can affect traffic operations at a highway-rail grade crossing. Additional geometric concerns, such as the elevation of the crossing and the number of lanes, are also aspects that shall be considered during the design of the crossing. The geometric characteristics of a highway-rail grade crossing greatly affect the visibility of the crossing to users—motorists and pedestrians alike.

Sight distance requirements for horizontal and vertical highway geometry are defined within the Caltrans Highway Design Manual, the AASHTO Manual, the CA MUTCD, and highway agency standards and regulations. Sight distance shall be considered to the extent possible within the design of the highway-rail grade crossing geometry and provide horizontal and vertical curves that provide an unobstructed view of the crossing. The horizontal and vertical alignment of the highway at the approaches to the crossing, in addition to the geometry of the railroad tracks, are major factors in considering sight distance and overall visibility at the crossing.

3.4.1 Highway-Rail Grade Crossing Geometry

3.4.1.1 Perpendicular Crossings

It is SCRRA's policy, wherever possible, to have the highway intersect the railroad at a right angle. This highway-rail grade crossing configuration allows the most direct and safest means of traversing the railroad right-of-way. An example of a perpendicular highway-rail grade crossing is shown on Figure 3-1. **Active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast, at new or existing highway-rail grade crossings. A Special Design Consideration may be requested for active warning devices installed less than 15 feet; in no case shall an active warning device be installed less than 12 feet from the centerline of the track.** This standard is consistent with the requirement of Part 8 of the CA MUTCD. The benefits of a perpendicular highway-rail grade crossing are as follows:

- Shortest route across the crossing.
- Minimal gate-arm length and standard location for placement.
- Decreased opportunity for the wheels to become caught in the flangeways.
- Improved visibility of the highway-rail grade crossing and all approaches.

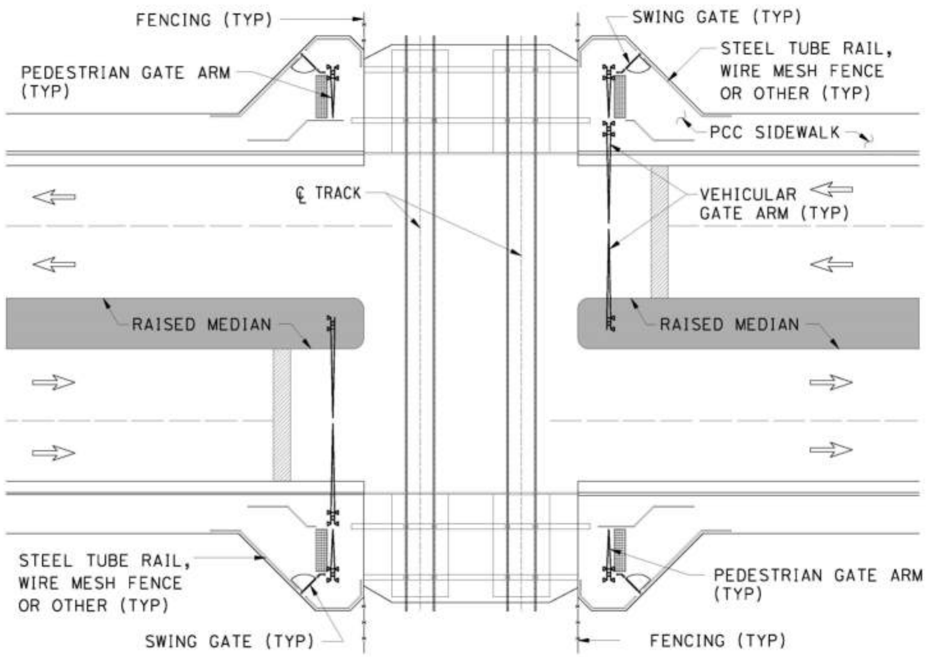


Figure 3-1. Perpendicular Highway-Rail Grade Crossing

3.4.1.2 Skewed Crossings

A skewed highway-rail grade crossing is one where the highway intersects the track at an obtuse or acute angle. Although this is undesirable highway-rail grade crossing geometry, it is often unavoidable. Examples of the standard layouts for a skewed highway-rail grade crossing are shown in Figures 3-2 and 3-3.

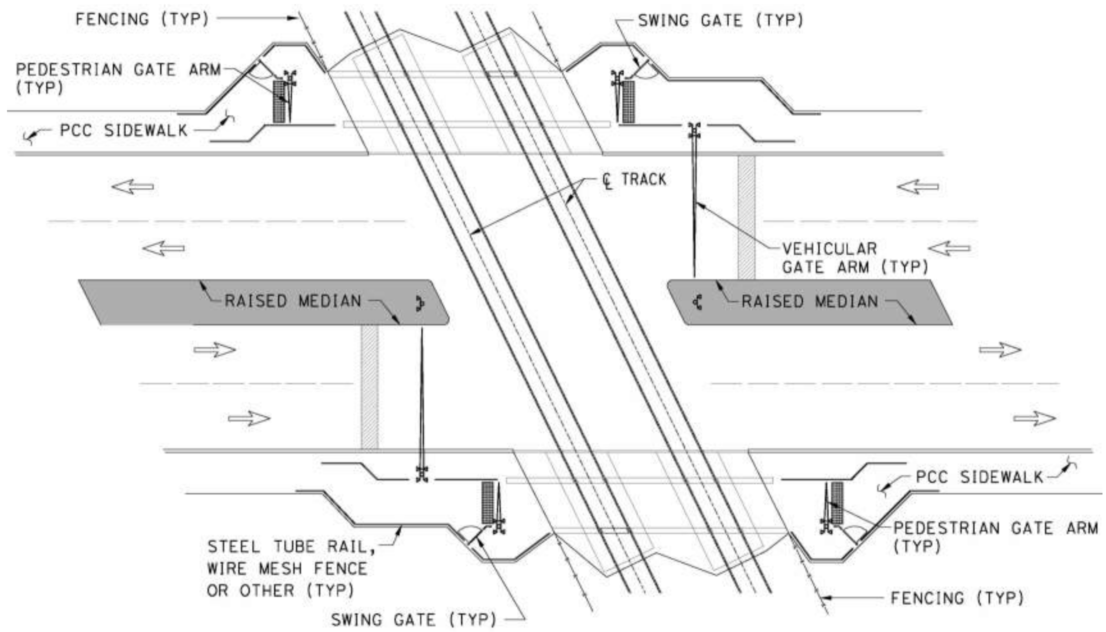


Figure 3-2. Skewed Highway-Rail Grade Crossing (Left)

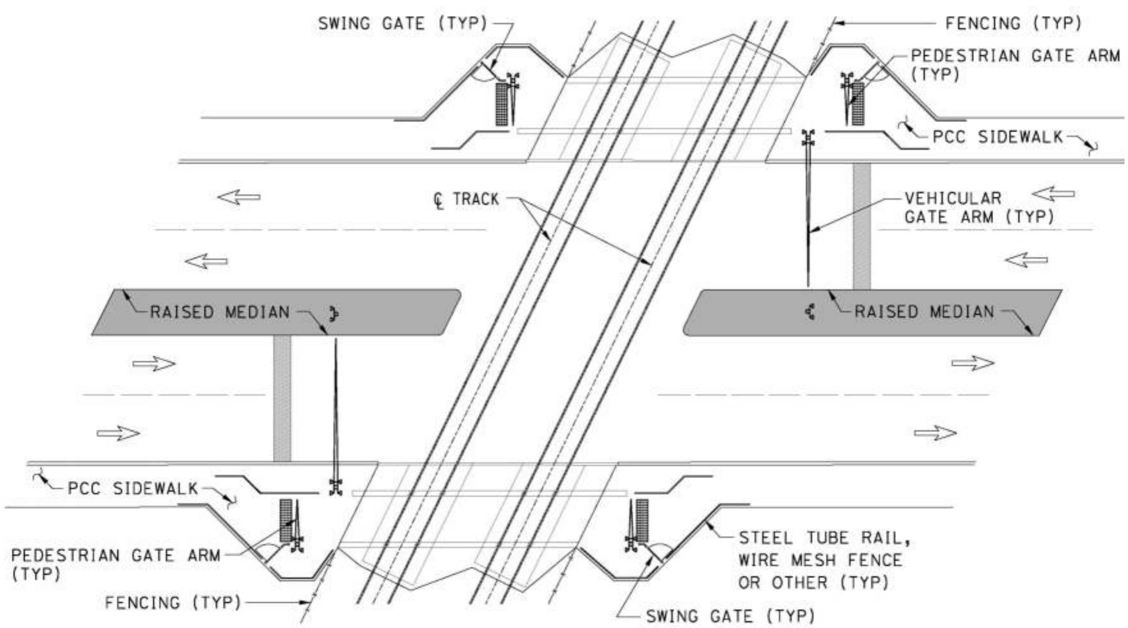


Figure 3-3. Skewed Highway-Rail Grade Crossing (Right)

A skewed highway-rail grade crossing has several undesirable characteristics, including the following:

- Increased time for motor vehicles and pedestrians to traverse the highway-rail grade crossing.
- Highway geometry may significantly increase the length of the gate arms.
- Often results in undesirable locations of highway-rail grade crossing devices that may affect overall design needs.
- Increased opportunity for wheels to become caught in the flangeways.
- Decreased visibility of the highway-rail grade crossing and all approaches.

A skewed highway-rail grade crossing introduces additional complicating factors into the design of the overall highway-rail grade crossing. Where standard applications of warning devices may be applied without modification at perpendicular highway-rail grade crossings, the skewed highway-rail grade crossing requires adapting the standard design to meet the highway-rail grade crossing angle. For example, an angled crossing may require that gates be placed at greater, nonstandard distances from the track to provide proper lane coverage.

For skewed crossings, highway active warning devices shall be installed perpendicular to the highway and 15 feet from the centerline of the track, as measured from either the center of gate mast or tip of the gate (whichever is closer). If the geometry of the highway-rail grade crossing precludes installing the gates at 15 feet from the centerline of the track, then a Special Design Consideration shall be requested to place the device closer to the crossing, but in no case less than 12 feet from the centerline of the track. Application of these standards and criteria: 1) minimizes the length of gate arms; and, 2) directs the lights on the arm along the highway approaches for maximum visibility.

When a right-angle highway-rail grade crossing cannot be achieved due to physical constraints, the interior angle shall be designed as close to 90 degrees as practical, but shall not be less than 75 degrees. Refer to Figure 3-4. In instances where this crossing geometry is satisfied, the gates shall be installed perpendicular to the highway-rail grade crossing highway. If the angle of skew must be less than 75 degrees due to physical constraints, then a highway-rail grade crossing geometry that will maximize the angle of skew shall be developed.

A significant challenge that arises with modified, nonstandard gate placement is the increased travel distance for pedestrians and vehicles traversing the highway-rail grade crossing. Configurations that will minimize pedestrian travel time between pedestrian gates over the highway-rail grade crossing, while providing pedestrian gate arms of minimum length shall be developed.

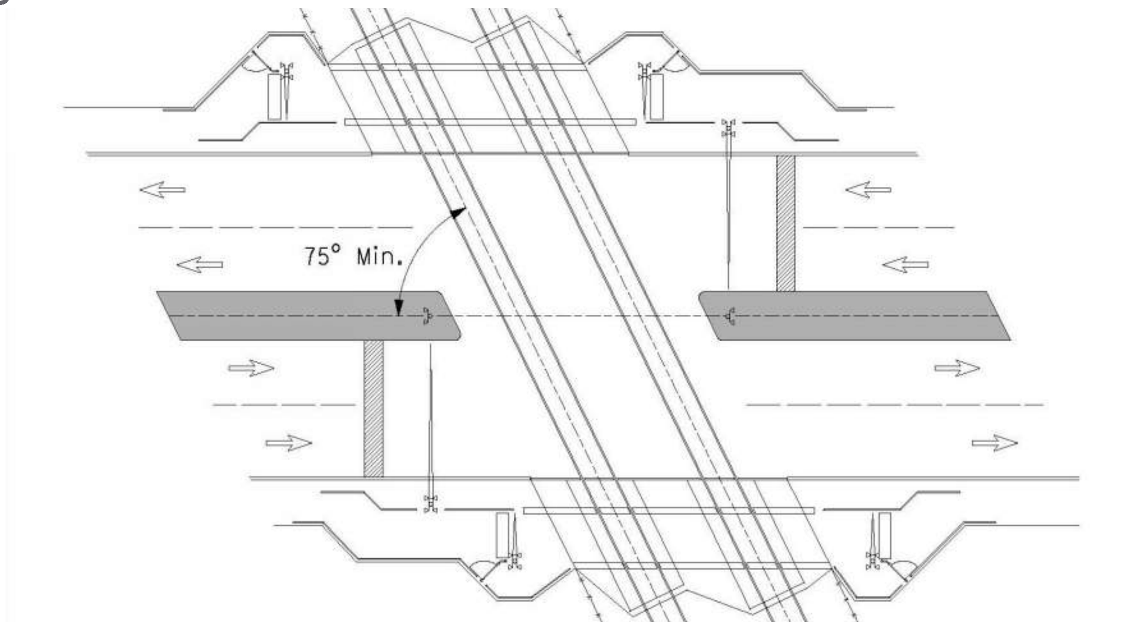


Figure 3-4. Skewed Highway-Rail Grade Crossing (75º Minimum)

3.4.2 Highway Features

Several highway features pertinent to the design of the highway-rail grade crossing must be considered to ensure an adequate design. The design should satisfy both the physical and operational needs of the railroad, as well as accommodate the traffic (vehicles, pedestrians, and bicycles) that must safely traverse the highway-rail grade crossing.

3.4.3 Level of Service

The term “Level of Service” (LOS) is normally used to describe the performance of a road or street in terms of its operational ability to meet traffic volume demands. LOS describes the operational characteristics of the traffic stream, based on qualitative measures of the highway facility. Factors that characterize LOS include vehicle speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. LOS is a mechanism used by highway departments, or highway agency, to determine if a road is operating at ideal, average, or poor efficiency. The LOS relates the quality of traffic service to given traffic volumes. The Transportation Research Board Highway Capacity Manual defines six levels of service, designated A through F, with A being the highest (free flow) and F the lowest (extreme congestion). At all highway-rail grade crossings that SCRRA owns and maintains, any major modification to the crossing should allow the crossing to perform at a level of service rating of “D” or higher.

The following factors are used to determine LOS:

Highway Factors

- Number and width of lanes

- Exclusive turn lanes
- Lateral clearance
- Horizontal and vertical alignment
- Number of access points (driveways, alleys, side streets, etc.)
- Drainage

Traffic Factors

- Free-flow speed
- Heavy vehicles
- On-street parking
- Bus stops
- Peak hour factor
- Turning movements

Traffic Control Factors

- Signal phasing
- Signal timing
- Signal cycle length
- Signal coordination
- Pedestrian phasing at crosswalks

Factors other than LOS will affect the overall operation of traffic at a highway-rail grade crossing. For example, a highway may have a LOS of ‘A’ but also have a downstream driveway that will force traffic to queue back onto the tracks in the event of a right turn into the driveway. To accommodate traffic-related issues, the design of a highway-rail grade crossing should include all aspects affecting the flow of traffic—regardless of LOS.

The LOS is affected by warning devices and signage associated with highway-rail grade crossings. Also, the LOS may directly affect the coordination between traffic signals at adjacent intersections with the highway-rail grade crossing signaling system. Refer to Section 3.13 for additional information.

3.4.4 Highway Design Vehicles

Both the highway horizontal and vertical design criteria and the design vehicles are established by the highway agency having jurisdiction over the highway. The highway shall be designed to accommodate the largest, longest, and lowest ground clearance vehicle that may be expected to traverse the highway-rail grade crossing. These vehicles and their characteristics are discussed in the AASHTO publication, A Policy on Geometric Design of Highways and Streets. In the State of California, and for SCRRA highway-rail grade crossings, **the AASHTO WB-65 semi-tractor-trailer shall be the highway “design vehicle” used for horizontal highway geometry design at highway-rail grade crossings and grade crossing approaches.** In locations where the WB-65 vehicle may be prohibited access, the mere posting of signage restricting access to a highway, such as “NO TRUCKS OVER 3 AXLES” or “NO TRUCKS OVER 3 TONS”, should not be considered a reliable deterrent for controlling truck access to a SCRRA highway-rail grade crossing.

3.4.5 Horizontal and Vertical Alignment

The horizontal and vertical geometry of the highway approaches and adjacent intersections (immediately upstream and downstream of the highway-rail grade crossing) shall safely accommodate all anticipated traffic movements and required clearances of the highway “design vehicle”.

Railroad vertical geometry is limited to relatively flat slopes and minimal changes in grades due to the railroad equipment’s physical nature and mechanical limitations. Therefore, the highway surface at a highway-rail grade crossing must conform with the railroad track profile, while providing a smooth transition to and from the crossing to allow motorist to safely and efficiently traverse the crossing.

3.4.6 Proximity to Adjacent Traffic Outlets

The design must consider highway-rail grade crossing proximity to highway intersections, alley intersections, and driveways, and the impact of adjacent traffic control devices on the operation of the highway-rail grade crossing. Refer to Section 3.6 for additional information on driveways.

3.4.7 Highway Pavement

The pavement within 50 feet of the highway-rail grade crossing should be “overdesigned” or designed to very high standards in terms of thickness, materials, and quality of construction, in order to minimize or prevent the need for any future repairs or rehabilitation. The need for a high quality, low maintenance pavement is particularly important where any exit gate loop detectors are located. Pavement repairs and rehabilitation in the vicinity of a highway-rail grade crossing can be extremely difficult, disruptive (both to motor vehicle users and to the railroad), and costly to perform, due to the difficulty of coordinating traffic outages of both the highway and railroad. Asphalts shall conform to Caltrans or Greenbook specifications and asphalt lifts shall be a minimum of 2” and a maximum of 4” to allow for proper compaction to ensure a quality pavement section.

3.4.8 Design Speed

The design speed of the highway-rail grade crossing highway is usually equal to or slightly above the posted speed limit that is set by the highway agency. The highway agency having jurisdiction over the highway-rail grade crossing shall be consulted to determine the design speed over the highway-rail grade crossing.

3.4.9 Highway Horizontal Curves

Horizontal curves in the highway may create overall visibility challenges. In many cases, enhancements to highway-rail grade crossings do not include modifications to the existing highway geometry. Often, the existing highway geometry cannot be modified due to limited right-of-way or other reasons. In cases where existing horizontal curves in the highway affect the overall visibility of the crossing, the following process shall be adhered to:

- Analyze the sight distance through the approaches to the highway-rail grade crossing, utilizing highway design criteria defined by the agency having jurisdiction over the highway.
- Determine the feasibility of highway geometry modifications to enhance the visibility of the crossing.
- Use additional signaling or warning devices as necessary to mitigate the effects of horizontal curves on visibility.

3.4.10 Vertical Profile of the Highway and Highway Cross Slope

The vertical profile of the highway is often a matter of matching existing topography with the surface geometry of the railroad highway-rail grade crossing. As a result, there may be several design options to design an efficient and safe crossing. The following items shall be followed when developing the design of the vertical profile of the highway:

- The approach grades to the highway-rail grade crossing shall be minimized. This is to allow large vehicles to properly accelerate and quickly traverse the highway-rail grade crossing when stopped before the highway-rail grade crossing warning gates. A steeper slope on the approaches to the highway-rail grade crossing will increase the acceleration time and, consequently, will increase preemption time for the traffic signals related to the crossing. Refer to Section 3.14 for additional information on preemption.
- Transitions of the edges of the pavement (EP) of the highway-rail grade crossing approach highway—from the normal 2% cross-fall (from centerline to EP) to the track grade (where both halves of the highway will slope to match the profile of the railroad track)—shall be accomplished in a manner that will not create any abrupt changes in the highway. The guidelines shown in Figure 3-5 shall be followed, to determine the length of the EP transition.
- **Vertical curves within the highway at a highway-rail grade crossing shall not be allowed.** If necessary, vertical curves should meet the Stopping Sight Distance requirements from the Caltrans Highway Design Manual, or AASHTO publication entitled A Policy on Geometric Design of Highways and Streets.
- **At highway-rail grade crossings with multiple tracks, the tops of the rails for all tracks shall be in the same plane.** If this is not accomplished, traffic tends to slow down as vehicles traverse the uneven crossing. This leads to traffic congestion and increases the probability of rear-end accidents. In addition, highway-rail grade crossing maintenance requirements shall increase due to the need for pavement repairs adjacent to, and in between, highway-rail grade crossing panels.
- The intersection of highway and railroad shall be as level as possible.
- **The highway vertical profile grade at lip of gutter pan should be 0% within 10 feet of the centerline of the nearest track and the grade can be increased to 1.11% up to 37.50 feet from the centerline of the nearest track. Beyond**

37.50 feet from the centerline of the nearest track, the grade on the approach to the highway-rail grade crossing shall be minimized, with due respect for low-ground-clearance vehicles, to allow maximum acceleration by heavy trucks. This shall minimize track clearance time during railroad preemption. Refer to Figure 3-6 and SCRRA ES 4001 for additional details. Refer to Section 3.14 for additional information on preemption and highway-rail grade crossing profiles.

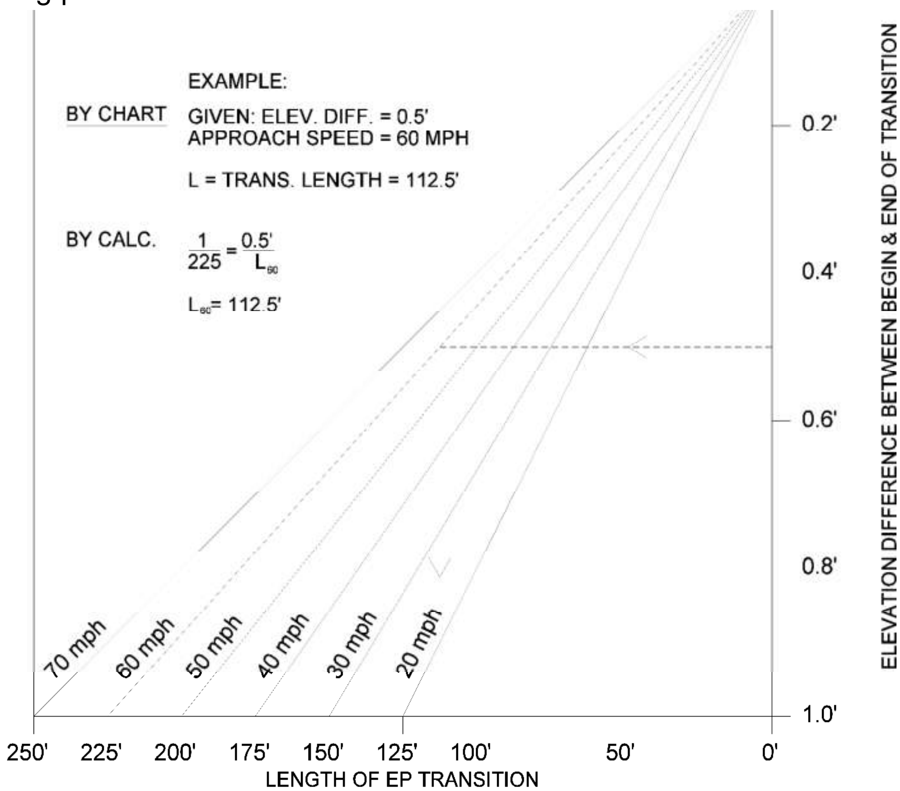


Figure 3-5. Rate of Change in Pavement-Edge Elevation Changes for Highway Approaches to Highway-Rail Grade Crossings

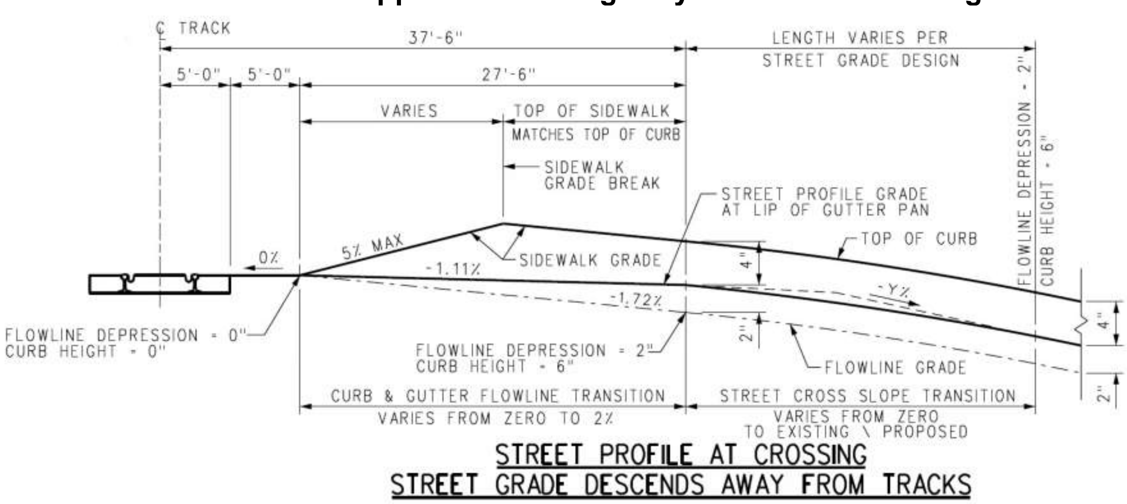


Figure 3-6. Highway Profile at Highway-Rail Grade Crossing

Often railroad tracks are constructed higher than adjacent topography to allow for proper drainage of the railroad right-of-way. This often creates a vertical "hump" at the crossing. A severe hump may cause long and low trailers to become "high centered" and stranded on the crossing. A similar situation can occur with long limousines. These trapped vehicles, in addition to stopping or slowing traffic, represent a serious hazard to both the vehicle and train.

Highway-rail grade crossing vertical profiles shall be analyzed with the Low-Ground Clearance Vehicle template to determine the clearance for this vehicle type. The Low–Ground Clearance Vehicle template has a nominal six (6) inch ground clearance. Highway-rail grade crossings should provide a minimum clearance of three (3) inches between the street surface and the lowest point on the Low-Ground Clearance Vehicle template as illustrated in Figure 3-7.

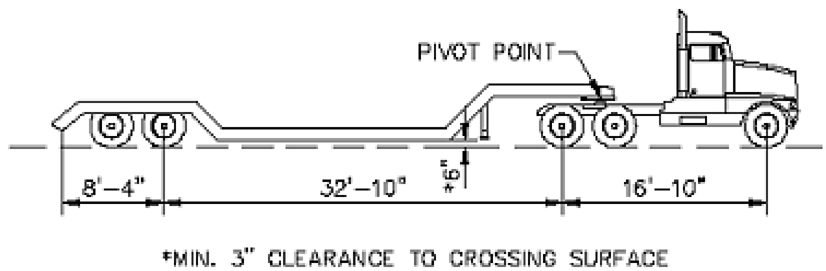


Figure 3-7. Low-Ground Clearance Vehicle Template for Highway-Rail Grade Crossing Design

All vehicles that may utilize the crossing shall be considered, regardless of posted signs prohibiting access.

In the event site conditions do not allow for the design to meet the Low-Ground Clearance Vehicle template, a special design consideration may be requested to allow a W10-5 low-ground-clearance sign (as specified in the CA MUTCD) to be installed on each approach to the highway-rail grade crossing sufficiently in advance of the crossing to allow low-ground clearance vehicles to turn around in advance of the highway-rail grade crossing. In addition, as recommended by the CA MUTCD, a supplemental message such as "Ahead," "Next Crossing," or "Use Next Crossing" (with appropriate arrows) should be placed at the nearest intersecting road where a vehicle can detour, or at a point on the highway wide enough to permit a U-turn.

3.4.11 Truck Movements

3.4.11.1 Truck Turning Capabilities

The design of improvements to the highway-rail grade crossing must factor in all likely means by which the highway-rail grade crossing shall be traversed. The design shall allow for the free movement of all motor vehicles throughout the highway-rail grade crossing envelope. In areas of heavy industrial use, truck size becomes a factor in the design of the crossing. A truck that cannot safely traverse the highway-rail grade crossing represents a serious hazard. The turning radius of the horizontal design vehicle shall be applied for all allowable turning movements, superimposing the vehicle wheel paths and vehicle body paths onto the proposed highway-rail grade crossing design. This shall be accomplished using the appropriate truck turning templates or computer software.

Figure 3-8 shows the turning radii of the AASHTO WB-65 design vehicles when traversing a designed crossing. As shown in this figure, the characteristics of the design vehicle have a major impact on the design of the crossing. Issues such as curb return radius, the placement of medians, and the overall length of medians are affected by this placement. In some cases, the installation of additional traffic control methods such as medians may not be required if the median (or other control measure) would prevent a design vehicle from safely exiting the crossing.

Effective egress shall be provided for the typical design vehicle traversing the crossing. The following steps shall be followed during the design process:

- Analyze the turning radius of the WB-65 design vehicle within the proposed design.
- Mitigate the effects of insufficient turning radius within the design.
- The lead Engineer shall demonstrate the effects of the vehicle turning radius and the swept path of the wheels and body of the vehicle on the overall design of the highway and crossing.

3.4.11.2 Truck Turning Radius Mitigations

The following mitigations shall be implemented to cope with an inadequate turning radius:

- Where multiple lanes are involved, provide for a truck's unobstructed movement, so it may easily traverse the highway-rail grade crossing without being impeded by cross traffic. This may include the use of additional traffic signaling to control cross traffic.
- Consider revising a proposed median design to allow the free movement of the truck. This may require a Special Design Consideration.

Figure 3-8 demonstrates an effective mitigation for an inadequate turning radius. In this example, the AASHTO WB-65 design vehicle is unable to remain in the curb lane throughout its right turn after exiting the crossing. The traffic signal at the intersection, which controls both the movement of the vehicle over the crossing and the cross traffic (and therefore the mitigation), was to modify the signal phasing so that the truck has a clear movement path over the highway-rail grade crossing and onto the adjacent street.

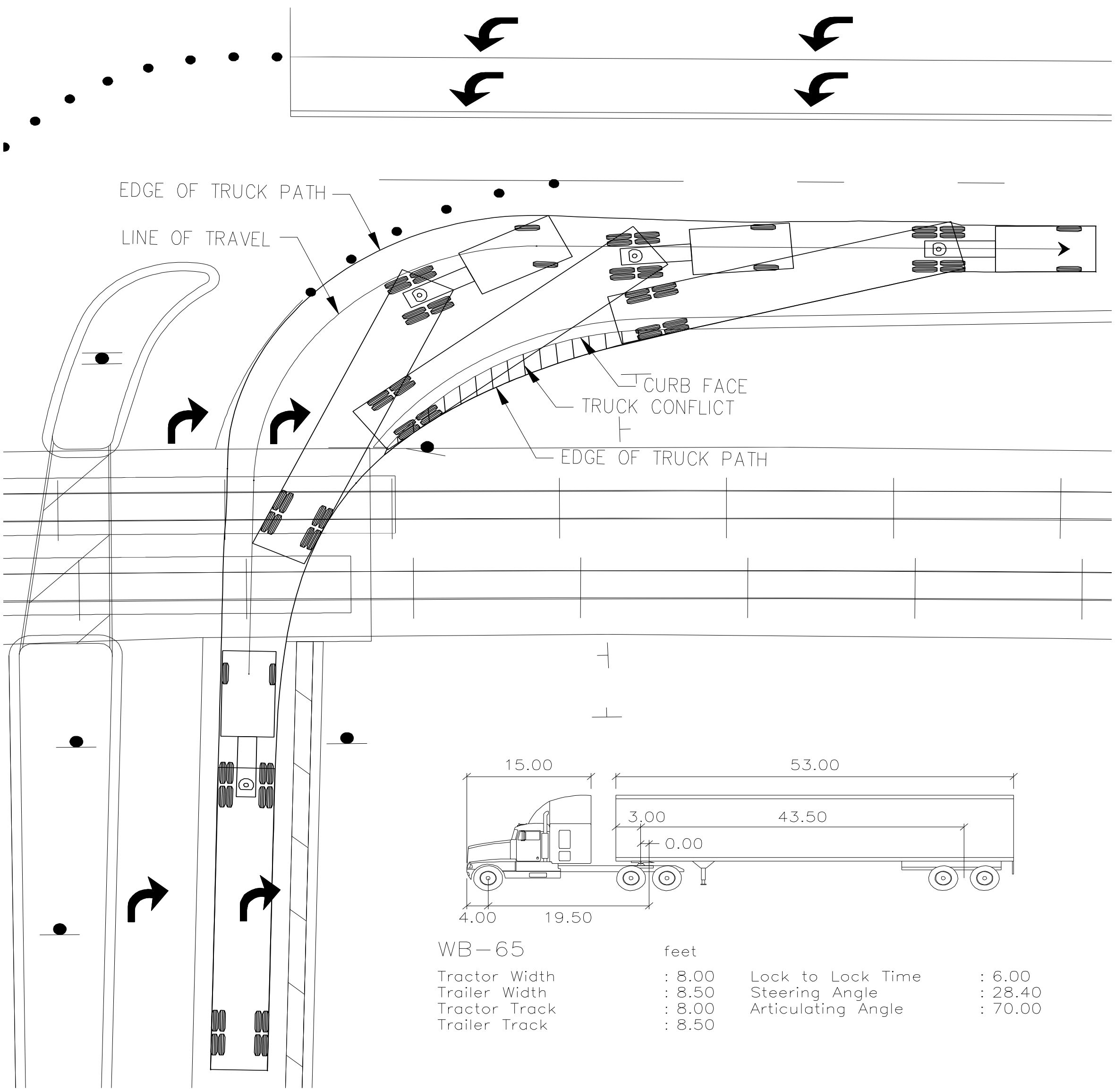


Figure 3-8. Turning Radius of the WB-65 Design Vehicle

3.4.12 Railroad Geometry and Condition of Railroad Facilities

In conjunction with investigating and analyzing the highway geometry in the vicinity of the highway-rail grade crossing, the railroad geometry and condition of the railroad facilities should also be investigated and analyzed to determine compliance with current SCRRA standards and criteria. **If the railroad geometry and facilities in the vicinity of the highway-rail grade crossing do not meet current SCRRA standards, or the railroad facilities are not in acceptable condition, the railroad facilities shall be reconstructed to correct any deficiencies.** It is very important to bring the railroad up to current standards and good condition as part of the overall grade crossing safety enhancement project: it is extremely difficult and costly to coordinate the simultaneous closure of both the railroad and highway for repair, rehabilitation, and construction activities. The overall objective should be to reconstruct both the highway and railroad elements of the highway-rail grade crossing so major repairs or rehabilitation will not be required for 20 to 30 years. Additional information regarding the design of the railroad tracks and highway-rail grade crossing facilities is included in Section 3.15.

A review and analysis of the railroad geometry is particularly important if the highway-rail grade crossing is located within, or near, a railroad curve; or if other special railroad facilities exist near the crossing such as special trackwork (turnouts and crossovers), a passenger station, or a railroad bridge. Preliminary surveys, aerial photographs, and detailed topographic maps of the grade crossing should extend outward along the railroad alignment for 1000 feet or to the end of any curves in both directions for the crossing. The survey should include: the top of rail of any track(s); the amount and location of superelevation; the beginning and end of any spirals and curves; the distance (every 100 feet) between track centerlines; and the limits of the existing grade crossing surface.

Additionally, the location of special trackwork, station platforms, bridges, wayside signals, signal or communication houses, pull boxes, longitudinal utilities (both surface and underground), and the location of all existing active warning devices should be determined. The mapping accuracy of the railroad facilities should be as accurate as the highway facilities: typically, one-inch per 40-foot scale. SCRRA should also be consulted to determine the likelihood of needing additional track or other railroad facilities, or if SCRRA plans include future tracks or other facilities; these future facilities shall be incorporated into the plans.

After the survey of the existing railroad geometry and facilities is conducted, the necessary engineering and condition analysis to determine the changes and modifications required to bring the railroad facilities into compliance with current SCRRA standards and criteria shall be performed with input from SCRRA.

3.4.13 Highway and Railroad Drainage

All surface drainage along the highway approaches to the highway-rail grade crossing and across the crossing itself shall be channeled away from the highway-rail grade crossing to minimize opportunities for hydroplaning within the highway-rail grade crossing and approaches. In particular, the following conditions shall apply to surface drainage within the area of highway-rail grade crossings:

- All surface runoff within the highway-rail grade crossing shall be collected by appropriate drainage devices outside the limits of the track structure. No surface flow shall be allowed to enter the area of the track structure.
- For all approaches to the highway-rail grade crossing, a highway cross-fall and cross-slope transition at a nominal 2% to the highway gutter shall be considered.
- Sufficient drainage and cross-flow shall be provided within the design drawings.

- Highway and track drainage systems shall be continuous within the limits of the crossing.

Poor drainage is the primary cause of track structure and highway pavement failure. In the initial analysis of a crossing, the existing conditions shall be examined to determine the effectiveness of existing drainage and any deficiencies shall be corrected. A Hydraulics and Hydrology (H&H) Analysis shall be performed to study onsite and offsite flows at and around the highway-rail grade crossing. A H&H Report shall be provided to SCRRA for review and approval; and shall include recommendations for drainage improvements to be incorporated into the project. Table 3-1 lists possible drainage issues that warrant consideration, but the scope of the improvements should follow the H&H Report.

Table 3-1. Drainage Considerations

Condition	Possible Reason	Solution
Rough crossing	Track settlement and tie or roadbed failure	Reconstruct track structure and improve drainage and roadbed
"Alligator" pavement adjacent to the highway-rail crossing panels.	Poor drainage of highway and insufficient pavement structure	Install additional catch basins. Re-profile highway to affect surface flow. Reconstruct highway with high quality low maintenance pavement
Rough pavement on approaches	Highway structure failing, or in poor condition	Reconstruct highway profile to affect surface flow. Reconstruct highway with high quality low maintenance pavement.

3.4.14 Highway Approaches

3.4.14.1 Design Requirements

Highway approaches to a highway-rail grade crossing shall, at a minimum, be designed to meet the requirements set forth in CPUC GO 72. The following highway-rail grade crossing requirements are contained in CPUC GO 72:

- Part III, Width of Public Crossings:

  [Highway-rail] grade crossings shall be a width not less than the traveled approach portions of the adjacent sections of road, highway or street, including usable shoulders and sidewalks [pedestrian pathways].

- Part IV, Minimum Width:

  [Highway-rail grade] public **crossings** hereafter constructed **shall not be less than twenty-four (24) feet wide in effective roadway width measured at right angles with the centerline of the roadway.**

- Part V, Deceleration and Acceleration Lanes:

  Deceleration and acceleration lanes for vehicles required to stop at railroad [highway-rail] grade crossings should be provided wherever public agencies [highway agencies] determine such lanes are necessary.

- Part X, Surface of Crossings:

  At the time of construction, the surface of the highway shall be installed to conform substantially to the plane of the rails for the entire area between rails, between tracks, and to lines two (2) feet outside the rails.

  Where crossings involve two or more tracks, the top of rails for all tracks shall be brought to the same plane where practicable. The surface of the highway shall be at the same plane as the top of rails for a distance of at least two feet outside of rails for either multiple or single-track [highway-rail grade] crossings. The top of rail plane shall be connected with the grade line of the highway each way by vertical curves of such length as is required to provide riding conditions and sight distances normally applied to the highway under consideration.

- Part XI, Approach Grades:

  Approach grades not in excess of six 6 percent are desirable, but where not reasonably obtainable due to local topographical conditions, the gradients in the vicinity of the rails shall be kept as low as feasible.

Often a highway intersection may be immediately adjacent to the highway-rail grade crossing. It is important that vehicles traversing the highway-rail grade crossing be given a clear avenue of escape after, or downstream of, the highway-rail grade crossing. To clarify, **a vehicle entering the footprint of the highway-rail grade crossing shall have an unimpeded means of clearing the crossing.** In cases where there is an intersection adjacent to the crossing, it may be necessary to add a refuge in the cross-traffic direction to allow a design vehicle to clear the intersection and move onto the cross street without constraining the movement of cross traffic.

3.4.14.2 Highway and Railroad Interface

The proper design of a highway and railroad interface will allow for efficient passage of vehicles and pedestrians through the crossing, as well as provide maintenance flexibility for both the highway agency and the railroad. **Sidewalks and pavement approaches to the highway-rail grade crossing shall be constructed using hot mix asphalt concrete between the crossing panels and a distance of ten (10) feet from the centerline of the track.** The use of hot mix asphalt (HMA) concrete beyond the railroad crossing panels will allow for maintenance to be performed to the highway and/or railroad independently from each other. The HMA creates a buffer between the railroad crossing panel and the highway that can be easily removed and replaced during maintenance activities.

3.5 MEDIAN ISLANDS

3.5.1 General

Installing raised medians at the centerline of highway approaches to highway-rail grade crossings is an effective way to discourage gate circumvention or making U-turns in the vicinity of the highway-rail grade crossing. As shown in Figure 3-9, the use of a median island(s) minimizes opportunities for violations by creating a well-defined corridor across the tracks. For a two-gate system, installation of median barriers can reduce violations up to 80% (source: National Safety Council and National Highway Traffic Safety Administration – Cost-Effectiveness Analysis). In addition, FRA's Final Rule on Use of Locomotive Horns lists gates with median islands, or channelization devices, as an approved supplementary safety measure for a quiet zone.

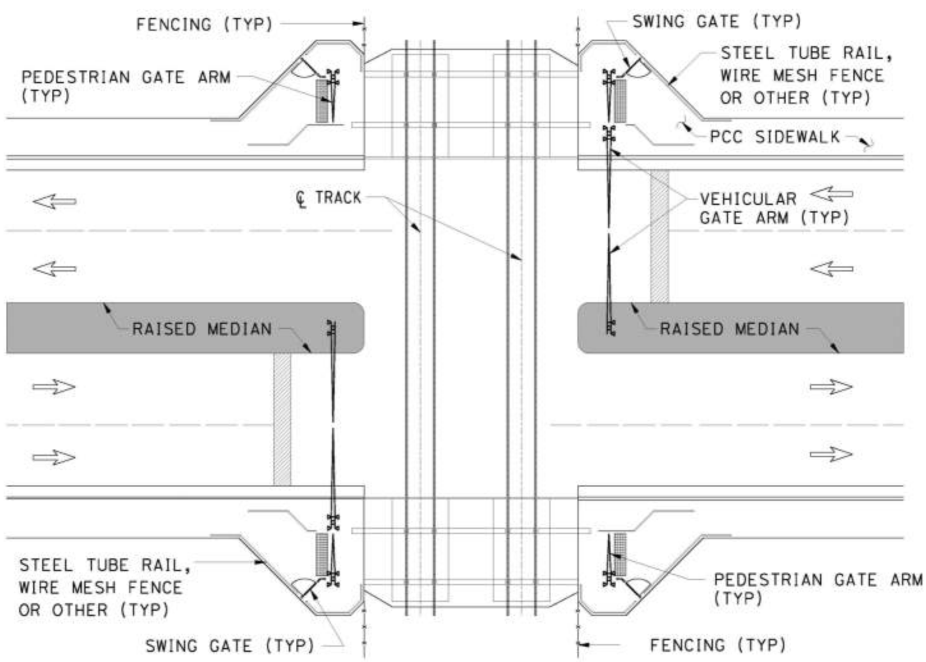


Figure 3-9. Raised Medians at a Highway-Rail Grade Crossing

3.5.2 Design Requirements

Design of median islands shall conform to the latest SCRRA Engineering Standards as well as criteria from the AASHTO publication titled A Policy on Geometric Design of Highway and Streets.

Raised median islands shall be used on both approaches to the highway-rail grade crossing to constrain undesirable traffic movements, such as driving around the automatic crossing gates or making U-turns in the vicinity of the highway-rail grade crossing.

To be effective, a raised median should be centered on the street between both directions of traffic. **On each approach to the highway-rail grade crossing, the raised median shall begin 10 feet from the centerline of the nearest track. The end of the**

median adjacent to the highway-rail grade crossing shall be square, with a six (6) inch radius on the corners to discourage motorists from making left or U-turns between the medians.

The minimum length of the median as measured from the highway-rail grade crossing gate shall be 100 feet. A Special Design Consideration will be required where the 100 feet is unobtainable, but in no case shall the median be less than 60 feet. The width of the median shall be ten (10) feet if a warning device is installed in the median and four (4) feet if no warning device is installed in the median. The minimum width of the median may be two (2) feet with the approval of SCRRA and the highway agency. Raised median curbs shall be eight (8) inches.

It is preferable that the median island width remains a minimum of 10' for the entire length of the median. However, in circumstances where ROW is limited, the median width must remain a minimum of 10' for a distance of 20' beyond the warning devices, to allow adequate room for SCRRA's signal forces to maintain the warning devices. Beyond 20' of the warning device, the median may taper down to 4' at the end of the median to limit the amount of ROW acquisition. The median island shall be continuous throughout its length without any breaks. However, there may be instances where an existing manhole or valve box must remain in its current location. In this case, the median shall be designed to accommodate access to these facilities. Wherever possible, the elimination of manholes, valve boxes, or other features requiring regular maintenance within the approaches to the highway-rail grade crossing shall be considered. Figure 3-10 shows an effective use of median islands.

Figure 3-10. Effective Use of Medians and Signage

Table 3-2 shall be used in the selection and design of medians:

Table 3-2. Standard SCRRA Applications of Medians

Design Conditions	Option 1	Option 2	Notes
Adjacent driveways	Medians to extend past driveway	Medians extending past the driveway, and shaped to limit vehicular movements	The use of the median shall effectively control vehicular activity at the driveway
Multiple lanes	Install raised medians for additional highway-rail grade crossing gates	N/A	Medians are mandatory in instances where additional gates and lights are needed for proper lane coverage
Light traffic or rural area	Install raised medians		The use of the median shall effectively control vehicular activity
Limited highway right-of-way	Install raised medians	Install raised delineators	The installation of medians may require the acquisition of additional highway right-of-way
Insufficient truck turning radius	Extend median to the maximum length that still accommodates truck movements, and consider exit gates	N/A	Truck turning radius may be a defining component on the use of exit gates
Insufficient right-of-way for a raised median	Acquire additional right-of-way for the installation of the raised median	Consider the use of raised delineators, but only if right of way acquisition is not possible	The installation of delineation between traffic directions may be needed if the acquisition of additional right-of-way is not an option

In addition to preventing vehicles from driving around gates, well designed medians limit movements out of driveways near highway-rail grade crossings, as discussed in Section 3.5, thus minimizing vehicle queuing hazards associated with cross-traffic vehicle movements.

The primary median width requirement, per CPUC, is that there shall be a minimum horizontal clearance of two (2) feet between the railroad flasher backplate and the face of the curb. The lead Engineer shall plan for future highway uses when considering the ultimate width of the median. The position of the median gate counterweight, when the gate is in the horizontal position, must also be considered.

3.5.3 Median Islands versus Exit Gates

Two mitigation methods can minimize the opportunities for motorists to circumvent crossing gates:

- The use of a median of sufficient length and height, eight (8) inches high and preferably 100 feet long (measured from the gate), to prevent motorists from driving around the lowered gate.
- The installation of exit gates, as discussed in Section 3.10.3.2, at the crossing, blocking motorists from entering the highway-rail grade crossing when gates are lowered.

3.5.4 Median Landscaping

In general, **trees, shrubbery, and similar view obstructing landscaping are not allowed on highway approaches within 150 feet of a highway-rail grade crossing. Low maintenance stamped concrete, pavers, or other hardscape materials shall be the standard landscape treatment for median islands and sidewalk approaches.**

3.6 DRIVEWAYS

The location of driveways, alleys, or similar facilities (with respect to the highway-rail grade crossing) can significantly affect the safety associated with highway-rail grade crossing operations. Driveway locations, in relation with highway-rail grade crossings, are defined as near-side or far-side.

- A near-side driveway is defined as a driveway that is located on the crossing approach prior to, or upstream of, the crossing. An example of this type of driveway is shown in Figure 3-11.

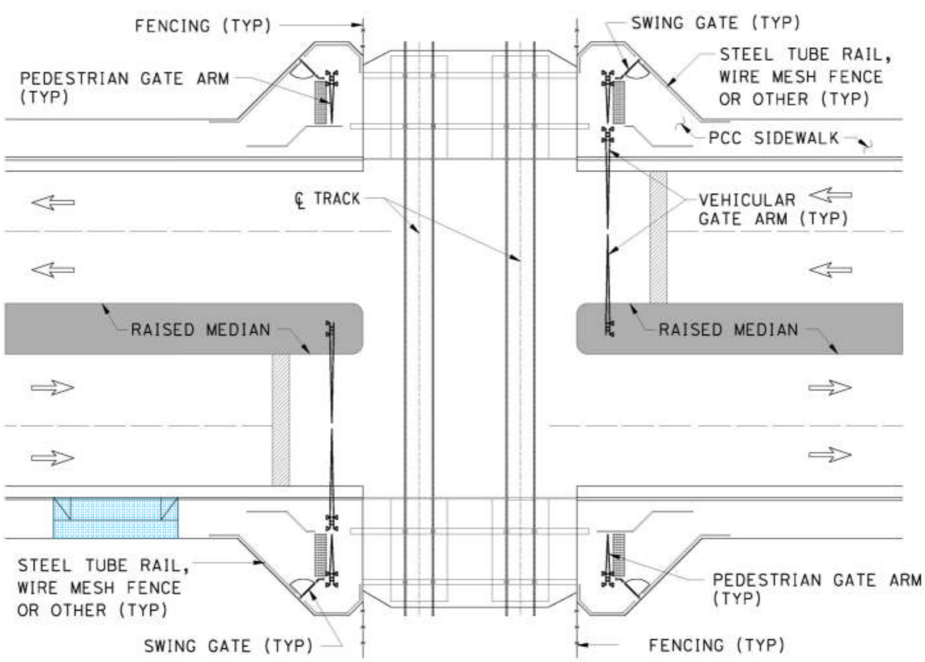


Figure 3-11. Near-Side Driveway at Highway-Rail Grade Crossing

- A far-side driveway is defined as a driveway located beyond, or downstream of, the highway-rail grade crossing as shown in Figure 3-12.

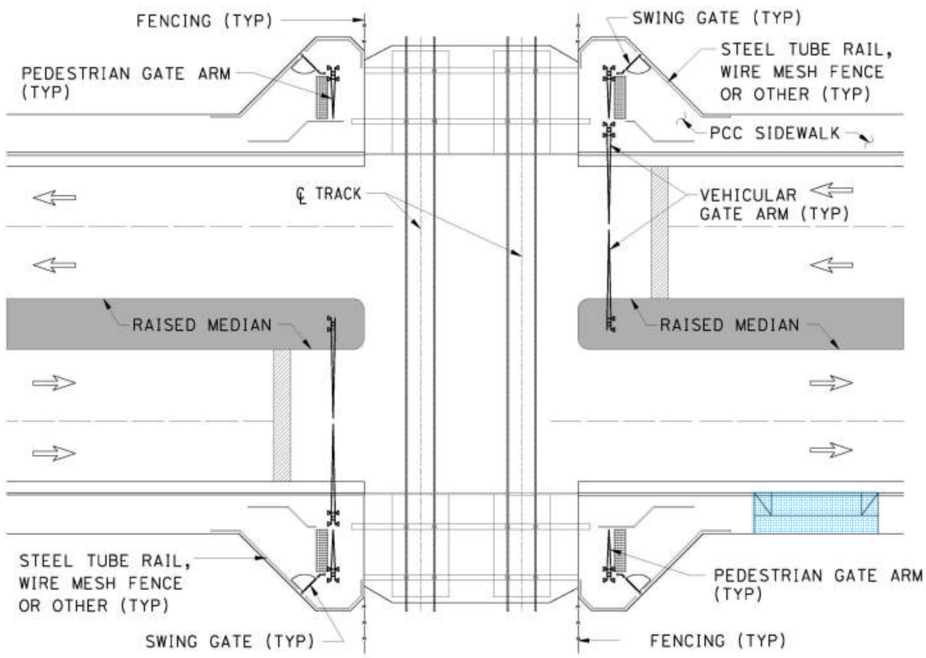


Figure 3-12. Far-Side Driveway at Highway-Rail Grade Crossing

New driveways (private or public) shall not be located within 100 feet of the nearest highway-rail grade crossing active warning gate. Existing driveways within 100 feet of the nearest highway-rail grade crossing active warning gate shall be removed or appropriately reconfigured to achieve safety objectives.

Vehicles entering and exiting a driveway immediately adjacent to a highway-rail grade crossing can affect the traffic flow over that crossing. In particular, vehicles making right or left turns into, or out of, the far-side driveway may force approaching traffic to slow or stop, which may result in queuing over the crossing. Where there is an existing near-side or far-side driveway, the first choice is to eliminate the left turn into, and out of, the driveway by providing raised median islands, and using other measures coordinated between the highway agency and the property owner. This shall minimize the opportunity for vehicles to be stopped on the tracks by uncontrolled cross traffic.

Another solution for the mitigation of an existing driveway adjacent to a highway-rail grade crossing is the use of a shaped median in the driveway. The shaped median allows for a right turn out of the driveway while eliminating turning movements toward the highway-rail grade crossing. An example of shaped median in the driveway is shown in Figure 3-13.

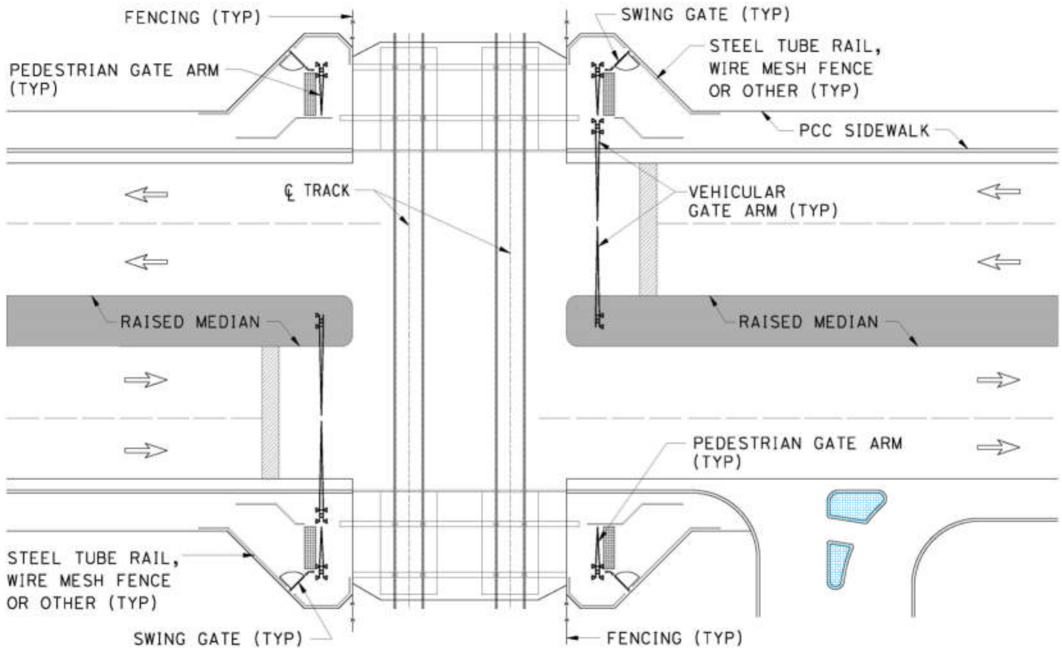


Figure 3-13. Use of a Shaped Median to Control Access

Table 3-3 below shall be consulted for the design of mitigations when driveways are located adjacent to the crossing:

Table 3-3. Standard Mitigations for Driveways Adjacent to the Crossing

Driveway Location	Raised Medians	Signage	Warning Gates	Traffic Control
Near-side	• Yes	R3-5 (RT) “Right Turn Only” sign	• Installed at entrance quadrant	Consider traffic signals in cases of large traffic volumes
Far-side	• Yes • Install island at the driveway to prohibit left turns toward the tracks (see Figure 3-13)	R3-5 (RT) “Right Turn Only” sign	• Installed at entrance quadrant • Exit gates if there is a possibility of unsafe access through the median	Consider traffic signals in cases of large traffic volumes

During the design of the highway-rail grade crossing, the type of vehicle that will use the driveway and how the driveway will be used shall be evaluated. The actions of vehicles and motorists using the highway-rail grade crossing should be observed during the diagnostics and field reviews, and findings incorporated into the design.

Driveways adjacent to a highway-rail grade crossing which require vehicle reversing (backing) movements shall not be allowed and the highway agency shall prohibit the reversing moves. If the driveway can only be accessed by a backing movement by the design vehicle, then this driveway will need to receive one of the following mitigations to eliminate this unsafe way to access the driveway:

- Relocate the driveway to provide sufficient turning capability for the design vehicle.
- Modify the loading/unloading area/location to provide sufficient turning capability for the design vehicle so that a reverse movement into the driveway is not required.
- Widen the highway so the design vehicle can exit the travelled way and provide sufficient turning capability for the design vehicle.

In some instances, there may be a near-side driveway that leads to a truck loading dock as shown on Figure 3-14. In this case, the truck may drive past this near-side driveway, back over the tracks and, while backing up, turn into the near-side driveway to line up to access the loading dock. **The design and actual usage of the driveway shall not allow the reverse movement of vehicles through and over the highway-rail grade crossing while entering or exiting the driveway.**

In such instances, the highway agency shall endeavor to close the near-side driveway or work with the adjacent property owner to control this access or address the unsafe vehicle movements. **Special traffic signage shall be installed to control undesirable traffic movements, especially reverse or slow movements into or out of driveways near tracks.**

Figure 3-14. Loading Dock Adjacent to Right-of-Way

3.7 VISIBILITY

It is SCRRA's policy to work jointly and responsibly with highway agencies, and other adjacent private property owners, to ensure that proper visibility is maintained at the highway-rail grade crossing. Buildings, fences, walls, billboards, highway geometry, trees, vegetation, natural or man-made embankments, or other man-made structures will play a significant role in the overall visibility at the highway-rail grade crossing, and these features will become important in the geometric design process. Motorists should be able to visually detect the presence of the highway-rail grade crossing, identify and react to the type of traffic control devices at the crossing, and determine whether a train is approaching or occupying the crossing. The CA MUTCD requires that all advance warning signing, pavement markings, and highway-rail grade crossing warning devices be clearly visible to the approaching motorist.

Horizontal and vertical curves within the highway near, or at, the highway-rail grade crossing create additional concerns. In cases where the sight distance is not sufficient to allow adequate braking prior to the crossing, the the need for advance warning devices should be examined.

Of particular concern is stopping sight distance near and across the highway-rail grade crossing. Refer to Sections 3.4.9 and 3.4.10 for highway geometry that affect stopping sight distance. All aspects of the highway geometry shall be examined and follow the Caltrans Highway Design Manual or AASHTO publication titled "A Policy on Geometric Design of Highways and Streets" requirements for stopping sight distance. Developments consisting of structures often border the railroad right-of-way that prevent the motorist from clearly seeing down the tracks when approaching the crossing. During the design phase, all measures for improving visibility at these crossings shall be examined and any detected hazards shall be mitigated.

The following actions shall be taken during the design of a grade crossing to preserve and improve visibility at highway-rail grade crossings:

- Prohibit new trees at highway-rail grade crossing approaches and medians, and ensure existing trees are trimmed for proper visibility.
- Prohibit new ground covers or shrubs exceeding 36 inches in height, and ensure the existing trees are trimmed for proper visibility.
- Investigate the possibility of mitigating the effects of adjacent development on overall visibility at the crossing.
- Ensure stopping sight distances are per the Caltrans Highway Design Manual or the AASHTO publication titled "A Policy on Geometric Design of Highways and Streets".
- **Vehicle parking within 100 feet of the highway-rail grade crossing, as measured from the furthest automatic warning device from the tracks, shall be prohibited.**

Figure 3-15 is an example of how visibility can be impaired at a highway-rail grade crossing by highway geometry and landscaping.

Figure 3-15. Restricted Visibility at a Highway-Rail Grade Crossing Approach

Note the following items:

- Advance warning signs are obscured by trees.

  Mitigations:

  - Relocate signs where they will not be obscured by trees.
  - Avoid the planting of trees adjacent to advance signs.
  - Work with the highway agency to adequately maintain trees and landscaping.

- Advance visibility of vehicles downstream of the highway-rail grade crossing is impeded by geometry. The vertical curve at the highway-rail grade crossing may prevent the motorist from seeing possible highway obstructions concealed by the highway profile.

  Mitigations:

  - To the extent possible, design highway geometry to eliminate these cases.
  - Install advance warning signs to warn motorists.

Regular trimming of vegetation along the approaches to the highway-rail grade crossing is an important responsibility of the highway agency or private property owner.

3.8 SIGHT TRIANGLES

It is SCRRA's policy to work jointly and responsibly with highway agencies, and other adjacent private property owners, to ensure that improvements to properties adjacent to the railroad corridor, and particularly at highway-rail grade crossing, are designed so as to mitigate the effects of the development on highway-rail grade crossing safety.

A sight triangle is the triangular area of visibility required to allow a driver to see an oncoming train (approaching from either direction) in advance of the crossing. The stopping sight distance is measured along the highway and is a function of the distance required for the design vehicle, traveling at the posted speed limit, to stop safely.

The use of the sight triangle for highway-rail grade crossing design is an effective tool for the development of the overall design, as well as to mitigate the effects of restricted visibility. The FHWA handbook shows a calculation used to determine sight triangle distances. Unfortunately, urban areas seldom have the proper site triangle (as shown in the FHWA handbook). In these cases, signal timing, and highway-rail grade crossing warning device timing, must provide adequate warning to enable the motorist to stop prior to the crossing.

The effects that commercial or residential development can have on the visibility at a highway-rail grade crossing are shown in Figure 3-16. The sight triangles for this highway-rail grade crossing show the effective visibility of the highway-rail grade crossing from the motorist's perspective. This figure demonstrates the effect on overall visibility when buildings are placed adjacent to the right-of-way. The solid green fill shows a constricted sight triangle resulting from the location of proposed buildings on a development site adjacent to the railroad right-of-way.

Figure 3-16. Sight Triangle Impeded by Adjacent Buildings

Figure 3-17 demonstrates the same building configuration relocated to the backside of the property, which results in much improved visibility of the track area. Although this realignment of the buildings does not alter or impair the overall use of the property, it is an effective way of improving visibility and places driveways away from the highway-rail

grade crossing.

Figure 3-17. Sight Triangle Enhanced through Alternative Placement of Buildings

3.9 PASSIVE TRAFFIC CONTROL DEVICES

Passive warning devices are traffic control warning devices not activated by trains, vehicles, or pedestrians. Passive warning devices provide static messages of warning, guidance, and (in some instances) mandatory action for the motorist, bicyclists, or pedestrian. Their purpose is to identify and direct attention to the location of a highway-rail grade crossing in order to permit motorists, bicyclists, and pedestrians to take appropriate action. Passive warning devices consist of regulatory, warning, and guide signs, along with supplemental pavement markings. Passive warning devices shall be incorporated into the design of active traffic warning devices. The application of passive warning devices is defined in Part 8 of the CA MUTCD.

3.9.1 Signage

The application of signage at highway-rail grade crossings is defined in Part 8 of the CA MUTCD and SCRRA ES 4006. The requirements within this section of the CA MUTCD for the proper application of highway signs at the crossing and SCRRA ES 4006 shall be adhered to.

The highway agency is responsible for approving the use of highway signs. Design of

highways signs at and around highway-rail grade crossings will require coordination between the highway agency and the lead Engineer.
In addition to highway signs to be installed at the highway-rail grade crossing, there may be additional signs required to inform the public of what they can and cannot do at a highway-rail grade crossing, such as “No Trespassing” and “Emergency Notification” signs. Installation of such signs on SCRRA’s member-owned right-of-way shall be installed per the latest SCRRA Engineering Standards.

Emergency Notification Signs (ENS) - Grade Crossing Emergency Notification Signs are signs that are placed on each highway approach to the railroad. Each blue sign is mounted on the highway approach side of the gate mechanism mast and identifies the Metrolink Grade Crossing Hotline number: (888) 446-9721 and crossing specific information that can be used by motorists or pedestrian to report emergencies involving the crossing. These signs are required by the Code of Federal Regulations Title 49 Part 234.311 and sign specifications are identified in SCRRA ES 8270. See Figure 3-18 for an example for placement of an Emergency Notification Sign.

Figure 3-18. Emergency Notification Sign Placement

3.9.2 Pavement Markings

Striping and pavement marking are defined within Part 8 of the CA MUTCD and SCRRA ES 4006. The configuration and location of striping shown in Chapter 8 of the CA MUTCD and SCRRA ES 4006 shall be adhered to.

SCRRA has defined additional striping and delineation requirements that apply to highway-rail grade crossings where SCRRA is jointly responsible with the highway agency. These measures include the following:

- Striping with raised pavement markers along edge of travel way: (SCRRA ES

4011 through 4017)

- Striping with raised pavement markers between medians: (SCRRA ES 4011 through 4017)
- Possible use of “KEEP CLEAR” pavement markings: (Caltrans Standard A24E)
- Possible use of “WAIT HERE” pavement markings: (Caltrans Standard A24D)

The highway agency is responsible for approving the use of highway pavement markings. This will require coordination with the highway agency. Maintenance responsibilities for striping and pavement markings are the responsibility of the highway agency, unless defined otherwise in the C&M agreement. Also, refer to CPUC GO 72 for additional maintenance responsibilities between the highway agency and the railroad.

3.10 ACTIVE TRAFFIC CONTROL DEVICES

3.10.1 General

All SCRRA “main track” public highway-rail grade crossings shall be equipped with active warning devices used to warn vehicles and pedestrians of potential hazards at the crossing, in accordance with CPUC GO 75, this Manual, and the CA MUTCD. Furthermore, it is SCRRA’s policy that any new SCRRA “main track” private highway-rail grade crossing shall be equipped with standard equipment at the private owner’s expense. (Refer to Appendix A for the definition of SCRRA “main track”).

Each of these types of devices is designed to fill a need at the highway-rail grade crossing to effectively warn of approaching trains. The placement of these devices is an important factor in the development of the highway-rail grade crossing and must be considered during design. It should be noted that these devices may be installed at locations other than at highway-rail grade crossings to ensure proper advance warning of oncoming trains.

3.10.2 Design Requirements

Warning gates are physical barriers that obstruct the entrance to the highway-rail grade crossing upon activation by an approaching train. The placement of active warning devices is an important factor in the overall design process. Baseline criteria have been developed to use for guidance in the placement of the highway-rail grade crossing devices. It is SCRRA standard to provide flashing lights for each traffic lane approaching the highway-rail grade crossing. For more detailed information on the location, dimensions, selection of warning devices, and how the railroad signaling system works in conjunction with the warning devices, refer to SCRRA’s Engineering Standards for Signals and Communications.

Each warning device is constructed on a substantial foundation required for the safe support of the device. These foundations may require a large footprint and must be considered in the placement of the device. The utilities and drainage associated with the highway-rail grade crossing shall be considered when developing the overall layout of the devices. Additionally, the position of present and future foundations must be taken into account when considering utility encroachment—it may be necessary to relocate utilities and other facilities that could interfere with these foundations. Consideration for

conflicts of overhead utility wires and gate arms should also be considered during the development of the overall device layouts.
Flashing signals are mounted on the mast or on an overhead cantilever to provide a visual warning of an oncoming train. These lights are directed toward the highway approach. In some cases (such as with adjacent driveways and highway), additional auxiliary lights are necessary to provide visual warning for each approach to the crossing.

Applications of warning gates and flashing signals (Automatic Warning Devices) are shown in Figure 3-19 through Figure 3-22. For additional information on the various types of warning devices, refer to CPUC GO 75 and SCRRA Engineering Standards. In addition, a crossbuck, and a sign indicating the number of tracks (if two or more tracks are present) at the crossing, is mounted on each gate to indicate the presence of multiple tracks at the crossing.

Some applications of flashing signals include backlights mounted on the mast in addition to the standard flashing signal configuration. *SCRRA's policy is to not use backlights on exit gates and median mounted entrance gates to avoid motorist confusion.*

When the use of a Standard No. 9 Gate (see Figure 3-21) is defined by SCRRA's Engineering Standards, the flashing light mounted on the mast shall provide warning for the curb and the traffic lane. If there is more than one lane, and highway width is greater than the maximum length of the single gate arm, an additional device on a raised median will be required adjacent to the second lane. Backlights shall not be mounted on median warning devices to avoid motorist confusion. A No. 9-A cantilever signal (see Figure 3-22) may be used in order to place the light over the traffic lane.

Where pre-signals are installed, the locations of both the railroad and traffic signals shall be evaluated to ensure the combination of traffic lights and highway-rail grade crossing warning lights is coordinated and do not conflict with one another, thus mitigating possible confusion for motorists approaching the tracks. Final configuration and types of proposed warning devices is subject to approval by SCRRA.

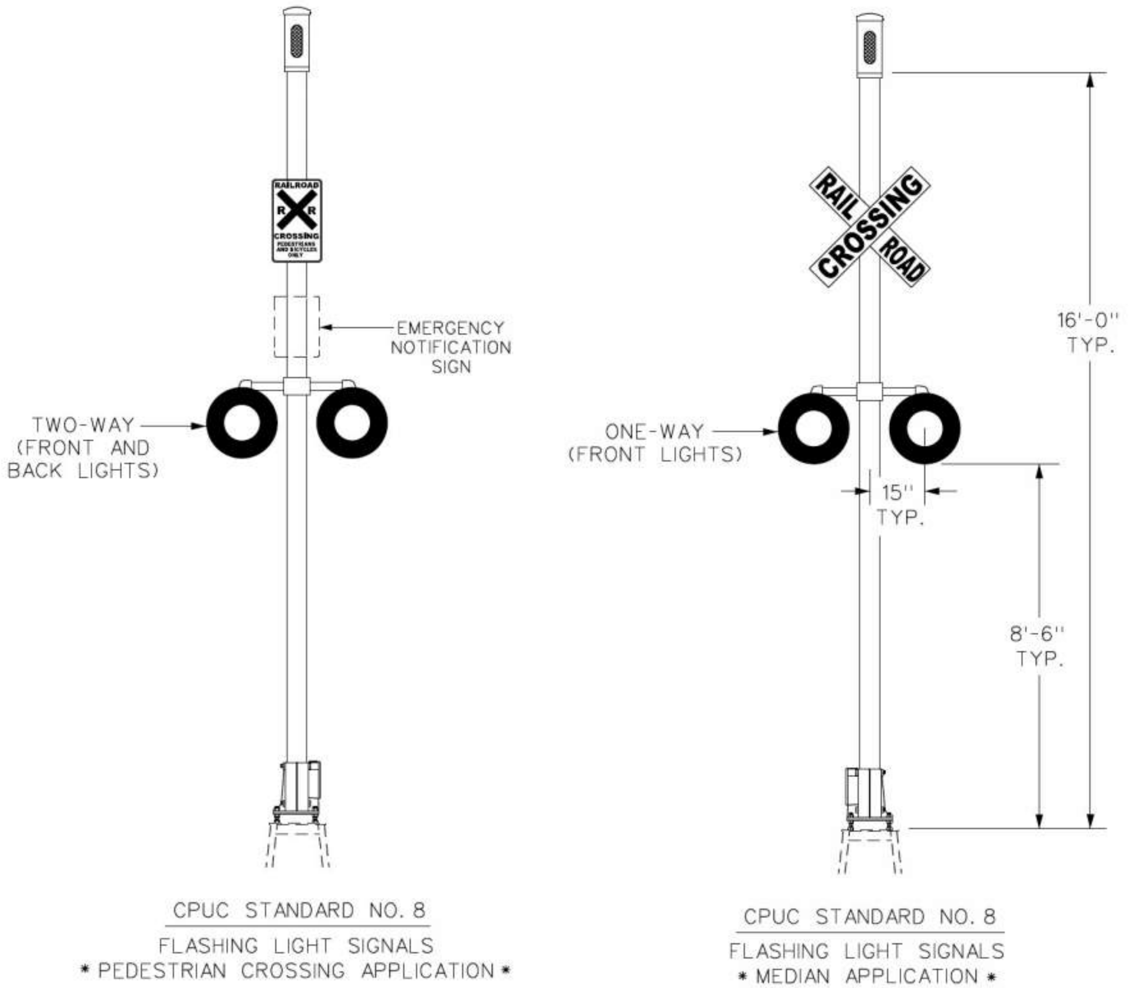


Figure 3-19. Active Warning Device Mechanisms – Standard No. 8 Pedestrian Crossing Application (Left) and Standard No. 8 Median Application (Right)

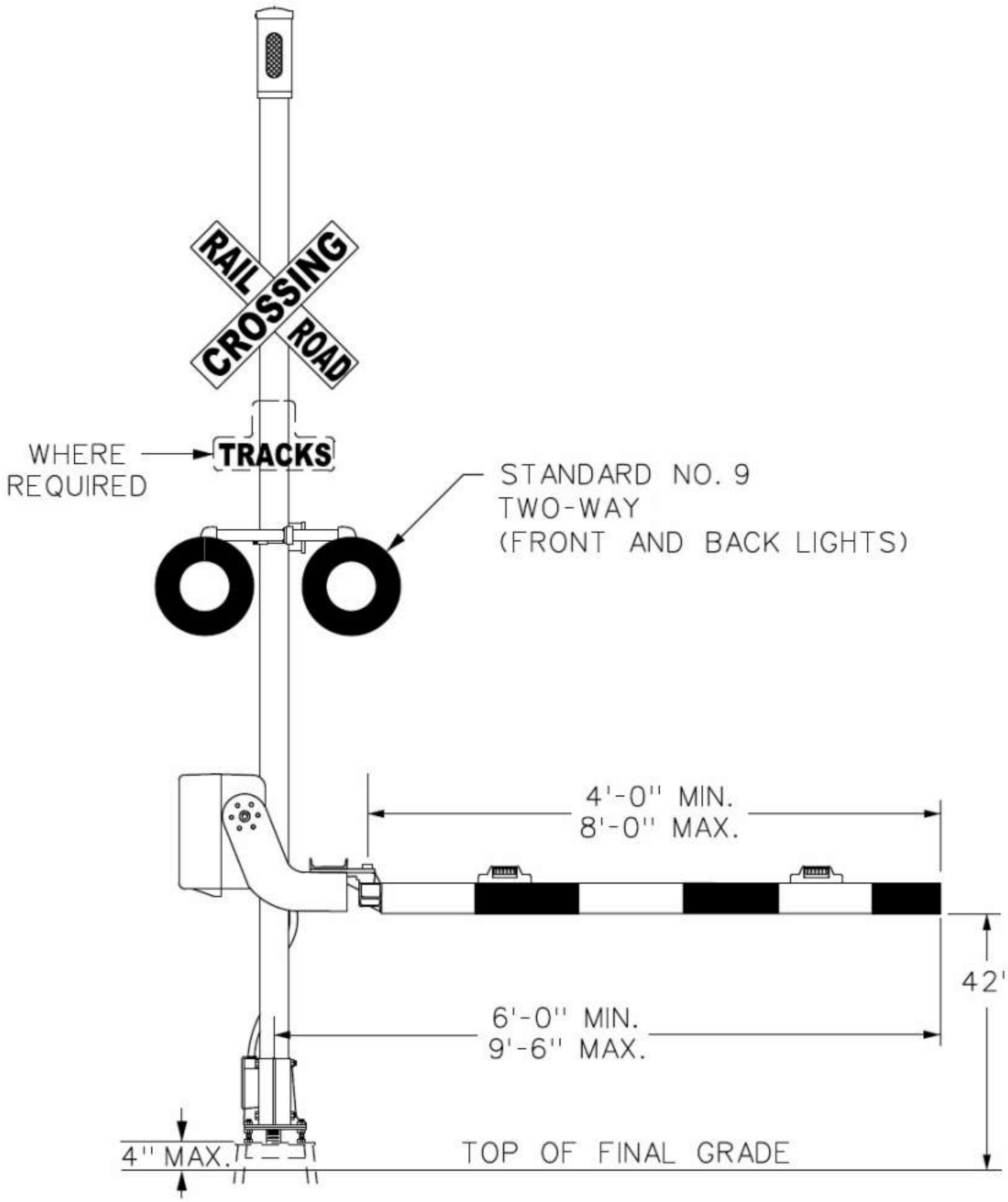


Figure 3-20. Active Warning Device Mechanisms – Pedestrian Gate

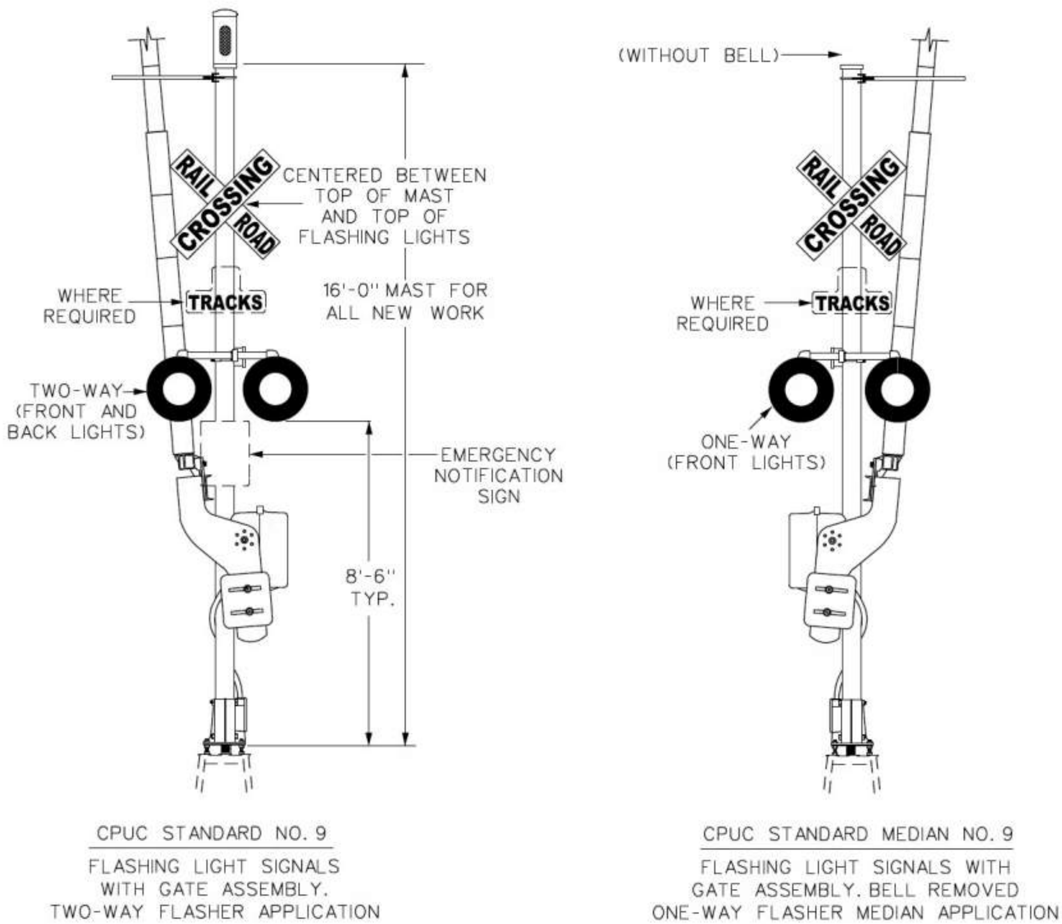


Figure 3-21. Active Warning Device Mechanisms – Standard No. 9 Curb Application (Left) and Standard No. 9 Median Application (Right)

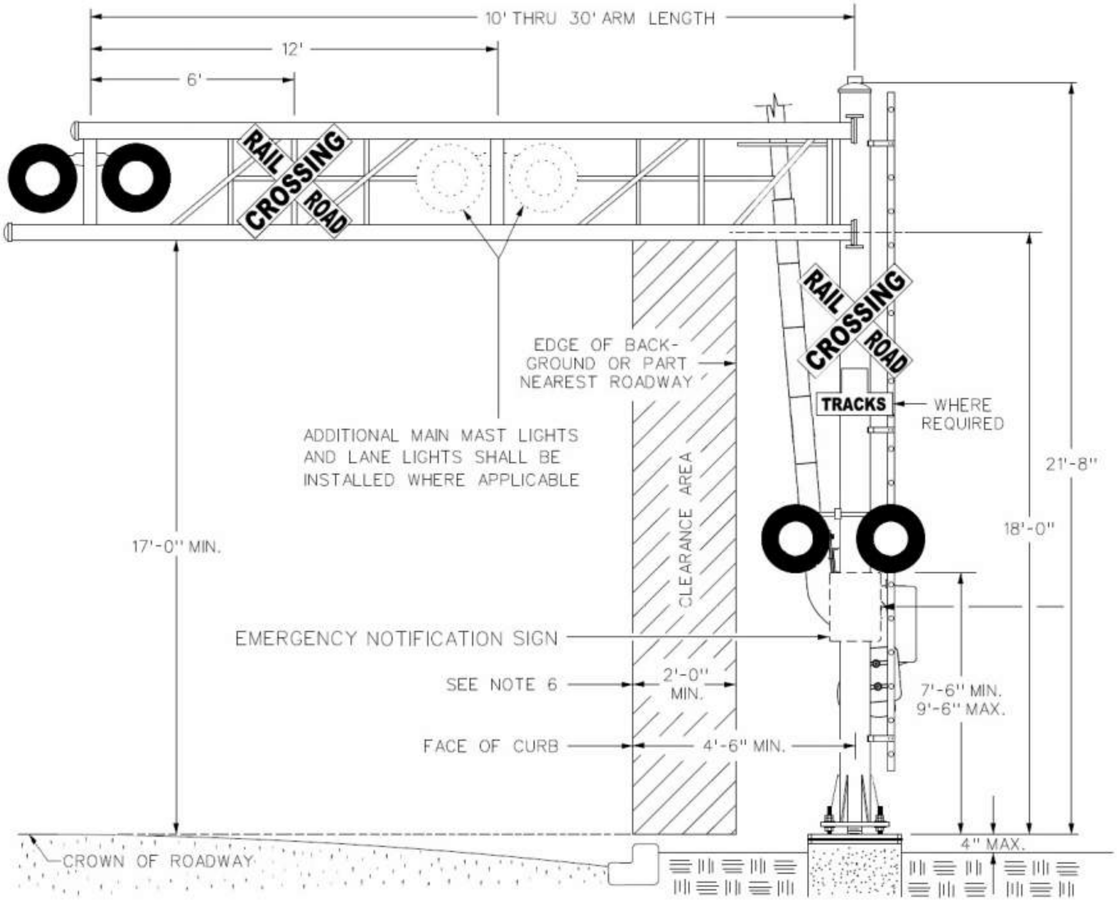


Figure 3-22. Active Warning Device Mechanisms – Standard No. 9-A

3.10.3 Crossing Gate Systems

3.10.3.1 Entrance Gate System

Standard gate systems utilize gates installed on the entrance, or upstream, quadrant of the highway-rail grade crossing. These gates are intended to prevent the motorist from proceeding into the path of the train when the gate is in the horizontal position. See Figure 3-23 below.

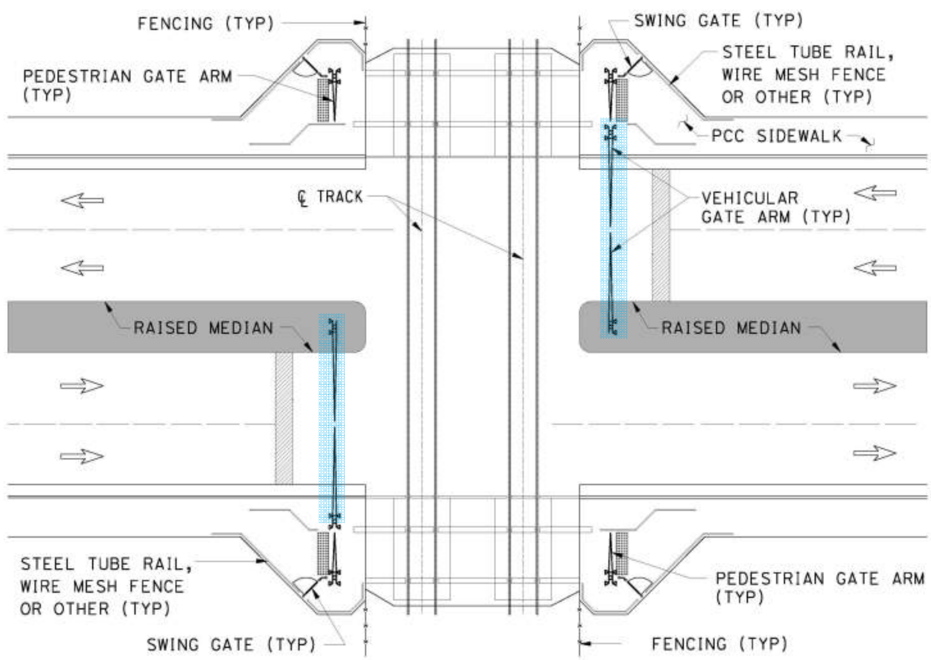


Figure 3-23. Two-Quadrant Gate System

3.10.3.2 Exit Gate System

Exit gates are gates installed on the exit, or downstream, quadrant of the highway-rail grade crossing and are usually installed in conjunction with the standard entrance gate system as an additional safety measure. **Exit gates shall only be used as a last resort, when all other options to mitigate gate circumvention have been exhausted and an exit gate system is the only feasible option. With the exception noted in Section 3.10.4.1, a Special Design Consideration and approval from SCRRA is required for all applications of exit gates.** All options to mitigate gate circumvention shall be evaluated, including the use of raised medians as discussed in Section 3.5 of this Manual, before considering the use of exit gates.

Exit gates are seldom used with raised medians of substantial length unless there are extenuating circumstances. Even so, they are discouraged by SCRRA. This is primarily due to the redundancy in the systems and the long-term life-cycle costs of repairing, maintaining, and replacing exit gates as compared to medians. For example, a raised median with exit gates may be utilized where there is a far-side driveway adjacent to the crossing. This will prevent an illegal turn out of the driveway and onto the crossing. An example of an exit gate system is shown in Figure 3-24.

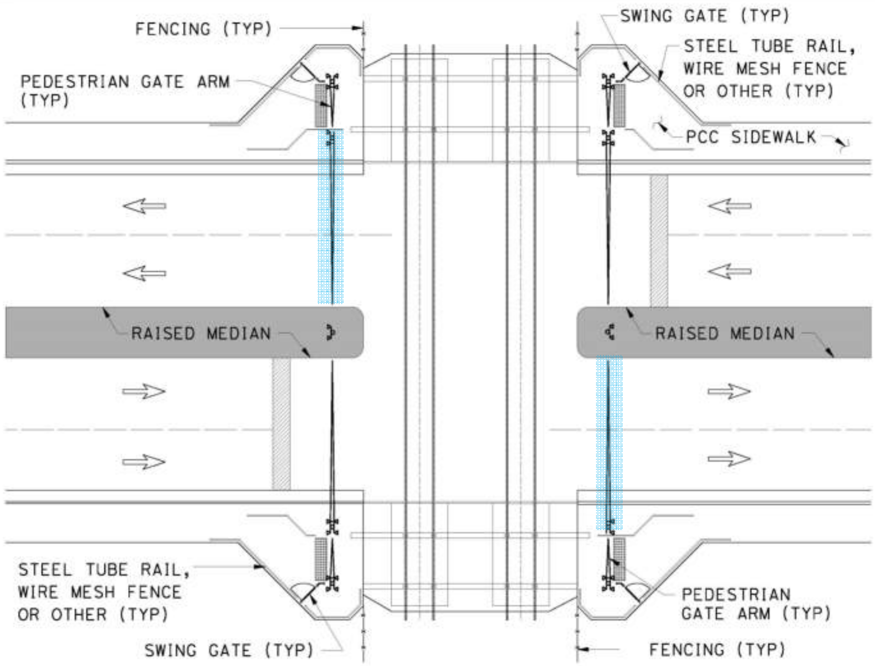


Figure 3-24. Exit Gate System

The inclusion of exit gates requires the installation of induction loops that are part of the vital crossing signal system within the pavement. *It is SCRRA's policy to maintain these loops when they are integrated into the vital railroad signal system.* Refer to SCRRA ES 8405 for further discussion on the use of induction loops. It is important to factor the maintenance cost of these into the overall C&M Agreement for the highway-rail grade crossing if the exit gates are installed solely for establishing a quiet zone, as noted in Section 2.5.1.

The following protocols shall be observed during the engineering and construction of these induction loops:

- SCRRA ES 8405 shall be referred to for placement of induction loops through the crossing.
- SCRRA ES 8405 shall be referred to as a minimum standard for the pavement structure through the crossing; shall verify the pavement section through appropriate engineering analysis; and enhance the specifications as necessary to meet the needs of the design. Low maintenance high quality pavement sections shall be installed within 50 feet of the highway-rail grade crossing as noted in Section 3.4.7.
- A mandate that the contractor shall not install pavement within the limits of the highway-rail grade crossing and the induction loops without the review and approval of SCRRA shall be included within the construction specifications.
- The highway agency having jurisdiction over the highway shall execute a C&M Agreement defining the induction loops, as well as the division allocation of maintenance responsibilities and costs regarding the crossing.

Table 3-4 below can be a used as a reference for the installation of gates.

Table 3-4. SCRRA Standard for Gate Installations

Number of Approach Lanes	Raised Median	Option 1	Option 2	Option 3
1	No	Two No. 9 devices	N/A	N/A
1	Yes	Two No. 9 devices	N/A	N/A
2	No	Two No. 9-A devices	N/A	N/A
2	Yes	Two No. 9-A devices	Four No. 9 devices	Two No. 9 devices with a cantilever
3	Yes	Two No. 9-A devices Two No. 9 devices	N/A	N/A
4	Yes	Four No. 9-A devices	N/A	N/A

3.10.4 Measures to Counter Potential Gate Circumvention

When analyzing a highway-rail grade crossing for gate placement, it is important to assess the opportunities that motorists will have to drive around the lowered gate. Many conditions exist that promote such opportunities. Several of these conditions are listed below:

- Higher traffic counts, and the resulting delays at the gates.
- In locations, or at times when there is light traffic, presenting less restrictions to gate violation.
- In locations where the vehicle crossing is adjacent to a station where dwell times within the station cause longer gate down time.
- The proximity of driveways or intersections that provide opportunities for gate violations.

The project location shall be analyzed to assess the need to install median islands, lengthen existing median island(s), or to include exit gate(s) in order to counter potential or observed gate circumventions.

3.10.4.1 Intersections of Highways Adjacent and Parallel to Rail Corridor

Highways that run adjacent and parallel to the rail corridor present a unique challenge. At an intersection with a highway that runs parallel with the rail corridor, there is a possibility for vehicles to circumvent the standard entrance gate configuration by utilizing the far-side lanes of opposing traffic; where the opposing traffic has been halted by the entrance gate of the opposing lanes, creating a clear, but unsafe and illegal path across the tracks. The possible paths for gate circumvention for this configuration are shown in Figure 3-25. This creates an unsafe situation that should be addressed in design with the use of exit gates.

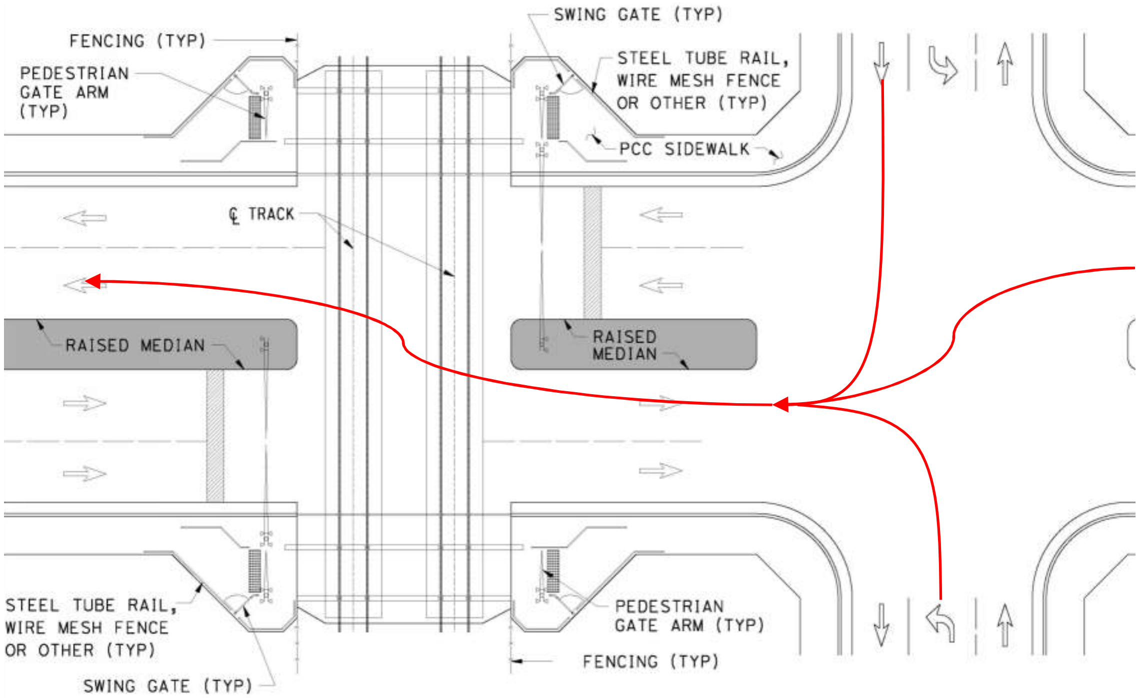


Figure 3-25. Possible Illegal Gate Circumvention Paths at Intersections with Highway Adjacent to Rail Corridor

For highway intersections within 100 feet of the highway-rail grade crossing with multiple main tracks, an exit gate system shall be installed to prevent any vehicular movements from accessing the track area. This is shown in Figure 3-26.

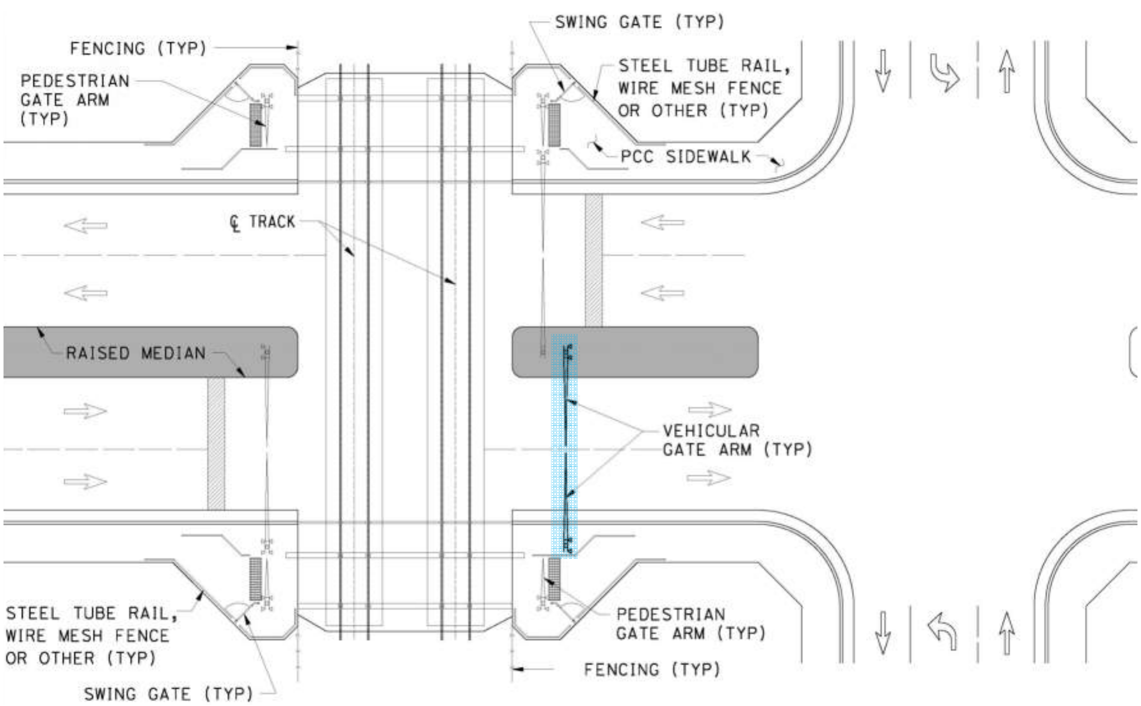


Figure 3-26. Exit Gate Installation Near an Intersection

3.11 ADJACENT CROSSWALKS

Pedestrian crosswalks parallel and adjacent to highway-rail grade crossings are strongly discouraged. Pedestrians using these crosswalks may cause vehicles to queue over the highway-rail grade crossing without an avenue of escape. Active measures should be taken to prohibit access using signage and barricades. **Any new proposed crosswalks that are adjacent to a highway-rail grade crossing will require that a Special Design Consideration be submitted to SCRRA for review and approval.**

Figure 3-27 below is an example of how the presence of pedestrians can inhibit vehicular traffic from clearing the track area.

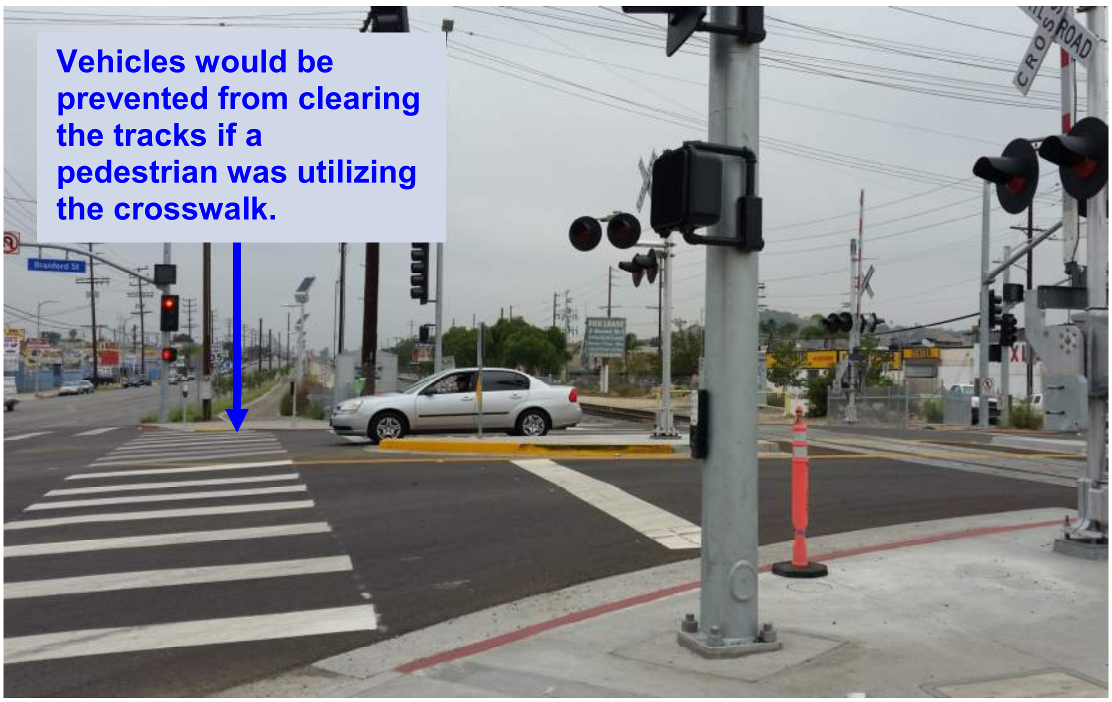


Figure 3-27. Pedestrian Crosswalk Parallel and Adjacent to a Highway-Rail Grade Crossing

3.12 ADJACENT HIGHWAY-RAIL GRADE CROSSINGS

The location of adjacent highway-rail grade crossings should generally be noted and analyzed with the operation of the subject highway-rail grade crossing. Separate railroad operations on the adjacent highway-rail grade crossing may cause vehicles waiting behind lowered gates to queue back over the adjacent highway-rail grade crossing. In these situations, the location and proximity of the operations will have a significant impact on the overall design.

At locations where there is a possibility of vehicles queuing over a highway-rail grade crossing, the design shall be coordinated with the owners and operators of both highway-rail grade crossings to develop a solution to avoid vehicles being trapped between the highway-rail grade crossings or over the adjacent highway-rail grade crossing.

3.13 TRAFFIC SIGNALS

The placement of traffic signals depends upon the proximity of the highway intersection to the highway-rail grade crossing, alley intersections, driveway intersections, vehicle queuing, and the impact of adjacent traffic control devices on the operation of the highway-rail grade crossing. Several factors shall be considered when deciding on the inclusion of a traffic signal into highway-rail grade crossing system, some of which are listed below. In addition, queuing studies should be conducted during traffic peak-hours to accurately assess actual traffic conditions at the project site.

- Traffic congestion should be minimized along the highway that crosses the railroad tracks. Various factors affect the operation of traffic at the highway-rail grade crossing and tend to cause traffic to queue over the tracks.
- The presence of a traffic signal downstream, or upstream, of the highway-rail grade crossing may tend to generate long traffic queues that could back up over the tracks.
- CA MUTCD, Section 8C.09, “Traffic Control Signals at or Near Highway-Rail Grade Crossings” recommends the preemption of traffic signals located within 200 feet of the highway-rail grade crossing. In addition, Section 8C.09, Paragraph 05 suggests preemption may be appropriate for longer distances, depending upon vehicle queuing. Refer to Section 3.14 of this Manual for additional information on preemption.
- The location of a nearby stop-controlled intersection may tend to cause traffic to back up into the highway-rail grade crossing, especially during peak traffic hours. If possible, consider removing the stop-control condition for vehicles clearing the grade crossing.

Some commonly used mitigation measures are as follows:

- Traffic signal coordination, including the installation of queue-cutter signals, pre-signals, and/or turning movement prohibitions.
- Replace the stop control with a preempted traffic signal.

3.13.1 Adjacent Stop-Controlled Intersections

Adjacent stop-controlled intersections should generally be avoided in all instances. Vehicles traversing the highway-rail grade crossing should have a clear path over the crossing that is unimpeded by vehicular cross traffic. The existence of a stop sign controlling vehicular movements over the crossing may force vehicles to wait for cross traffic to clear before proceeding. In cases where there is limited distance between the highway-rail grade crossing and the adjacent intersection, or significant vehicular traffic over the highway-rail grade crossing, vehicles can queue over the highway-rail grade crossing without a means of escape.

3.13.2 Design Scope

This section establishes the basic traffic engineering criteria to be used in the design of traffic signal systems affected by SCRRA’s operations.

The design shall specify all traffic signal equipment, including: traffic signal controller assemblies, the railroad interconnection system, lighting systems, sign illumination systems, communication systems electrical equipment, and provisions for future systems, and any combinations thereof. *The design shall incorporate equipment that has been proven to be reliable, durable, and effective on SCRRA or other major Class 1 inter-city passenger or commuter railroad systems, and already is or can be readily incorporated in current SCRRA System active warning devices.* In order to provide this, the lead Engineer shall coordinate with SCRRA forces for advice/direction regarding this matter.

The design shall incorporate features and equipment that are familiar to SCRRA Engineering, Construction and Maintenance staff and contractors and that will contribute to the inspection, testing, repair operations, and maintenance of the traffic signal system. Any new testing procedures, or methods required by new equipment, must be identified and submitted to SCRRA and the highway agency for consideration and approval before implementing the new equipment and procedures.

All designs shall be submitted for SCRRA approval in accordance with Section 7.10 “Submittals” of this Manual. The highway agency shall also approve the design of the traffic signal system.

3.13.3 Traffic Signal Standards

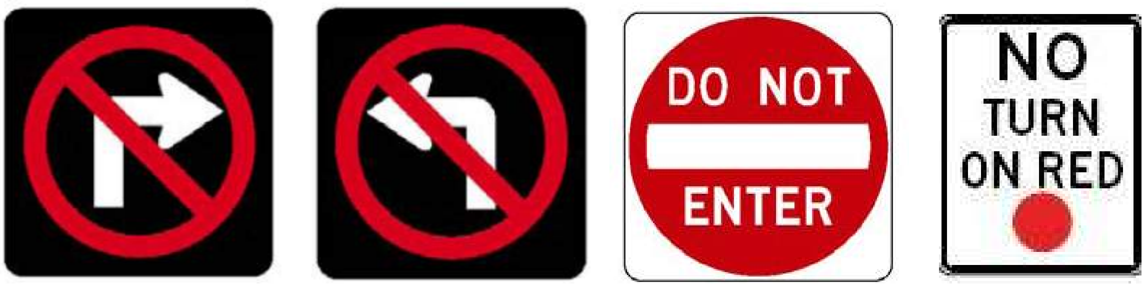
Traffic signal systems shall be designed in accordance with the standards and practices of the highway agency having jurisdiction over the specific traffic signal system. The most current version of the applicable standards in effect at the time of proposal submission shall be used.

The design shall adhere to the latest version of CA MUTCD and the highway agency’s design criteria for traffic signals, or to a separate criterion specifically established by the highway agency. Any new or modified traffic signal system shall be coordinated and integrated into the civil and track design to provide a seamless interface between the design disciplines.

3.13.4 Traffic Signal Design

As per the CA MUTCD, if preemption is provided at a signalized intersection, the normal sequence of traffic control signal operation shall be interrupted by the railroad (preempted upon the approach of a train). The sequence of traffic signal and railroad warning system operations during the interruption shall avoid entrapment of vehicles on the highway-rail grade crossing (entrapments that might result from conflicting displays in which the traffic control signals are green, even while the railroad active warning flashing-light signals are active). **During the preemption hold interval, the traffic signal indications shall prevent vehicles from moving toward the track area while displaying a green protected movement signal for through/turning movements to allow traffic to move off the tracks and away from the crossing.** All turning movements toward the highway-rail grade crossing that are currently permitted shall be prohibited during the signal preemption sequences. **A blank-out, changeable message sign, appropriate highway signal indication, or other similar control shall be used to prohibit turning movements toward the highway-rail grade crossing during preemption**. The R3-1 and R3-2 blank-out signs that are to be used as appropriate for turn prohibition are shown in Figures 3-28 and Figure 3-29. Turn prohibition blank-out signs that are associated with preemption shall be visible only when the highway-rail grade crossing restriction is in effect. For signalized intersections that display a red indication, during preemption, to restrict all movements across the tracks, an R10-11 blank-out sign may be used.

The R3-1, R3-2, and R5-1 blank-out signs are typically placed where they may most easily be seen by the motorist intending to make a turn. The R3-1 signs should be placed over the highway in line with the right-turn lane, or at the right corner of the intersection. The R3-2 should be placed over the highway in line with the left-turn lane adjacent to the left-turn signal indication, or on the median (in line with the left-turn lane). The R5-1 should be placed appropriately for the movement being restricted.



R3-1 Activated Blank-Out | R3-2 Activated Blank-Out | R5-1 | R10-11

Figure 3-28. Turning Movement Blank-Out and Associated Signs

R3-1 Blank-Out Sign (Deactivated)

R3-1 Blank-Out Sign (Activated)

Figure 3-29. Turning Movement Blank-Out Sign

Per the CA MUTCD, Section 4D.27, “Preemption and Priority Control of Traffic Control Signals”, whenever a traffic signal is provided with emergency vehicle preemption and railroad preemption, the railroad preemption shall have priority. In the event of a demand for emergency vehicle preemption during the time the intersection is operating on railroad preemption, the railroad preemption sequence shall continue unaffected until completion. In the event of a demand for railroad preemption during emergency vehicle preemption operation, the railroad preemption function shall immediately assume control of intersection operations.

Traffic signals may be used to enhance the control of highway users at highway-rail grade crossings. A detailed analysis shall be conducted for any planned signalized intersection to properly define the lane geometry and configuration. The objective is to efficiently control the signalized intersection and maintain a reliable railroad operating system.

Traffic signal system design shall incorporate input from the highway agency having jurisdiction over the signal system. A traffic signal system plan shall be prepared for each new or revised traffic signal system. The traffic signal system plan shall be in a format acceptable to the highway agency having jurisdiction over the signal system and shall be prepared by a professional Civil or Electrical Engineer registered in the State of California.

The following general criteria shall apply to designs of traffic signals:

- Traffic signals, pedestrian signals, and any special signs and signals required shall be designed and installed in accordance with the highway agency's specifications.
- Where there are existing conductors, interconnecting traffic signals, and railroad signals, they may be used if in good condition and adequate for the desired type of interconnection. See Section 6.1.2 for information on interconnection circuitry. New traffic signals shall be integrated into the existing or modified system, as appropriate, in accordance with the highway agency's standards and specifications, and SCRRA requirements.
- The lead Engineer shall be responsible for coordinating with the appropriate local utility company to determine the source of power and the utility company's requirements for each new or revised traffic signal and safety lighting system.
- The design and placement of vehicle induction loops near the tracks shall be coordinated with SCRRA.
- *Where the traffic signal system design requires the removal of existing traffic signal equipment, the existing traffic signal system shall be kept operable until the new equipment has been installed, tested, and put into service.* During periods when the existing traffic signal is inoperable, the intersection shall be flagged in accordance with the requirements of the highway agency. In cases where this occurs within 200 feet of a highway-rail grade crossing, SCRRA shall also control the highway-rail grade crossing with railroad flagging.

3.13.5 Left-Turn Movements

A traffic study shall be conducted to determine the need and length for left-turn pockets and protected left movements at existing signalized intersections that are preempted by trains, which do not have left-turn pockets and/or protected left-turn signal indications (green arrows). All legs of the intersection shall be evaluated to determine the appropriateness of the left turn protection. In addition, the length of the left-turn lane shall be evaluated for proper application according to traffic demands. The left-turn protection (green arrow) shall provide the following criterion during the preemption sequence:

- Provide sufficient green time for the left-turn movements traveling away from the highway-rail grade crossing to clear any queues over the railroad tracks.
- Restrict conflicting left-turn movements toward the tracks.
- Allow non-conflicting left-turn movements away from the tracks during railroad preemption.
- **In cases where there is an existing left-turn lane not provided with a signal head equipped with a protected left-turn arrow, the traffic signal shall be modified to provide a protected left-turn arrow or a blank-out sign restricting the left-turn movement towards the tracks.**

The lead Engineer shall analyze the length of left-turn lanes in association with the overall crossing. **A left-turn lane pocket configuration extending across the tracks shall be avoided.** Several concerns arise with this configuration:

- Vehicles waiting to turn are impeded from turning by cross-traffic, since the turn onto the cross street is not controlled by a traffic signal.
- Vehicles queuing in this left-turn lane over the track will not have an unimpeded egress should a train arrive.

If a left-turn pocket extending across the tracks is required, a Special Design Consideration must be requested and shall include countermeasures to warn motorists not to stop on the tracks, such as traffic signals, striping, and signing. A proper engineering study shall be performed to evaluate the traffic movements associated with adding or modifying a left-turn pocket through the highway-rail grade crossing. The study shall recommend appropriate mitigations to avoid the trapping of vehicles across the highway-rail grade crossing that shall be included in the design, such as:

- Install a preempted traffic signal at the highway intersection to allow the clearance of the left-turn lane upon the arrival of a train.
- Install a queue-cutter signal or pre-signal to control vehicles stopping on the tracks.

3.13.6 Pre-Signals

Pre-signals are traffic signals that control traffic approaching a highway-rail grade crossing, in conjunction with the traffic system of an adjacent downstream highway intersection, to prevent queueing over the highway-rail grade crossing. See Figure 3-30 for a typical pre-signal layout.

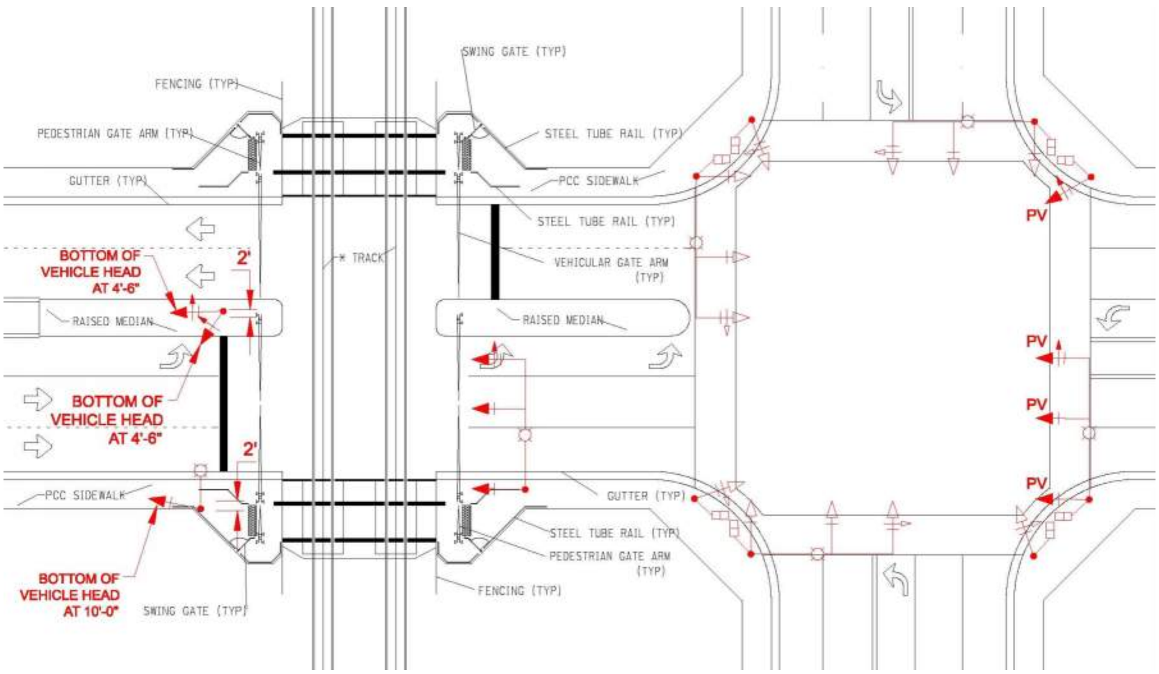


Figure 3-30. Typical Pre-Signal Layout

3.13.6.1 Design Requirements

Refer to CA MUTCD, Section 8C.09, “Traffic Control Signals at or Near Highway-Rail Grade Crossings” for requirements associated with pre-signals. Whereas existing traffic signal preemption is mandated to clear queued vehicles from the crossings upon arrival of trains, a pre-signal is intended to preclude, or minimize, and queuing across the highway-rail grade crossings during each traffic signal cycle, regardless of the presence of a train on the approach. A pre-signal does not eliminate the need for preemption, but it does significantly reduce the likelihood that vehicles are within the minimum track clearance distance and clear storage distance, at the onset of the track clearance green time (see Section 3.14 for an explanation of these terms).

The installation of pre-signals, in coordination with railroad warning signals, can create instances where the motorist may become confused by conflicting signal directions. This can be a particular problem when the traffic signals on an overhead mast-arm flash red as the railroad signal lights on a cantilever flash red. These send conflicting messages to the motorist: a flashing red traffic light indicates stop and proceed, while a flashing railroad warning light indicates stop. To mitigate the possible confusion of conflicting signal directions between the pre-signal and railroad crossing warning signal, **a Standard No. 9-A cantilever shall not be used as or used to mount a pre-signal.** In locations where both a pre-signal and a cantilever are already present or are typically required; installation of the pre-signal only should be considered, when possible, to avoid motorist confusion; the final determination shall be made by SCRRA’s Director of Communications and Signals. This installation allows the railroad warning gates and lights to operate in conjunction with the traffic pre-signals to send the appropriate message to the motorist.

Pre-signals and all associated signage installed in front of a railroad crossing gate shall be positioned to not interfere with the visibility of the railroad flashing-light signals or other traffic control signals.

A pre-signal shall be considered in the following cases:

- Where the clear storage distance (see Section 3.14.2) is 50 feet or less.
- At approaches where high percentages of long-length vehicles (i.e. semi-trucks with trailer, buses, recreation vehicles, etc.) are evident and the clear storage distance is less than 75 feet. A vehicle classification study should be conducted to determine the types of vehicles using the crossing.
- Where the clear storage distance is greater than 50 feet or 75 feet (depending on the highway vehicle design length), but less than 120 feet, and an engineering study determines that the queue extends into the track area.

An engineering study should be made to evaluate the various elements involved in a pre-signal, addressing the following as a minimum:

- Site conditions of the highway-rail grade crossing and intersection, including minimum track clearance distance and clear storage distance.
- Traffic patterns, including queuing at the crossing.
- Type of vehicles that use the highway-rail grade crossing (to determine timing parameters).
- Highway-rail grade crossing and road intersection geometry, including grades, horizontal and vertical curves.
- Visual obstructions to lateral and vertical angles of sight toward a signal face, to determine the vertical, longitudinal, and lateral position of the signal face.

Pre-signals can be used for stopping vehicular traffic before the highway-rail grade crossing where the clear storage distance is 200 feet or less. When the clear storage distance is less than 120 feet, an engineering study shall be performed to evaluate the need and correct application of a pre-signal.

3.13.6.2 Pre-Signal Location

There are two primary alternative locations for placement of traffic signal heads at the crossing. Pre-signals on poles can be placed on the near-side of the highway-rail grade crossing and on mast-arm poles placed ahead of the highway-rail grade crossing (upstream), or between the highway-rail grade crossing and the intersection (downstream). *Downstream placement of the pre-signal mast-arm pole is the preferred position, so the stopping position of the vehicular traffic is close to the crossing.* Where the pre-signal pole is placed upstream of the highway-rail grade crossing with multiple approach lanes, a pole shall be placed on the sidewalk and on the median. **In all cases, pre-signal poles shall be positioned to maintain visibility of the railroad flashing lights.**

CA MUTCD, Section 4D.11, “Number of Signal Faces on an Approach” states that a minimum of two signal faces shall be provided for the major movement on the approach to an intersection. At least one and preferably both signal faces shall be located as follows:

- Not less than 40 feet beyond the stop line, unless a supplemental near-side signal face is provided.
- Not more than 150 feet beyond the stop line, unless a supplemental near-side signal face is provided.
- As near as practical to the line of the driver’s normal view, if mounted over the highway.

3.13.6.2.1 Downstream Pre-Signals

Figure 3-31 shows a typical downstream installation, which includes a supplemental near-side signal face in the median.

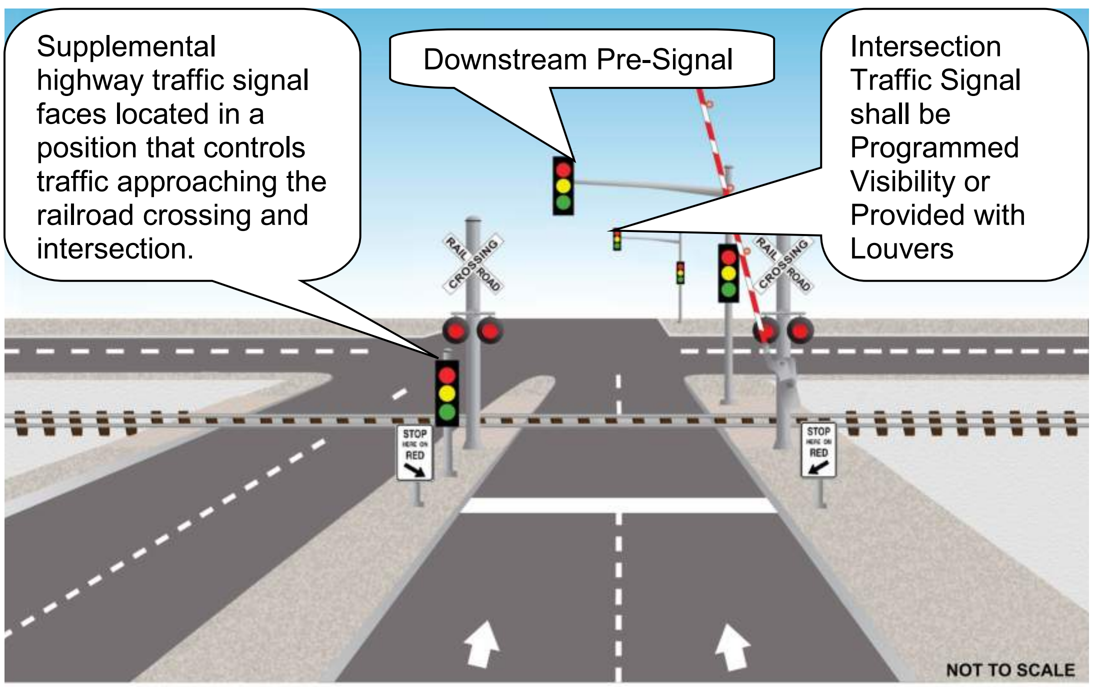


Figure 3-31. Pre-Signal Placement

As specified in CA MUTCD, Section 8B.28, “Stop and Yield Lines”, the stop line should be placed no closer than 15 feet from the nearest rail, and eight (8) feet from the railroad gates (if present). It is desirable to utilize this same stop line for the pre-signal indications, if possible. Placement of the traffic signal stop line at the same location as the railroad warning gate stop line has two advantages:

- Transit vehicles and trucks required to stop at crossings would not be subject to a double stop.
- Heavy vehicles will be closer to the crossing, and therefore more able to clear the minimum track clearance distance during preemption.

If clear storage distance is 50 feet or less, and if it is possible to use the near-side intersection signal heads as a pre-signal, the stop line of the pre-signal should be at the same location as the railroad warning gate stop line. **The far-side intersection signal heads shall be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to drivers at the pre-signal stop line**.

If the clear storage distance is more than 50 feet, and if it is possible to locate a pre-signal between the highway-rail grade crossing and the intersection, the pre-signal faces should be located such that the stop line of the pre-signal is at the same location as the railroad warning gate stop line.

3.13.6.2.2 Upstream Pre-Signals

When traffic signal faces are located near the railroad warning devices, the stop line must be located a minimum of 40 feet ahead of (upstream) the signal faces to allow for visibility of the traffic signal heads per CA MUTCD requirements. If the stop line distance is shortened, a low mount pre-signal head and a “STOP HERE ON RED” (R10-6) sign shall be installed to warn approaching traffic of the traffic control signal. The far-side intersection signal heads should be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to the drivers at the pre-signal stop line.

3.13.6.3 Signs and Markings for Pre-Signals

Figure 3-32 shows typical placement of signs and markings for a pre-signal. If a pre-signal is installed at an interconnected highway-rail grade crossing near a signalized intersection, an R10-6 (“STOP HERE ON RED”) sign shall be installed at the stop line. If there is a nearby, signalized intersection with insufficient clear storage distance for a design vehicle, or if the highway-rail grade crossing does not have gates, an R10-11 (“NO TURN ON RED”) sign shall be installed for the approach that crosses the railroad track.

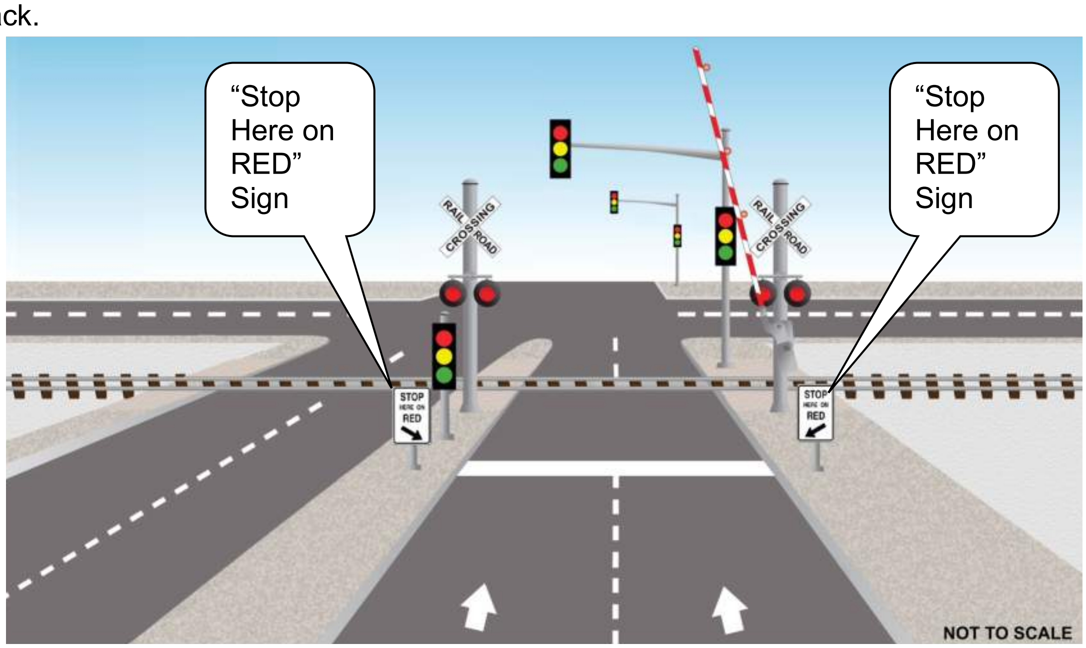


Figure 3-32. Pre-Signal Signs and Markings

3.13.6.4 Pre-Signal Operations

The pre-signal intervals should be progressively timed with the downstream intersection signal intervals, providing adequate time for vehicles to clear the minimum track clearance distance and continue through the clear storage distance area and downstream intersection. Vehicles that are required to make mandatory stops (such as school buses and vehicles hauling hazardous materials) should be considered when determining the preemption timing design parameters. Unless otherwise defined, the design vehicle for the design of a pre-signal shall be the AASHTO WB-65 semi-tractor-trailer as noted in Section 3.4.4.

Where the clear storage distance is inadequate to store the design vehicle clear of the minimum track clearance distance, consideration should be given to the installation of vehicle detection loops within the clear storage distance. This could prevent vehicles from being trapped within the minimum track clearance distance by extending the track clearance green time. Pre-signals shall display a red signal indication during the transition into the preemption control portion of a signal preemption sequence. This shall prohibit additional vehicles from crossing the railroad tracks.

3.13.7 Queue-Cutter Signals

Another solution to traffic queuing onto the tracks, and an alternative to a pre-signal, is the use of an automated queue-cutter traffic signal upstream of the highway-rail grade crossing. A queue-cutter signal differs from a pre-signal in that if the clear storage distance is greater than 200 feet; any traffic signal heads located at a highway-rail grade crossing should be considered to be a separate, mid-block highway-rail grade crossing (a “queue-cutter”) signal and not a pre-signal. The queue-cutter signal can be utilized in conjunction with R8-8 signs (“DO NOT STOP ON TRACKS”), as per CA MUTCD requirements. The queue-cutter traffic signal can be activated by vehicle detection (typically induction loops) on the far-side of the highway-rail grade crossing to detect a growing queue between the highway-rail grade crossing and the downstream highway intersection. Cue-cutter signals must be interconnected to the railroad crossing warning system to allow a red stop signal to be displayed when a train is approaching. Figure 3-33 indicates the use of a queue-cutter signal.

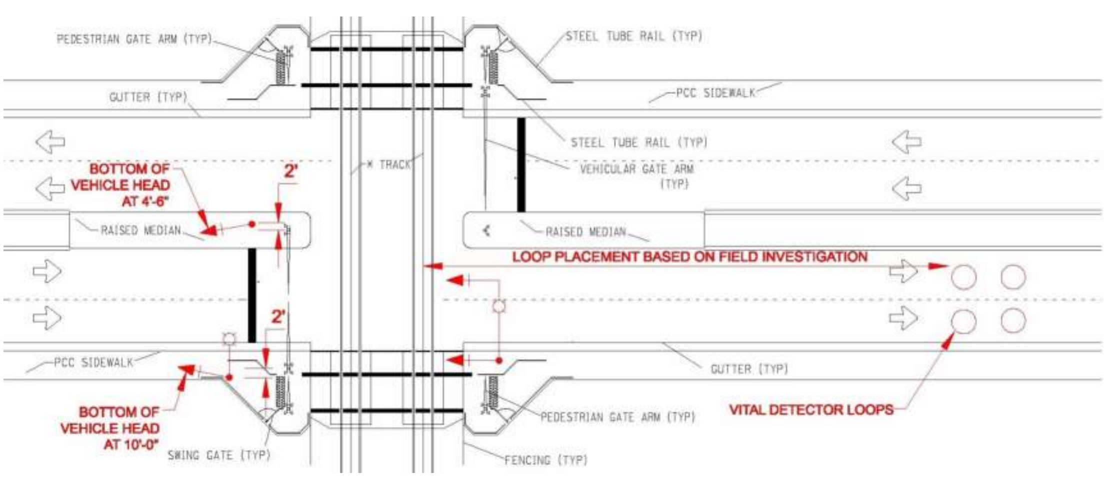


Figure 3-33. Queue-Cutter Signal Placement Layout

3.13.8 Traffic Signal Controller Units

There are two types of traffic signal controller units: those that are designed to NEMA specifications and those that are Type 170/2070 Controller Units (discussed below). Traffic signal controller units manufactured according to older NEMA TS 1 standards do not have internal preemption. These units are generally not capable of accommodating preemption without special external control processes. The current industry standard for both pretimed and actuated traffic signal controller units—the NEMA TS 2 standard—includes provisions for internal preemption.

The Model 2070 Controller Unit includes various provisions for internal preemption; these depend on the specific software packages being run by the microprocessor. The Model 2070 is an open platform advanced transportation controller (ATC) that completely separates hardware from application software by defining a common controller unit hardware on which multiple applications from multiple developers can operate.

The preemption capabilities of traffic signal controller units vary from manufacturer to manufacturer. It is very important to be familiar with the preemption operation provided in each controller unit being used in the field.

The IEEE 1570 standard for the interface between the railroad active warning system and the traffic signal controller unit is a digital communications interface. Designed according to both fail-safe and closed-loop principles, it provides equivalent functions while maintaining the required safety attributes at the highway-rail grade crossings. Application of the IEEE 1570 interface shall be explored for all new highway-rail construction and modifications. For more information on the IEEE 1570 standard, consult the IEEE Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection (IEEE publication no. 1570-2002).

The traffic signal controller unit shall be able to meet the following functions and requirements:

- Receive multiple preemption inputs and provide multiple routines on a priority basis, at least one of which shall be assigned to railroad preemption. Per CA MUTCD, the railroad preemption shall have priority at a traffic signal provided with emergency vehicle preemption and railroad preemption.
- The preemption feature shall have either an electrical circuit based upon the closed-circuit principle, or a supervised interconnect circuit (preferable) between the control circuits of the railroad active warning system and the traffic signal controller unit.
- Detect broken wires/cables and respond as programmed. One possible programming alternative is to first clear the tracks and then display all-way flashing red signal indications.
- Remotely notify the responsible highway agency as soon as a detectable problem is known to exist at the highway-rail grade crossing.
- Provide an indication, via health check circuit, to the railroad active warning system cabinet when the traffic signals are in flashing mode, on battery backup, or “dark” (without power) condition.

- Provide a backup power system for the traffic signal controller in the event of a commercial power outage, and remote notification to the highway agency responsible for maintenance of the controller.

3.13.9 Standby Power

In accordance with FRA rules and requirements, railroads install backup power systems to provide power to flashing light signals during commercial power failures. This practice for back-up power is different from traffic signals that are generally dark when the commercial power is off. When traffic signals are dark, motorists in most jurisdictions are expected to know traffic signals are ahead; they are supposed to stop their vehicle at the stop line and proceed with caution through the intersection as if the dark signal were a stop sign. Since dark traffic signals cannot provide preemption, **backup or standby power systems shall be required at all traffic signals interconnected with railroad signals.**

When traffic signals malfunction, which may cause an all-red flash, the advance preemption time becomes ineffective in helping clear vehicles from the crossing. As a result, vehicles may have less time to clear the crossing. The incorporation of a health check circuit can serve to convert some or all advance preemption time to warning time when this occurs.

3.14 PREEMPTION

The design of preemption for a highway-rail grade crossing owned or maintained by an agency other than SCRRA shall be in accordance with the standards used by that agency. The resulting design must be consistent with, or more stringent than, the standards and criteria in this Manual or other applicable SCRRA Standards.

In establishing preemption operations at highway-rail grade crossings adjacent to signalized highway intersections, the highway agency shall coordinate with SCRRA and the CPUC. The need for preemption, type of preemption, preemption time, right-of-way transfer time, queue clearance time, track clearance green time, etc., for preemption shall be determined by the highway agency and must be agreed to by SCRRA.

3.14.1 Abbreviations and Formulas

The following abbreviations are provided to assist in preparing the appropriate preemption timing parameters for the highway-rail grade crossing interface. These are also shown in Appendix A.

APT	Advance Preemption Time
BT	Buffer Time
CT	Clearance Time
CSD	Clear Storage Distance
ERT	Equipment Response Time
MHTSPT	Maximum Highway Traffic Signal Preemption Time (MPT)
MT	Minimum Time

MTCD	Minimum Track Clearance Distance
MWT	Minimum Warning Time
QCT	Queue Clearance Time
RWTT	Right-of-Way Transfer Time
ST	Separation Time
TAT	Total Approach Time
TWT	Total Warning Time

MHTSPT (MPT) = RWTT + QCT + ST or CT (whichever is greater)

TAT = MWT + BT + ERT + APT

TAT = TWT + ERT + APT

TWT = MWT + BT

MWT = MT + CT

APT = RWTT + QCT - MWT

RWTT = Minimum green interval, or pedestrian change/walk and pedestrian clearance time (whichever is higher) + yellow change + red clearance

3.14.2 Highway-Rail Grade Crossing Elements that Affect Railroad Preemption

The following highway-rail grade crossing and intersection elements affect preemption timing calculations and/or highway-rail grade crossing operations and should be evaluated carefully to determine their impact:

- Intersection geometry.
- Highway-rail grade crossing geometry:
  - Track clearance distance (track clear zone).
  - Clear storage distance; distance from clear track zone to intersection.
- Approaches to the highway-rail grade crossing during preemption calculations.
- Travel times to clear the intersection or crossing.
- Vehicle volumes.
- Frequency of train movements.
- Train stops within the approach to the highway-rail grade crossing (especially for sidings and stations).
- Vehicle queue lengths and dissipation rates.
- Design vehicles and special classes of vehicles, and their operating abilities through the intersection.
- Types of active warning devices.
- Pedestrian activity.

Intersection Geometry

No traffic movements toward the highway-rail grade crossing shall be allowed during preemption. Therefore, the lane configuration and traffic signal operation of the intersection must be evaluated to determine the need for additional lanes and traffic signal modifications to properly control the intersection movements. For example, if the highway parallel with the tracks has a shared through and left lane, and operates with a permissive green ball that allows left turns, the intersection would need to be reconfigured with a left-turn pocket with protected operation so the through movement can operate during preemption, while the left-turn movement toward the tracks is restricted. Alternatively, an R3-2 blank-out sign can be installed to prohibit left turns. This must be evaluated first to help define what the advance preemption time needed to provide the appropriate transition from conflicting movements to the preemption sequence.

Minimum Track Clearance Distance

The minimum track clearance distance (MTCD) is measured along the highway from either the highway stop line; or from the railroad gate; or 12 feet perpendicular to the track centerline (for crossings without gates); to six (6) feet beyond the furthest track, measured perpendicular to the far rail. The measurement is taken along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. This measurement is used to determine the "track clearance green time" and is also used to determine the "clearance time."

Geometric features, such as elevation differences of the tracks or the skewed angle of the crossing, should also be considered when evaluating the effects that the track clearance distance has on timing parameters.

Clear Storage Distance

Clear storage distance is the distance available for vehicle storage. It is measured between 6 feet from the rail nearest the intersection to the intersection stop line, or to the normal stopping point on the highway. At skewed crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail, either along the centerline or along the edge line of the highway (as appropriate to obtain the shorter clear distance).

Highway agencies will often use this distance when calculating the "queue clearance time." Typically, the queue clearance time only includes the area between the MTCD and the intersection if there is not enough room to store a design vehicle. The lead Engineer must work with the highway agency to determine the most appropriate method.

The operating abilities of the design vehicle must be considered when evaluating the queue clearance time; e.g., start-up for a heavy truck loaded down is much slower than for a normal vehicle. The movement the truck makes at the intersection also determines the time required to clear the vehicle.

3.14.3 Railroad Parameters for Preemption

Minimum Time

CA MUTCD, Section 8C.08, "Rail Traffic Detection" and Title 49 Code of Federal Regulation (CFR) Part 234.225, requires that the Minimum Time (MT) flashing-light signals shall operate is 20 seconds before the highway-rail grade crossing is occupied by train traffic. The exception to this requirement is on tracks where all trains operate at less than 20 mph, and where flagging is performed by an authorized person on the ground.

The FRA regulations in Title 49, Code of Federal Regulations (CFR), Part 234.225, state that a highway-rail grade crossing warning system shall be maintained to activate in accordance with the design of the warning system, but in no event shall it provide less than 20 seconds of warning time before the highway-rail grade crossing is occupied by train traffic.

CPUC GO 75 states that highway-rail grade crossing signals at main or branch line crossings shall be actuated by trains approaching on main tracks through track circuits or by electronic controls for a minimum of 20 seconds, with limits of 20 to 30 seconds in advance of the fastest train that is normally operated over the highway-rail grade crossing being protected.

Within the Minimum Time, the gate arm shall start its downward descent a minimum of 3 seconds after the railroad flashing-lights are activated and shall be in the final horizontal position a minimum of 5 seconds prior to the arrival of any train. The gate arms shall remain in the final horizontal position until all trains have passed and there are no trains approaching the crossing on another track.

Clearance Time

Clearance Time (CT) is additional time that is often provided in excess of the minimum time to account for track clearance distances (track clear zone) that are wider because of a skewed highway-rail grade crossing or because of other specific features (i.e., one track being considerably higher than the other tracks, causing vehicles to slow down in the crossing). Clearance time should also consider the large number of slow vehicles that utilize the crossing; vehicles that take more time to cross than a normal vehicle.

Clearance time is added to the minimum time at a rate of one (1) second for each 10 feet (or fraction thereof) of minimum track clearance distance exceeding 35 feet.

Minimum Warning Time

Minimum Warning Time (MWT) is the CA MUTCD mandated minimum time of 20 seconds, and any additional clearance time. This is the time between when the railroad warning system is activated and when the train enters the crossing. Refer to SCRRA Signal Standards for SCRRA's standard for MWT.

$$MWT = MT + CT$$

Equipment Response Time

Equipment Response Time (ERT) is the additional time provided to account for delays in railroad circuitry before the railroad warning devices are activated. This is typically set at 5 seconds, and is used to establish the approach time for train detection placement.

Buffer Time

Buffer Time (BT) is discretionary time determined by the railroad. It is added to the required 20-second Minimum Warning Time (MWT). The railroads add this buffer time for train handling to ensure that a required minimum warning time for track clearance is provided. SCRRA uses a BT of 10 seconds as noted in Section 33.7.1 of SCRRA's Design Criteria Manual.

Total Warning Time

Total Warning Time (TWT) is a combination of each element defined above. Although the equipment response time is never reflected in the total warning time calculation, it should be figured into the approach time and distance for train detection.

$$TWT = MWT + BT$$

3.14.4 Preemption Operational Sequence

FHWA and ITE publications (see Appendix B for references) have tables and charts that help identify different paths that preemption can take during phased operation. These tables and charts indicate the displays that would be shown, depending on what phase was active when preemption input was received. Each highway-rail grade crossing is unique; an engineering study should be conducted for each signalized intersection near a highway-rail grade crossing to determine the most appropriate preemption operational sequence and the preemption parameters to be implemented.

The traffic signal controller unit shall enter into preemption operation as soon as the interconnect circuit from the railroad active warning system is activated. Some controller units may incorporate a delay time to verify the continuity of the preemption call.

Railroad preemption results in a special traffic signal operation; depending on the relationship of the railroad tracks to the intersection, the number of phases in the traffic signal, and site-specific traffic conditions. Preemption ensures that the actions of the traffic control devices complement, rather than conflict, with the railroad warning system devices. There are three basic elements to railroad preemption:

1. Right-of-way transfer into preemption control
    a. Termination of normal operation
2. Preemption control
    a. Track clear/clear storage interval
    b. Hold/dwell interval

3. Transition to normal operation
    a. Exit phases
    b. Transition to coordination

3.14.4.1 Right-of-Way Transfer into Preemption Control

There are many possible transition scenarios, depending upon which interval in the traffic signal control cycle is operational when preemption is initiated. Upon receiving a preemption call, right-of-way transfer of the traffic signal should provide the following basic sequence of operation:

- The length of yellow change and red clearance intervals shall not be altered by preemption for any signal phase that is green or yellow when preemption is initiated.
- Phases that are in the green interval when preemption is initiated, and which shall be green during the track clearance interval, shall remain green, unless doing so creates a left-turn trap. In that case, they must be terminated normally and then restarted after a brief all-red period.

3.14.4.2 Preemption Control

3.14.4.2.1 Track Clear/Clear Storage Interval

There are two basic scenarios that could occur with the pedestrian walk interval or the pedestrian clearance time, depending on the highway agency's requirements:

- Immediate termination of the pedestrian walk or clearance intervals, with all pedestrian signals faces displaying a steady upraised hand during the track clearance green interval.
- Shortening of the pedestrian walk interval, while allowing the pedestrian clearance interval to follow the normal time.

The signal phase (or phases) controlling traffic, as it approaches the intersection after crossing over the railroad tracks, should be green during the track clearance interval. A yellow change interval shall be provided if a green signal indication was provided during the track clearance interval.

In cases where the approach has a phase that conflicts with the track clearance green time (queue clearance), the right-of-way transfer time (RWTT) shall be maximized when the preemption call is received at the traffic signal controller just after the onset of green. The maximum traffic signal timing required for the transition can vary, depending on the programmed phasing of the controller when the preemption call is established. The maximum RWTT used in the calculation of preemption time establishes the upper limit of the preemption time. This set of circumstances is sometimes referred to as "worst case" scenario.

The RWTT shall be nonexistent or zero if the preemption call is received when the traffic signal controller is already in the phase that is used as the track clearance green time (queue clearance phase). This scenario is usually known as the "best case" scenario.

These variations in traffic signal operations can be unsafe if not properly recognized in the timing and design of simultaneous and advance preemptions. The "worst case" scenario shall be used in the determination of maximum preemption time, while both the "best case" and "worst case" scenarios shall be used in the design of any preemption sequence. A "gate-down" circuit should be used when there is a substantial difference between the minimum and maximum RWTT. Some traffic signal controllers are capable of dynamically calculating the maximum RWTT, adding extra time to the track clearance green when the actual RWTT is below maximum. The use of the "not to exceed" timing circuit can also be used to control the advance preemption time; however, this type of circuit cannot prevent shorter advance preemption times.

3.14.4.2.2 Preemption Hold/Dwell

Limited Service shall be used for traffic signals interconnected to SCRRA active warning devices. The transition into preemption hold occurs after the queue clearance time and separation time (track clearance interval) have been completed and continues while the train is occupying the crossing. Preemption hold shall remain in effect until the preemption input to the controller unit is removed. The purpose of the preemption hold interval is to allow those movements that do not conflict with the train to proceed through the intersection.

Depending on traffic requirements and the phasing of the traffic signal controller unit, the traffic signal may do the following:

<u>Limited Service (standard)</u>

- Revert to limited operation with those signal indications controlling through and left-turn movements toward the railroad tracks displaying steady red.
- Limited operation shall allow through and left-turn movements away from the railroad tracks to operate.
- With slow-moving trains and long interruption times, the preemption dwell may allow the traffic signal controller to rotate through various defined non-conflicting traffic phases.
- Permitted pedestrian signal phases shall operate normally.
- This operation shall be used only if the highway-rail grade crossing warning equipment includes gates.

<u>Flashing All Red (only with SCRRA approval)</u>

- Go into flashing operation; with flashing red or yellow indications for the approaches parallel to the railroad tracks and flashing red indications for all other approaches.
- Pedestrian signals shall be extinguished.
- If flashing red is used for all approaches, an all-red or other clearance interval shall be provided prior to returning to normal operation.
- Blank-out signs shall be used to prohibit turn movements across the tracks.

3.14.4.3 Transition to Normal Operation

There are many possible scenarios for the transition from preemption control to normal operation; they depend on the type of intersection control that was in effect at the time of preemption (e.g., running free, actuated [semi or full], recalls, coordinated, etc.).

3.14.4.3.1 Exit Phases

The user can define the exit phases that shall operate after the preemption call has been released. Most controllers shall run the normal split time for the exit phases, and then, depending on user-programmed parameters, the controller shall attempt to resynchronize with the defined offset. There are basically three types of resynchronization capabilities (dwell, short way, add only) that control the transition back to normal operation.

3.14.4.3.2 Transition to Coordination

Some controller software has the capability to monitor the coordinated cycle during preemptions so that upon release of preemption, the transition to normal operation is right in step with the coordinated background cycle. The lead Engineer should be aware of the highway agency’s preferred operation.

3.14.5 Preemption Timing Parameters

The highway-rail grade crossing elements that affect railroad preemption (as defined in Section 3.14.2) help calculate the timing parameters defined in this section. The narrative below presents preemption timing parameters that should be evaluated carefully and calculated for each appropriate sequence of preemption operation.

- Maximum RWTT
- Minimum RWTT
- Queue clearance time
- Separation time
- Maximum highway traffic signal preemption time
- Advance preemption time
- Total approach time

3.14.5.1 Maximum RWTT

The maximum RWTT is the “worst case” scenario and consists of the following timing parameters:

- Minimum traffic signal green time or minimum pedestrian walk time, whichever is longest
- Pedestrian clearance time
- Yellow change interval

- All-red clearance interval for opposing traffic

Minimum Green Interval

Two components are necessary to establish the minimum green interval for transition phases:

- Vehicle timing requirements
- Pedestrian timing requirements

If pedestrian timings cannot be truncated, then the vehicle timing requirements must be compared to the pedestrian timing requirements; the greater of the two shall set the minimum green interval. The minimum green time is the shortest green time allowed for each phase. The vehicle timing requirements shall consider both directions of travel, and the time required to clear the intersection if there is not sufficient clear storage distance for the design vehicle. This is very important for simultaneous preemption, where a design vehicle approaching the highway-rail grade crossing from the intersection does not have sufficient storage between the intersection and the crossing. Additional time may be necessary to allow the vehicle to cross the intersection, the insufficient storage area, and the minimum track clear area.

Pedestrian Clearance Time

The pedestrian clearance time shall adhere to CA MUTCD, Section 4D.27 “Preemption and Priority Control of Traffic Control Signals”, which addresses the shortening or omission of pedestrian walk and clearance intervals. The application of permitted pedestrian control during the transition into preemption control requires the agreement of the highway agency. The walk interval, if provided, should be at least seven (7) seconds long so that pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time begins. For pedestrians in the crosswalk who left the curb or shoulder during the WALK signal indication, and who are traveling at a normal speed of 3.5 feet per second, the pedestrian clearance time, if provided, should be sufficient to allow them to reach at least the edge of the lane, or a median of sufficient width that they can wait safely. Where slower or less mobile pedestrians routinely use the crosswalk, a walking speed less than 3.5 feet per second and as low as 1.5 feet per second may be used in determining the pedestrian clearance time.

The “worst case” pedestrian interval is not restricted to pedestrian phases that run concurrently with vehicle phases serving traffic parallel to the tracks (or the track clearance phase). The “worst case” pedestrian interval may be associated with the vehicle phase approaching the highway-rail grade crossing. All pedestrian intervals that are required to time out must be evaluated to determine the maximum right-of-way transfer time.

3.14.5.2 Minimum RWTT

The minimum RWTT is the “best case” scenario in which all movements away from the tracks are being served when the preemption call is received by the traffic signal controller. If the intersection phasing operates with a permissive left turn for the approach that opposes the movement away from the track, then both movements must be terminated, and the clear track interval may be reestablished without serving any other movements. This would consist of the following timing parameters, in sequence:

- Minimum traffic signal green time
- Yellow change interval
- All-Red clearance interval
- Re-establish green clear track time

Some traffic signal controllers have the functional capability to lengthen the track clear green interval based on preprogrammed, required maximum right-of-way transfer times. This shall prevent the track clear green interval from terminating before the railroad warning system has been activated.

3.14.5.3 Queue Clearance Time

The queue clearance time (QCT) of the preemption sequence must be displayed long enough to clear all vehicles that might be stopped within the limits of the highway-rail grade crossing (minimum track clearance distance). Design vehicle characteristics, geometry of the highway-rail grade crossing, and the clear storage distance affect the queue clearance time.

There are two possible scenarios that determine the queue clearance time:

- If there is significant clear storage distance for the design vehicle, the queue clearance time provided must be sufficient to clear the minimum track clearance distance, but it is not required to clear every vehicle from the clear storage area.
- Although it is recommended that the queue clearance time provide enough time to remove all vehicles from the clear storage area, this is a jurisdictionally defined parameter that depends greatly on how long the clear storage distance might be.

The green indication for the queue clearance time should be displayed until the gates block the path of approaching vehicles, especially if the clear storage distance is insufficient for the design vehicle. The preemption calculations shall ensure that the gates start to descend before the queue clearance green interval terminates. This operation can be achieved through the use of a “gate down” circuit. (Refer to Section 6.1.2 for more information on “gate down” circuits). The queue clearance time should account for the following:

- Minimum track clearance distance
- Clear storage distance
- Start-up time of first vehicle in the queue and subsequent vehicles within the clear storage distance, and the minimum track clearance distance to travel through the intersection

If the clear storage distance has sufficient space for the design vehicle, the queue clearance time need only be sufficient to allow the design vehicle to start up and travel from the highway-rail grade crossing stop line to a point clear of the minimum track clearance distance.

The Los Angeles Department of Transportation "(LADOT) Railroad Preemption Form" shall be used to calculate the duration of the queue clearance time. The Texas Department of Transportation Traffic Signal Preemption at Highway-Rail Grade Crossings form may also be used.

Track Clearance Green Time

One factor that some highway agencies take into consideration is the design vehicle's ability to clear the railroad gate on the approaching side of the highway-rail grade crossing when given a green indication to proceed. The concern is with the gap between the cab and trailer of the semi tractor-trailer. If the travel lane is close to the railroad gate, there is a good possibility that the gate will start to descend before the design vehicle (AASHTO WB-65) has moved far enough forward to prevent the railroad gate from getting trapped in the gap between the cab of the semi-tractor and the trailer, thereby snapping the gate from the mechanism. This is a leading cause of broken gates. Therefore, an evaluation/calculation should be conducted to determine if additional time must be added to the queue clearance time to prevent this from occurring. The term used for this calculation is "track clearance green time." The track clearance green time should account for the following:

- Everything defined in the queue clearance time
- Distance from the vehicle to the railroad mechanism
- Time required for the design vehicle to start up at the highway-rail grade crossing stop line and move forward, such that the railroad gate will not get trapped in the gap between the cab of the semi-tractor and the trailer

The time for the design vehicle to start up at the stop line of the highway-rail grade crossing and travel to a point clear of the minimum track clearance distance is known as the track clearance green time (TCG).

The TCG should be compared to the queue clearance time, and the larger of the two should be used in the preemption calculations. The "LADOT Railroad Preemption Worksheet" shall be used to calculate the duration of the queue clearance time and the track clearance green time.

3.14.5.4 Separation Time

Separation Time (ST) is the time during which the minimum track clearance distance is clear of vehicle traffic prior to the arrival of the train. The separation time is important under the following conditions:

- High-speed trains are present
- The passing traffic includes a high percentage of trucks and buses

The separation time should be a defined value (typically four to eight seconds) that is based on an engineering evaluation of the highway-rail grade crossing. Variations in traffic signal operation may affect the actual separation time experienced at the crossing. The separation time shall be considered to be at its minimum when the right-of-way transfer time and the maximum highway traffic signal preemption time are the largest. The "worst case" (maximum right-of-way transfer time) and "best case" (minimum right-of-way transfer time) scenarios shall be explored in the determination of maximum highway-rail traffic signal preemption time and separation time.

3.14.5.5 Maximum Highway Traffic Signal Preemption Time

To provide sufficient queue clearance or track clearance green time for a highway-rail grade crossing, the controlling traffic signal must be notified in advance of a train's arrival. The total time required for this function—the advance notification time—is called the Maximum Highway Traffic Signal Preemption Time (MHTSPT). The MHTSPT is the maximum RWTT plus the QCT and the ST.

MHTSPT = Max RWTT + QCT + ST

3.14.5.6 Advance Preemption Time

Advance Preemption Time (APT) is the time above and beyond the MWT that is required to provide sufficient RWTT, QCT, or GTC, and ST. The minimum warning time includes any CT that is necessary for the highway-rail grade crossing.

The formulas shall be used to determine how much time is needed for the traffic signal system to appropriately accommodate an arriving train, and how much time is needed for the rail equipment. These design procedures and the "LADOT Railroad Preemption Worksheet" shall be used to determine the advance preemption time.

APT = MHTSPT – MWT

3.14.5.7 Total Approach Time

The Total Approach Time (TAT) is not necessary for calculation of the required preemption time, but it is very useful for the rail operator when determining where to place the detection equipment. The total approach time includes the total warning time, the advance preemption time, and the equipment response time. The total warning time includes the minimum warning time plus the buffer time.

TAT = TWT + APT + ERT

TWT = MWT + BT

3.14.6 Types of Preemptions

Simultaneous Preemption

Under simultaneous preemption, the railroad flashing lights start to flash at the same time the preemption notification is received by the traffic signal controller. Simultaneous preemption is easier to apply and minimizes the variables that might otherwise come into play between the railroad warning system and traffic signal system. However, simultaneous preemption provides limited total warning times and may result in excessive gate down time if additional warning times are included.

To discourage unsafe behavior by impatient motorists, the railroad flashing-light signals shall start to flash and the gate arm shall descend to its horizontal position in a minimal amount of time. The traffic signals shall complete the RWTT and queue clearance time while the railroad warning system is activated. Actual railroad warning times can vary depending on the variable times provided by railroads for each train movement and the phasing of the traffic signal controller when the preemption signal is established.

Advance Preemption

Under advance preemption, the traffic signal controller unit receives the preemption notification from the railroad warning equipment before the railroad warning system is activated. The difference between the MHTSPT and the minimum warning time is called the advance preemption time.

Advance preemption has the following benefits:

- Provides additional track clearance and separation time, which clears the intersection prior to lowering the gates
- Gives vehicles stopped under the gates time to start up and clear the gates before they descend
- Provides adequate queue clearance time
- Facilitates a smooth transition from conflicting movements to the track clearance phase

3.14.7 Preemption Trap and Potential Solutions

Preemption trap is the condition wherein the queue clearance or the track clearance green time ends before the railroad flashing-light signals start to flash and the gates start to descend. Vehicles will continue to cross the tracks until the railroad gates actually begin to descend. Some vehicles will even try to squeeze under the descending gate. Therefore, the downstream traffic signals must display a queue clearance green indication until the gates have descended. The condition is exacerbated if the traffic signal controller that is used does not have the ability to expand the queue clearance time based on the green time already allocated to the conflicting movement. To properly define the preemption parameters, a thorough understanding of the capabilities of the traffic signal controller that is to be used is required.

The following factors can also create a preemption trap:

- Any warning time variation that is different from the value used in the initial preemption calculation and programming of the traffic signal controller (if it is implemented without adjustments to the other preemption parameters).
- A longer advance preemption time that is different from the value used in the initial preemption calculation and programming of the traffic signal controller (if implemented without adjustments to the traffic signal controller parameters).

These variations in time create a preemption trap.

Under simultaneous preemption, the railroad warning lights start to flash at the same time the preemption notification is received by the traffic signal controller. Therefore, the queue clearance green interval cannot end before the lights start to flash.

The main cause of the preemption trap is the "uncoupling" of the preemption notification from the warning light activation in the preemption calculations. This results in two separate processes, with no fixed time relationship between them.
The evaluation of the maximum highway traffic signal preemption time should evaluate all possible approaches to determine the maximum right-of-way transfer time. Potential solutions for the preemption trap shall be considered and implemented. The following are some of the methods that may be used to avoid preemption traps:

- Increase the queue clearance green interval in the traffic signal controller unit. The queue clearance green interval should be displayed at least until the gates start to descend, and ideally until the gates block the path of approaching vehicles. The use of older traffic signal controllers cannot guarantee that the gates will be down when the queue clearance green interval terminates. Increasing the track clearance green time may not be the best option, because an increased overall delay to the signalized intersection can cause other congestion-related problems, especially if train volumes are high.
- Use a controller that is capable of dynamically calculating the RWTT and adding the difference to the QCT to account for the variations in allocated (versus used) green time for the conflicting movements.
- Use a "gate down" circuit to guarantee that the queue clearance phase terminates only after the gates are down. This is the preferred method. Refer to Section 6.1.2 for more information on "gate down" circuits.
- Use the "not to exceed" timing circuit. A not-to-exceed timer may be able to control the maximum advance preemption time, but it will not be able to prevent shorter advance preemption times.
- Use the preemption delay function in the traffic signal controller unit to adjust the actual implementation of the preemption sequence so it more closely coincides with the railroad gate's descent.
- The highway agency should consider changing its traffic signal controller unit specifications, selecting a unit that has the ability to adjust the queue clearance green interval based on variations in the time allocated versus the green time used for the conflicting movements.
- The traffic signal controller should also have the functional ability to recognize a second preemption call during the initial preemption sequence, and either maintain the preemption hold state or reserve the queue clearance time before the railroad gates begin to descend for the second train.
- Consider the potential of conditional service solutions to prevent the preemption trap. Conditional service allows a signal phase to be served twice during the same cycle.

3.14.8 Preemption Timing Scenarios

The highway agency shall complete the "LADOT Railroad Preemption Worksheet" for both "worst case" and "best case" scenarios (see Section 3.14.5.1 and 3.14.5.2) for simultaneous and advance preemption scenarios. The evaluation shall consider all feasible approaches to the highway-rail grade crossing. The LADOT Worksheet, along with SCRRA's Highway-Rail Grade Crossing Traffic Signal Preemption Request Form (see Appendix D), shall be submitted to SCRRA for review and approval.

3.14.9 Other Preemption Considerations

Multiple Tracks

Multiple tracks at highway-rail intersections introduce two problems that must be considered when designing a preemption timing plan:

- Additional clearance distance is required during the queue clearance time. The additional clearance distance increases the track clearance green time and thus increases the total approach time required for preemption.
- The possibility that a second preemption call could be sent to the controller unit, immediately after the first preemption input, is removed. This occurs when a train traveling on the second track approaches a crossing right after a train on the first track has left the highway-rail grade crossing area.

Older traffic signal controller units could not recognize a second preemption call that was received while the first preemption was being serviced; the first preemption sequence had to time out first. Typically, the older traffic signal control units would then continue in the hold state even though the railroad gates had risen. If the railroad gates were to rise before the control unit recognized the second preemption call, it could lead to skipping the clear track interval and potentially trapping vehicles on the tracks.

Provisions to avoid this problem may include use of an “extended hold” to keep the highway-rail grade crossing gates down until the second train has arrived, as well as use of traffic signal control logic that ensures that a second track clearance can be provided in the event the gates have been raised prior to the arrival of a second train.

When pedestrian clearance time becomes a driving factor for long preemption times and affects levels of service at an intersection, consideration should be given to providing a separate pedestrian input to the traffic signal controller. This is particularly true when there is a station stop in the approach to the highway-rail grade crossing.

The determination whether to use the vehicle gate interaction time shall be determined jointly by the railroad and highway agency. Among the factors to be considered are whether the highway-rail grade crossing has a history of broken gates and the impact on the additional preemption to the level of service.

Multiple Intersections

Where a highway-rail grade crossing is located between two closely spaced signalized intersections, the two highway traffic signals must be interconnected. Further, their preemptions must be coordinated to permit the tracks to be cleared in both directions.

When the railroad diagonally crosses two interconnected highway intersections, it is normally necessary to clear out traffic on both highways prior to the arrival of the train, requiring approximately twice the preemption time computed for a single approach. An example of this condition is shown in Figure 3-34. Both railroad warning systems shall be designed to operate concurrently to prevent the traffic signals and railroad warning systems from falling out of coordination with each other. When the railroad warning system is activated, traffic leaving the intersection and approaching the highway-rail grade crossing may queue back into the intersection and block traffic if there is not adequate storage for those vehicles between the highway-rail grade crossing and the intersection. Traffic turning at the intersection toward the other highway-rail grade crossing may also be unable to proceed due to stopped traffic. When this occurs, the following recommended solutions could be used:

- Utilization of advance preemption
- Activating one highway-rail grade crossing before the other
- Extension of gate delay time and minimum warning time
- Use of blank-out turn restriction signs

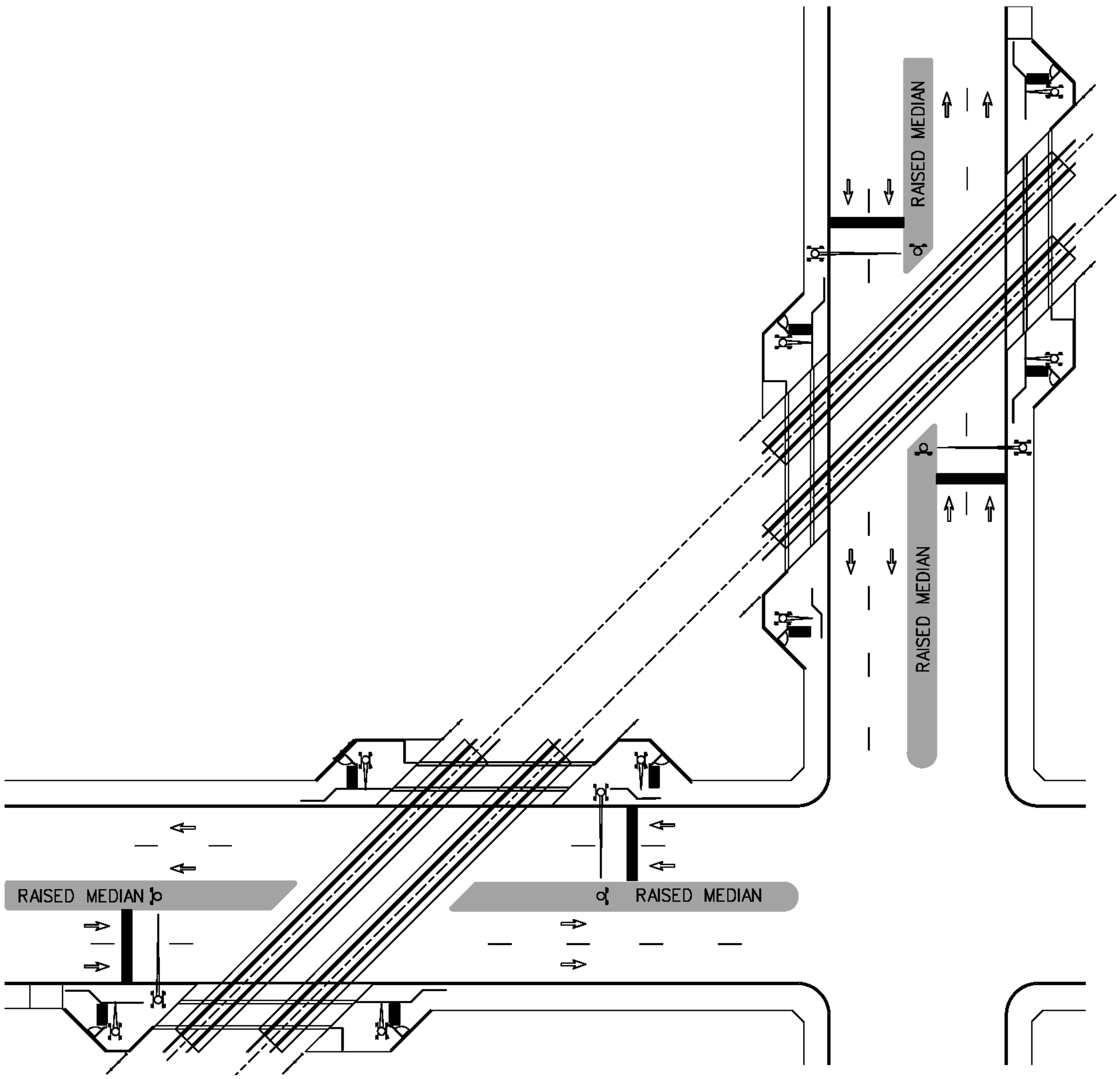


Figure 3-34. Railroad Diagonally Crossing Two Interconnected Highway Intersections

3.14.10 Preemption Form with Gate Interaction

It is SCRRA's policy for designers to use the "LADOT Railroad Preemption Form" spreadsheet to determine the amount of advance preemption and track clearance green time needed at preempted traffic signals near highway-rail grade crossings. **Total Approach Time for highway-rail grade crossing warning systems shall not exceed 50 seconds.** Requests for additional traffic signal preemption time will be submitted, through a special design consideration, to SCRRA's PTC, C&S Engineering Services Department for review and approval. The LADOT Railroad Preemption Form is included in Appendix D-1, while an electronic version is available from SCRRA upon request.

This tool also provides a graphical depiction of the timeline of events occurring prior to train arrival at the highway-rail grade crossing to help the user visualize the effects of changes in preemption timing. It was designed to simplify the process of determining specific preemption timing values, and to enable the user to experiment with different scenarios based upon engineering judgment. The form computes the necessary times based upon input data regarding specific geometric, signal timing, and railroad equipment parameters. As data is entered into the form, a timeline is updated to show the effect of each entry. Once all the entries are completed, the timelines can be reviewed to determine whether the settings are appropriate for the crossing. This gives the user the ability to experiment with different timings and immediately see the result of those changes.

3.15 RAILROAD FEATURES

3.15.1 Gate Operations Near Stations

Most stations function as both near-side and far-side stations (relative to the highway-rail grade crossing and the travel direction of the trains). Figure 3-35 shows a station adjacent to a highway-rail grade crossing.

Figure 3-35. Stations near a Highway-Rail Grade Crossing

The station scenarios described below are ideal; however, each situation is unique and should be carefully examined during the diagnostic analysis and design in order to address the challenges at the highway-rail grade crossing and station interface.

3.15.1.1 Near-Side Station

A station functions as a near-side station when a passenger train stops at the station before proceeding through the highway-rail grade crossing. In cases where the station is within the highway-rail grade crossing detection circuitry, but not directly adjacent to the crossing, it is desirable to have the highway-rail grade crossing gates remain raised until the train is ready to depart (assuming there is sufficient distance between the highway-rail grade crossing and the station to allow this protocol). *When stations are very near vehicular crossings, it may be preferable to have the gates remain down while the train is waiting in the station to depart.* This is particularly important at a multiple-track station adjacent to a crossing, where the train stopped at the station may block the view of a second oncoming or overtaking train in the far track.

3.15.1.2 Far-Side Station

A station functions as a far-side station when passenger trains proceed through the highway-rail grade crossing before stopping at the station. The highway-rail grade crossing gates should recover immediately after the train proceeds through the highway-rail grade crossing unless a second train is approaching on the opposite track (in the case of multiple-track stations only), in which case the gates shall react and remain down as required.

3.15.2 Track Structure

The track structure within the highway-rail grade crossing is defined from the subgrade up through the highway surface. All components of the track structure shall be designed in accordance with SCRRA Engineering Standards to:

- Minimize maintenance.
- Minimize opportunities for vehicles to become trapped on the tracks due to an uneven surface or failing pavement.
- Maximize the lifetime of the track structure.

Within the limits of the highway-rail grade crossing, the track structure works in concert with the highway structure to provide a smooth, safe, and efficient means for vehicles to cross the tracks. It is important to note that the track structure—designed for maintenance and sustainability—is a significantly stiffer structure than the highway structure on the approaches. With the addition of concrete crossing panels and asphalt overlays, the track modulus is significantly increased. The effects of this increase are mitigated within the structure to maintain an effective highway-rail grade crossing design.

In the design of the track structure, the conditions existing at the highway-rail grade crossing shall be thoroughly examined to detect any indications of failure of the surface or structure. The track structure at highway-rail grade crossings shall follow SCRRA design standards and meet the following criteria:

- No exothermic rail welds, insulated joints, or bonds shall be placed in highway-rail grade crossings or within 10 feet of a crossing.
- No turnouts or crossovers shall be located within a crossing.
- The highway-rail grade crossing structure shall be designed to permit the maximum amount of drainage of the track structure. Therefore, it may be necessary to construct underdrains within the vicinity of the highway-rail grade crossing to maximize the highway-rail grade crossing life. Under no circumstances shall street surface or gutter runoff be permitted to flow into the track structure.

3.15.3 Multiple Tracks

Multiple, parallel tracks within the highway-rail grade crossing create additional concerns that need to be addressed. The following concerns shall be mitigated during the design of the crossing:

- The curvature of the railroad tracks and the resulting superelevation of the tracks shall be evaluated and addressed within the design. Refer to Section 3.4 for additional details on geometry.
- The path for a pedestrian to traverse the highway-rail grade crossing shall be designed for the shortest and quickest path across the crossing. This is especially important with skewed crossings that inherently increases the width of a crossing.
- Visibility of a second train approaching on an adjacent track shall be considered.
- Visibility of all active tracks, where a train may be temporarily stopped or spotted on the adjacent track, shall be considered. This is especially important when the adjacent track is a siding or industrial lead where locomotive and railroad cars may be stored for long durations.
- Refer to Section 5.1 for issues related to consideration of grade separation based on multiple tracks at the crossing.

3.15.4 Geometry

Horizontal curves on mainline tracks are superelevated to account for vehicle dynamics. This superelevation is accomplished through maintaining the profile of the low rail (the inside rail) and lifting the outside rail to superelevate the track. Traditionally, the railroad profile shown in drawings and track charts refer to the low rail as the profile grade. The horizontal geometry will define the amount of superelevation applied to the track.

Where highway-rail grade crossings are located within a superelevated curve, the surface of the highway plane should be in the same plane as the top of rails of the superelevated curve. This minimizes undulations in the highway surface that can cause a vehicle to become stranded on the tracks. The Highway Agency should review the roadway interface at the crossing and determine if traffic speed on the approaches and through the crossing should be reduced due to the undulations of the railroad superelevation.

At multiple-track crossings involving concentric superelevated curves, the inside rails for each track may be at equal elevations, while the outside rail are also at equal elevations. The elevations of the four individual rails create an uneven surface through the highway-rail grade crossing. Figure 3-36 is an example of superelevated curves within a highway-rail grade crossing that are not on an even plane.

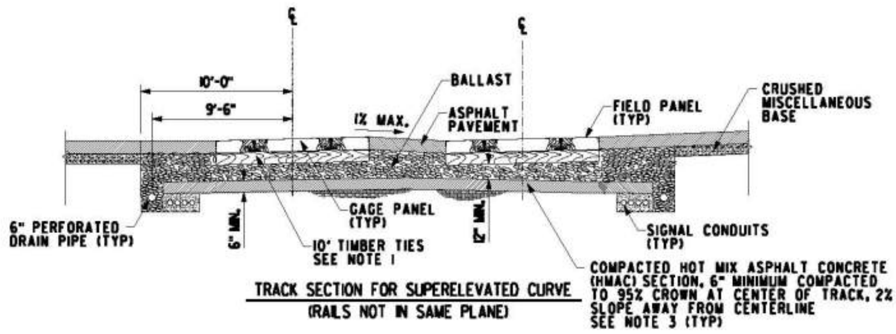


Figure 3-36. Uneven Highway Surface Created by Superelevation

To avoid this situation, multiple tracks shall be brought to the same plane to provide a smooth and level highway-rail grade crossing plane for the highway as shown in Figure 3-37.

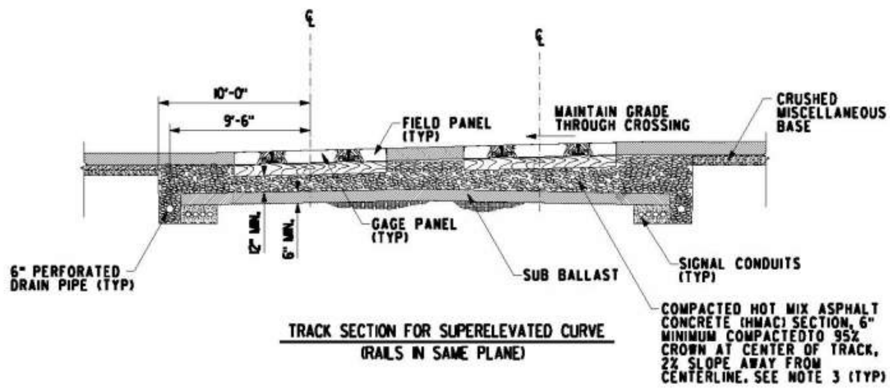


Figure 3-37. Superelevation with Rails in the Same Plane

This may not always be possible due to railroad vertical profile constraints; therefore, highway vertical profiles should be designed on either side of the highway-rail grade crossing to provide as smooth a transition as feasible, and to provide the proper clearance for the lowest vertical clearance design vehicle. Additional warning signs (such as a W10-5) are required to alert motorists of a low-clearance situation.

3.15.5 Special Trackwork

Highway-rail grade crossings located in close proximity to special trackwork are discouraged. The main concerns about the proximity of special trackwork to a highway-rail grade crossing are as follows:

- Additional train movements with switching movements.

- No exothermic rail welds, insulated joints, or bonds shall be placed in highway-rail grade crossings or within 10 feet of a crossing.
- Signal design concerns related to adjacent railroad signals associated with the special trackwork.
- Additional prolonged railroad activity within the highway-rail grade crossing limits related to industry lead service.

The point of switch for turnouts and crossovers should be located a minimum of 100 feet from the edge of traveled roadway or sidewalk, if present. Figure 3-38 shows such an application. When turnouts and crossovers are close to the highway-rail grade crossing, the lead Engineer shall consult SCRRA about the railroad's need for special trackwork and shall refer to SCRRA communications and signal Engineering Standards.

Figure 3-38. Location of Turnout Adjacent to Highway-Rail Grade Crossing

3.15.6 Utilities

The term "utilities" includes electric power, cable TV, and lines for: telephone, water, sewer, gas, communications, street lighting, traffic signals, waste water, fuel, and oil.

Railroad right-of-way typically contains a wide variety of utilities that are related to the operations of the railroad and other public or private uses. The design shall address the location of each affected utility and mitigate the impacts on these utilities. The lead Engineer shall obtain the necessary right-of-way information regarding the license/easement agreements related to the utility and address any modifications that may be required. This includes potential limitations on access as a result of the construction of the crossing, the preservation of access for the utility for maintenance purposes, and safety impacts of the highway-rail grade crossing related to the utility.

After the acceptance of plans by SCRRA and other stakeholders, the lead Engineer shall submit and obtain written approval of design from all utilities within the construction area.

This includes all utilities that have established prior-use of the right-of-way under easement or license agreements.

For a new highway-rail grade crossing, existing underground and aboveground utilities shall be identified and mitigated, if needed, prior to any construction. When the new crossings involve gates, the minimum required clearance from existing overhead wires shall be maintained per SCRRA ES 2104, and gate foundations checked for utilities.

The lead Engineer shall locate and note all utilities in place at the crossing. These utilities shall be confirmed by potholing or other method to determine location and depth. This is especially important where additional highway-rail grade crossing devices are to be installed or existing devices relocated. The location of any utilities in relation to any device foundations or other structural considerations shall be reviewed and addressed.

The installation of conduits or encasements under the railroad shall be in accordance with SCRRA ES 5001 and ES 5002 for utility crossings. In addition, SCRRA requirements for details on jacking pipes or conduits under SCRRA tracks per SCRRA ES 5001 and ES 5002 shall be complied with.

3.15.7 Signs and Billboards

Advertising billboards are often located along the open spaces of the railroad right-of-way. These are to be treated as individual right-of-way items that shall be addressed early in the design phase. The lease agreements between the two parties often create special and time-consuming circumstances that must be addressed early to avoid delays if the billboards or signs must be relocated. The removal or relocation of a billboard shall be coordinated with the right-of-way departments of SCRRA member agencies.

Billboards and sign structures can create visibility problems and distract the motor vehicle operator’s attention from the warning devices locate near or at the highway-rail grade crossing. Figure 3-39 illustrates how billboards and signs can block the view of a crossing.

Figure 3-39. Billboard within the Railroad Right-of-Way

In many cases these billboards are mounted on substantial columns, impeding the view down the railroad right-of-way. Signage placed within or adjacent to the right-of-way for traffic control or other purposes must also be addressed during design. When developing the overall design of the crossing, the current locations of existing signs and billboards, and the ultimate effect that this placement will have on the operation of the crossing shall be considered and mitigated. Signs that could impede visibility should be noted during the diagnostic review and, if necessary, recommendations should be made regarding the treatment of these signs.

Enhancements to highway-rail grade crossings that involve improved pedestrian access, additional warning devices, widened highways, and additional traffic signal equipment may be affected by billboards located adjacent to the crossing. It may be necessary to remove or relocate the billboard prior to construction.

3.16 FUTURE IMPROVEMENTS

Enhancements to the highway-rail grade crossings, such as median islands, traffic signal system, preemption, widening, pedestrian and vehicular facilities, should be designed and constructed, such that future railroad improvements [second or more track(s)] and/or other railroad improvements can be accommodated without the need to completely modify the current elements of the crossing. *The lead Engineer should be cognizant of the potential to improve the highway-rail grade crossing system for future SCRRA tracks and other facilities. The design should incorporate the necessary accommodation of future railroad improvements.*

4.0 PEDESTRAIN-RAIL GRADE CROSSINGS

4.1 GENERAL

Pedestrians at highway-rail grade crossings present unique challenges. Many of the same considerations given to motor vehicles – such as channelization, signs, and warning lights – also apply to pedestrians. This section of the Manual will discuss and define the components and treatments that together, all or in part, comprise a pedestrian-rail grade crossing and then will describe the applications at the different types of pedestrian-rail grade crossings. Pedestrian-rail grade crossings can be placed in four different categories:

- Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings
- Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings and Adjacent to Rail Passenger Station
- Pedestrian-Rail Grade Crossings at Stations
- Pedestrian-Rail Grade Crossings

Each of these types of pedestrian-rail grade crossings generates unique challenges that need to be addressed during the design phase. In general, pedestrian-rail grade crossing design should facilitate efficient and safe travel across the railroad right-of-way.

The design of pedestrian-rail grade crossings and installation of pedestrian treatments shall be in accordance with the process in Section 4.8 and the Pedestrian-Rail Grade Crossing Design Consideration Flowchart in Figure 4-4. This process shall be similar for any type of pedestrian-rail grade crossing and defines SCRRA's required approach to the application of pedestrian treatments at pedestrian-rail grade crossings.

It is desirable that the pedestrian-rail grade crossing have the following features:

- A smooth, easily traversed surface that does not impede individuals with disabilities, strollers, or carts, incorporated into the adjacent sidewalk topography.
- Clear striping and signage that avoids confusing directions or features, a relatively straight path that is clearly marked and easily accessible throughout the footprint of the crossing and a readily accessible means of exiting the crossing.
- Deterrents such as signage, fences, and gates that minimize trespassing into prohibited areas of the railroad right-of-way.

4.2 PEDESTRIAN-RAIL GRADE CROSSING TYPES

The design of a pedestrian-rail grade crossing should provide an environment that provides ample opportunities for pedestrians to observe and comply with the warning devices and stay clear of any approaching train traffic. The decision to select passive and active warning devices depends upon the four types of crossing noted in Section 4.1. With each type, the following factors need to be considered:

1. The number of tracks, type of tracks (i.e. main, siding, industry lead), and track speeds
2. The proximity to rail passenger stations
3. The proximity to other rail facilities such as sidings, yards, industry spurs
4. The skew and vertical profile across the crossing
5. Establishment of quiet zones
6. Travel distance across tracks to reach a location well outside of train dynamic envelope
7. Skew and vertical profile across the rail crossing
8. Visibility restrictions
    a. Sight distance for pedestrians (as well as motorists) viewing approaching trains and conversely for trains viewing approaching or waiting pedestrians/vehicles.
9. Existing and future pedestrian and bicycle activity
10. Type of path (pedestrian only or combined pedestrian and bicycle)
11. The volume and pattern of pedestrian activity
12. Type of pedestrian activity (i.e., school, transit, hospital)
13. Current and future development (including transit service and transit oriented development) in close proximity to the pedestrian-rail crossing
14. Right-of-way constraints

4.2.1 Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings

Most pedestrian-rail grade crossings on SCRRA's system are of the type where the pedestrian-rail grade crossing is a part of the highway-rail grade crossing and is located on one or both sides of the highway and the highway-rail grade crossing.

When beginning the design for modifications to a highway-rail grade crossing, the lead Engineer should determine whether the highway agency allows pedestrians along the highway and to what degree pedestrian facilities are already in existence. A flowchart detailing the decision process for determining the type of pedestrian treatments warranted for a highway-rail grade crossing is provided in Section 4.8.

4.2.2 Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings and Adjacent to Rail Passenger Stations

Combined pedestrian-rail grade and highway-rail grade crossings near rail stations are considerably more complex than pedestrian crossings not near a rail station and represent a special case of pedestrian-rail grade crossings. Some of the complicating factors are as follows:

- These pedestrian-rail crossings may be used by large groups of commuter rail patrons accessing the platforms and by pedestrians crossing the tracks.

- The level of pedestrian activity at a station crossing is directly associated with the departure and arrival of passenger trains and other transit modes such as buses and shuttles; it is also associated with the presence of parking lots.
- The stopping patterns and dwell times of trains affect the performance of the active warning devices.

The lead Engineer shall follow the same design process used for a pedestrian-rail grade crossing adjacent to a highway-rail grade and determine the appropriate pedestrian treatments as provided in Section 4.8.

4.2.3 Pedestrian-Rail Grade Crossings at Stations

Pedestrian-rail grade crossings at stations (not located at highway-rail grade crossings) are primarily used by commuter rail patrons accessing the platforms; however, in some circumstances they may also be used by pedestrians to cross the rail corridor.

As noted in Section 4.2.2, the level of pedestrian activity at a station crossing is directly associated with the departure and arrival of passenger trains. Because of this, **station pedestrian-rail grade crossings shall provide "full pedestrian treatments" (signage, channelization, active pedestrian warning devices with gates, and swing gates) and fencing, and shall not cross more than two (2) tracks.**

Currently, there are two types of pedestrian-rail grade crossing configurations at stations on SCRRA's system:

(1) Pedestrian-rail crossings at any location on the platform

- Due to safety concerns and operating restrictions, **new pedestrian-rail grade crossings at any location on platforms shall not be allowed.**
- Reconstruction of existing stations that have a pedestrian-rail grade crossing at any location on the platform shall be relocate the pedestrian-rail grade crossing beyond the ends of the platform.
- If the pedestrian-rail grade crossing cannot be relocated beyond the ends of the platform, then a pedestrian grade separation (Overhead or Underpass) shall be constructed.

(2) Pedestrian-rail grade crossings located past the ends of platforms

- **New station pedestrian-rail grade crossings shall be constructed approximately 60 feet from the ends of the platform and include full pedestrian treatments.**
- It is desirable to have the gates recover during normal station dwell time.
- Fencing or metal hand railing should properly channelize pedestrians across the tracks at the pedestrian-rail grade crossing and deter the public from taking a "short cut" and trespassing across the tracks in prohibited areas.

4.2.3.1 Pedestrian-Rail Grade Crossing vs. Grade Separation at Stations

Pedestrian-rail grade crossings at stations shall be evaluated for grade separation per the criterion in Table 4-1, along with an analysis of the train volumes and pedestrian volumes. The lead Engineer will work and coordinate with SCRRA for the determination of the need for grade separation when pedestrians are required to cross two or more tracks to reach a platform.

Table 4-1. Pedestrian Crossing Configuration at Stations

Access to Platform(s) Requires Crossing:	Pedestrian Crossing Configuration
One Track	- Pedestrian-rail grade crossing acceptable
Two or More Tracks	- Consider pedestrian grade separation per Section 5.1

SCRRA concurs with the key conclusions of the FRA Guidance on Pedestrian Crossing Safety At or Near Passenger Stations, dated April 2012, which can be downloaded at https://www.fra.dot.gov/Elib/Document/2132. In particular, SCRRA concurs with this statement found within this document, “FRA recommends that railroads with busy passenger stations located on multi-track rail lines (particularly those with three or more main tracks) with frequent freight service should investigate the application of a high-capacity grade separation structure to carry large volumes of pedestrians to and from their busy passenger platforms, separated from the potential hazards of a crossing a multi-track railroad at-grade.”

4.2.4 Pedestrian-Rail Grade Crossings (for Pedestrians Only)

Pedestrian-rail grade crossings are crossing for pedestrians only. Pedestrian-rail grade crossings shall follow the same design process as a pedestrian-rail grade crossing at highway-rail grade crossings in Section 4.2.1.

SCRRA’s policy on new highway-rail grade crossings (Section 1.7) shall also apply to any new pedestrian-rail grade crossing; in that any **new pedestrian-rail grade crossings shall not be allowed unless one or more existing pedestrian-rail or highway-rail grade crossings are closed.**

Pedestrian-rail grade crossings are typically associated with walking paths and bike trails adjacent to the railroad right-of-way. Pedestrians may be tempted to take shortcuts and trespass rather than use the designated pedestrian crossings. This behavior shall be considered when designing the crossing and place the proper fencing and channelization to address this undesirable behavior. Where the right-of-way permits, the use of zig-zag channelization, referred to Section 4.7.1, should also be considered by the diagnostic team.

4.3 TEN-MINUTE WALK RULE

In order to determine if a crossing has, or has the potential for, pedestrian activity, pedestrian-rail grade crossings shall be evaluated using the 10-minute walk rule. This rule is based upon research conclusions that pedestrians will walk ten minutes to reach their destination. This equates to a one-half mile walk. Therefore, if the crossing is located within this radius of schools, hospitals, substantial pedestrian generators or other facilities, then full pedestrian treatment features shall be installed at the crossing.

4.4 AMERICANS WITH DISABILITIES ACT

The Americans with Disabilities Act Accessibility Guidelines (ADAAG) govern the design and construction of any features associated with pedestrian crossings. **ADA Accessibility Guidelines must be incorporated into the overall design for pedestrian-rail grade crossings.**

4.4.1 Detectable Warning Strips

The ADAAG requires that detectable warning be placed on approaches to hazardous vehicular areas, which includes highway-rail grade crossings (ADAAG 4.29.5). Detectable warning strips shall be installed on the sidewalk ahead of the warning device in order to show pedestrians where to stop when a train is approaching. The width of the detectable warning strip shall be three (3) feet wide as prescribed by the ADAAG.

The detectable warning strip shall also be placed in front of the pedestrian swing gates to warn people that there is a hazardous vehicle area beyond the swing gate.

The placement of the detectable warning strip shall follow the standards outlined in SCRRA's Engineering Standards.

4.4.2 Flangeway Gap

The track structure is made up of many components. The component that most affects the pedestrian-rail grade crossing is the flangeway. The flangeway is the area between the inside edge of the rail and the crossing surface, which allows the flange of the train wheel to ride along the rail, see Figure 4-1.

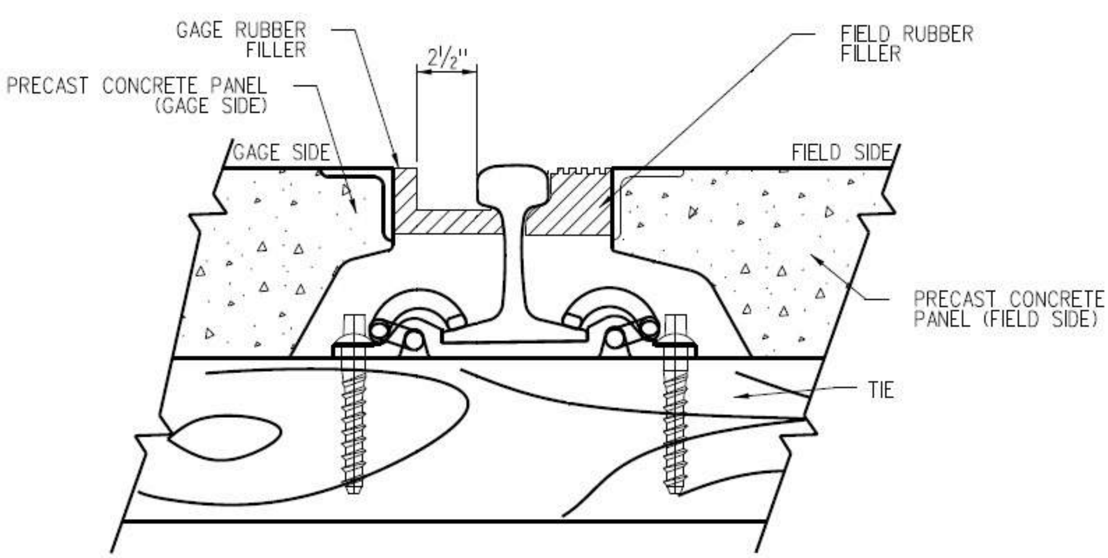


Figure 4-1. Flangeway Gap

The ADAAG limits the width of the flangeway gap to a maximum of two and a half (2½) inches (ADAAG 10.3.1). The surface of the crossing shall be level and flush with the top of the rail at the outer edge and between the rails. Freight railroads require a three (3) inch flangeway gap at installation to allow for wear of about one (1) inch in regular use. To accommodate both ADA and freight requirements, SCRRA standards call for a rubber flangeway filler for all new or improved crossings. The rubber filler allows a 2 and a half (2½) inch gap to be maintained for ADA requirements while providing flexibility to provide a three (3) inch gap by being compressed to provide an extra half inch as wheels of the freight train pushes against the rubber filler as it crosses over the concrete panel. After the freight train passes over the concrete panels, the rubber filler will return to its undisturbed shape and maintain the two and a half (2½) inch gap.

4.5 VISIBILITY

Visibility between trains and pedestrians shall be considered during the diagnostic analysis and design of the crossing. The design should provide the pedestrian reasonable visibility of a train upon its approach and departure. This is important when dealing with a multi-track crossing, when the view of an approaching train may be blocked by an additional train. In general, the installation of active warning devices including automatic gates and appropriate fencing will mitigate for the lack of visibility. During the initial site assessment, all features in and around the crossing that could impede pedestrian visibility shall be examined. Pedestrian gates shall be equipped with two-way warning lights, for all pedestrian approaches, aimed at the pedestrian path.
Many features present at a highway-rail grade crossing can hinder visibility for the pedestrian. These features may include the following:

- Buildings and/or walls
- Billboards, signs, and utilities
- Trees and other vegetation
- Traffic patterns of motor vehicles at the crossing
- An adjacent bus stop shelter and bus operations associated with that shelter
- Trains stopped at multiple-track crossings
- Adjacent developments such as housing units, buildings, and industrial parks
- Railroad features such as signal shelters and cabinets

The overall visibility at the crossing shall be considered from the pedestrian's perspective and deficiencies that could diminish the intrinsic safety of the crossing shall be mitigated. During the diagnostic analysis and inventory, the diagnostic team shall consider the following and take appropriate action:

- Diagram the crossing to show the obstructions to pedestrian visibility and incorporate solutions/mitigations into the design of the crossing.
- Examine each of the features at the crossing, and thoroughly explore the risk arising from those features. Include recommendations to remove a feature that is severely impeding pedestrian visibility.

- Additional devices or signage may be necessary to offset the lack of visibility created by the obstructions; however, placement of each of these devices should be carefully examined for compatibility with existing features.

4.6 WARNING DEVICES

Warning devices warn pedestrians of approaching trains and dictate the pedestrian to not cross the tracks. As with highway-rail grade crossings, there are two types of warning devices for pedestrian-rail grade crossings:

- Active Warning Devices
- Passive Warning Devices

4.6.1 Active Warning Devices

Active warning devices applicable for pedestrian-rail grade crossings are usually similar to those for vehicles. Active pedestrian warning devices include pedestrian gates, which is a variation of the CPUC Standard No. 9, with the main difference being that they have shorter gate arms and no counterweight. The active pedestrian warning devices also have an additional pair of flashers focused on pedestrian pathways facing the tracks. Refer to SCRRA ES 8308 and 8309 for pedestrian gate standards.

Active warning devices that are used to aid pedestrians take on a variety of configurations. Refer to SCRRA ES 4011 - 4021 for examples of these configurations.

Active warning devices for pedestrian-rail grade crossings shall be installed 15 feet from the centerline of the track, as measured from the center of the mast at new or existing crossings. A Special Design Consideration may be requested for active warning devices installed less than 15 feet from the centerline of the track, but in no case, shall an active warning device be installed less than 12 feet from the centerline of the track.

The location of adjacent track(s) owned and operated by another railroad company creates conditions that need to be evaluated during the design of warning devices for vehicles and pedestrians. The responsibility of installing and maintaining warning devices at the crossing will fall on the railroad that owns and operates the part of the crossing on which the warning devices are required. In such cases, there may be two separate crossing warning systems, one from SCRRA and one from the foreign railroad, at the crossing that must be interconnected to work in conjunction with each other. Coordination with the foreign railroad must be done throughout the design stages to ensure that adequate warning devices are installed at the highway-rail grade crossing and will work in conjunction with one another.

4.6.2 Passive Warning Devices

4.6.2.1 Signage

Signage is utilized throughout a crossing to guide pedestrians safely through it. Of particular note, are the signs warning pedestrians of multiple tracks, and the possibility of multiple trains at the crossing. These signs should be used at the approaches to the crossing. The potential presence of a second train is an important consideration when applying signage to the crossing.

4.6.2.2 Pavement Markings

Pavement markings for pedestrian-rail grade crossing should generally consist of white striping, similar to crosswalk striping for highways. Refer to the SCRRA ES 4006 and ES 4011 - 4021 for details on pavement markings. All pavement markings shall be thermoplastic per SCRRA ES 4006.

4.6.2.3 Swing Gates

Pedestrian swing gates have two distinct functions: they can serve as an entry/exit swing gate, or strictly as an emergency exit gate, as explained in further detail below:

- As an entry/exit swing gate, the swing gate is intended, when not used with a pedestrian-rail grade crossing gate, to slow pedestrians and encourage them to stop, look both ways down the track for approaching trains, and then pull the swing gate open to safely cross the tracks. A “LOOK” sign, as detailed in SCRRA ES 4002, shall be mounted on the approach side on the swing gate or on a separate post next to the swing gate. Particularly at pedestrian-only crossings without active warning devices and automatic gates, the pedestrian must determine if there is sufficient time to cross the tracks in front of an approaching train. The design of the crossing should provide the pedestrian with adequate visibility. Appropriate “Push Gate To Open” signs on the track side and “Pull Gate To Open” signs on the approach side shall be mounted on the entry/exit swing gates.
- As an emergency exit gate, the swing gate is incorporated with an active warning device, so pedestrians shall have an escape route in the event of occupying the crossing during the time when a crossing gate is activated. The gate shall only swing away from the crossing, with clearly marked “Push Gate To Open” signage on the track side. The approach side of the swing gate shall have signage marked as “Exit Only” to deter pedestrians from using the gates and entering the crossing while the active warning gates are activated.

Refer to SCRRA ES 4002 for details on the swing gates and signs. The responsibility for the installation and maintenance of swing gates shall be covered in a C&M Agreement.

4.7 CHANNELIZATION

The design of pedestrian-rail grade crossings shall provide clear, well-defined traveled-ways throughout the crossing and should discourage improper pedestrian behavior, such as circumventing the gates, walking onto the railroad right-of-way, or walking onto the highway. Fencing or railing should be provided along the sidewalk to direct pedestrians along the proper path. Coordination with the SCRRA Signal Department is required to ensure this railing, to the extent possible, does not block or impede maintenance access to railroad signal devices (See Section 8.8), and does not interfere with the location of the devices used for sealing the corridor. This channelization device can be tubular steel railing, ornamental fencing, or welded wire mesh fencing. The type of channelization device to be used shall be discussed and agreed upon with the highway agency.

Additional controls shall be used to identify the pedestrian travel-way such as striping per Section 4.6.2.2. Bold, white striping is used to delineate the pedestrian's safest path across the crossing. Refer to SCRRA ES 4011 - 4021 for examples of these treatments.

4.7.1 Influencing Pedestrian Line of Sight

The channelization of pedestrians is particularly effective when attention can be directed along a given line of sight. By controlling the direction taken by pedestrians approaching a crossing, pedestrians may be influenced to look in a given direction. For example, the creation of a zigzag pedestrian path forces the pedestrian to look along both approaches of the crossing, maximizing the likelihood that the pedestrian will notice trains approaching from either direction. Figure 4-2 illustrates this type of channelization on the approach to the pedestrian-rail grade crossing.

Figure 4-2. Pedestrian Channelization

4.7.2 Trespass Prevention

Pedestrians sometimes trespass into prohibited areas of the railroad right-of-way. This problem requires special consideration. Traditional designs have often used fencing to keep pedestrians out of protected areas. "No Trespassing" signs, complete with warnings about enforcement and prosecution, have also been used. During the diagnostic review, the team should review pedestrian access to the railroad right-of-way and develop safe and effective solutions to prevent unwanted trespassing onto the railroad right-of-way.

4.7.3 Inter-Track Fence

An inter-track fence is a fence between two tracks, at a station, that prevent pedestrians from unsafely crossing the tracks to get from one platform to the other platform. **At stations, track centers shall be a minimum of 19 feet-6 inches but not more than**

25 feet to accommodate an inter-track fence. Such fences must have an 8'-6" minimum (on tangent) clearance from each track center. If the inter-track fence is required through a curved alignment, the clearance from the fence to the track centerline must meet the CPUC GO 26 minimum requirement of 9'-6". The fence shall encompass the platform and channel the passengers to crossings at the ends of the platforms. The height of the inter-track fence shall be 4' within 150' of any crossing (station or highway) to ensure that proper visibility is maintained between the train and motorist/bicyclist/pedestrian. Where tracks cannot be widened to accommodate an inter-track fence, proper signage should be installed to deter pedestrians from crossing the tracks except at the proper and designated locations.

4.7.4 Refuge Areas

SCRRA standard pedestrian channelization include a refuge area that pedestrian can utilize as a means of exiting the crossing when the pedestrian gates are activating and a train is approaching. This refuge area is not intended as a location where a pedestrian can wait for the train, but rather as a safe harbor should the pedestrian hesitate between the downed gates and the track. Refer to Figure 4-3 and SCRRA ES 4011 - 4021 for examples of these refuge areas. The refuge area shall incorporate a swing gate (see Section 4.6.2.3 for additional information) to allow pedestrians to exit the refuge area away from the tracks.

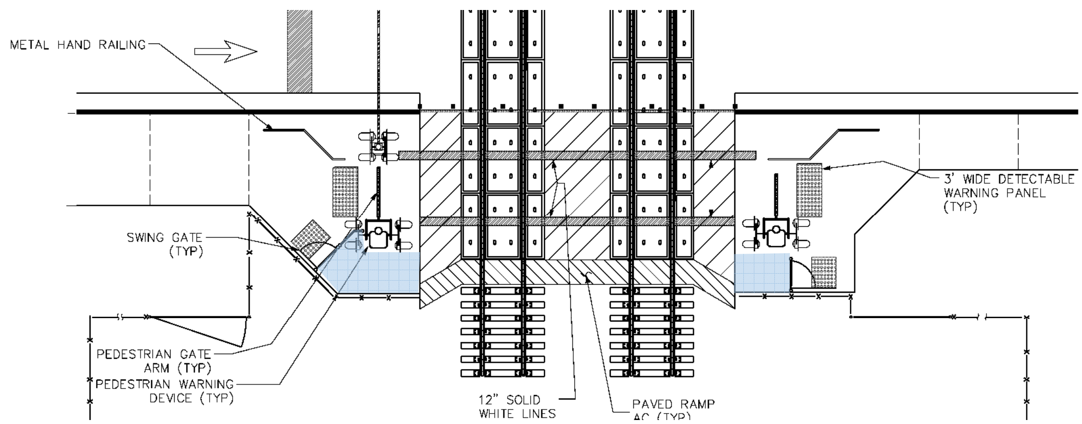


Figure 4-3. Pedestrian Refuge Areas

4.8 DESIGN PROCESS AND CONSIDERATION TABLE

Pedestrian-rail grade crossings should, in combination with the horns on locomotives, provide adequate warning devices which allow pedestrians and bicyclists to be warned of approaching trains and take appropriate action. During the design of the pedestrian-rail crossing, the factors noted in Section 4.2 shall be considered.

In the discussion of the design considerations, the term **"full pedestrian treatments" shall include signage, markings, channelization, fencing, active warning devices with gates, and swing gates.** *SCRRA's policy and practice is to apply full pedestrian treatments to highway-rail grade crossings consistent with the Pedestrian-Rail Grade Crossing Design Flowchart in Figure 4-4.*

Decision Point 1

The existence of pedestrian activity shall be determined. This includes sidewalks leading up to the right-of-way, or evidence of pedestrians crossing at that location. The lead Engineer shall determine from the Highway Agency the existing and desired future status of any pedestrian related facilities in the highway and railroad rights-of-way, including easements, licenses, and C&M Agreements. SCRRA standards and criteria call for the addition of pedestrian treatments if the highway agency and SCRRA are in agreement, and the highway agency legally allows pedestrians to utilize the highway right–of-way for crossing the track(s). The following actions shall be taken when evidence of activity exists without pedestrian facilities:

- Determine the level of pedestrian activity and if the pedestrian activity is legal and supported by the highway agency.
- Work with the highway agency to modify sidewalks and bring in compliance with ADA requirements.
- If warranted, the design shall provide sidewalks over the railroad right-of-way and tracks.
- If warranted, take steps to prevent possible trespassing.

Decision Point 2

If the pedestrian-rail grade crossing is to be included in a quiet zone, then full pedestrian treatments for safety enhancements and quiet zone signage shall be applied.

Decision Point 3

The type of pedestrian-rail grade crossing is analyzed at this step. A station pedestrian-rail grade crossing or a pedestrian-rail grade crossing combined with a highway-rail grade crossing adjacent to the station (including any LRT or HSR stations located on within a common rail corridor) require full pedestrian treatments.

Decision Point 4

Is the pedestrian-rail grade crossing located within a 10-minute walking distance of a school, hospital, or other facility that can be expected to support disabled people? If the answer is “yes” to any of the listed facilities, then full pedestrian treatment shall be applied. If the answer is “no”, then is there significant pedestrian activity?

In order to answer “no” to whether there is significant pedestrian activity, a study of the crossing shall be conducted to determine: the volume of pedestrian use, both on-peak and off-peak hours; the types of pedestrians (i.e., school children, elderly, disabled, bike riders, etc.); and pedestrians’ behavior patterns (i.e., are pedestrians behaving in a safe manner when using the crossing and cognizant of potential train activity?). The results of this study shall be discussed with SCRRA and CPUC for clear consensus with the Safety Review Team as to the presence or absence of significant pedestrian activity. Full pedestrian treatments shall be applied for a “yes” answer to any of these questions.

Decision Point 5

Does the crossing have three or more main tracks? If the answer is “yes”, a safety analysis of the crossing shall be performed to determine if the pedestrian-rail grade crossing can safely remain at-grade or will be required to be grade separated. See Section 5.1 for further details of the safety analysis. The grade separation can be an overhead or an underpass.

Decision Point 6

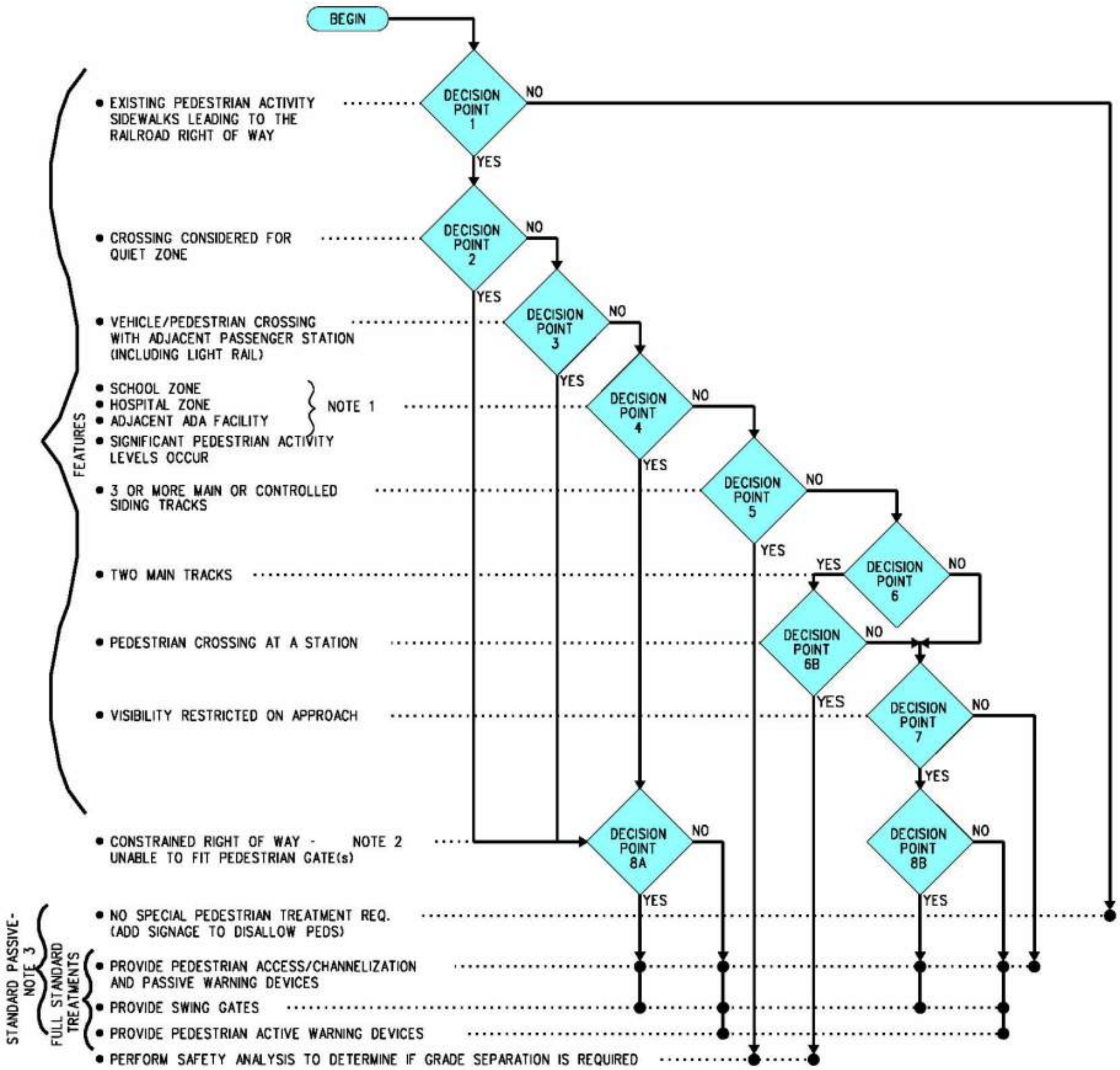
Does the crossing have two main tracks? If the answer is “yes”, decision point 6B needs to be answered to whether the crossing with 2 or more tracks is at a station. If the answer to decision point 6B is “yes”, a safety analysis of the crossing shall be performed to determine if the pedestrian-rail grade crossing can safely remain at-grade or will be required to be grade separated. See Section 5.1 for further details of the safety analysis. The grade separation can be an overhead or an underpass. This decision point is arranged so that a “no” answer for this question accounts for two tracks in rural areas that see few pedestrians. In this case, it may not be appropriate to install full pedestrian treatments, but a request for special design consideration not to do so must be submitted to SCRRA. In an urban/metropolitan environment, full pedestrian treatments shall be applied when multiple tracks are in a location with limited visibility.

Decision Point 7

Does the crossing location have restricted visibility? Full pedestrian treatments shall be applied where there is limited visibility at crossings.

Decision Point 8

Is the right-of-way necessary to comply with the Manual unobtainable? If not, then full pedestrian treatments are required. SCRRA Standard Drawings include variations to the standard configuration, depending on the available right-of-way. In cases where the right-of-way required for the use of one of these standard applications cannot be acquired due to existing property uses, or because of other conditions, a request for special design consideration for a non-standard design application must be submitted to SCRRA for review and approval.



CONSIDERATION TABLE NOTES:

1. TEN MINUTE WALK RULE - CROSSING LOCATED WITHIN TEN MINUTES WALK (⅓ TO ½ MILE WALK).
2. SCRRA APPROVAL REQUIRED.
3. FOR PASSIVE WARNING DEVICES, THE DESIGNER SHALL USE THE FOLLOWING ORDER FROM LEAST THE MOST:

   A. SIGNAGE (IF NO SIDEWALKS ARE PRESENT OR PLANNED).
   B. SIGNAGE AND DETECTABLE STRIP.
   C. SIGNAGE, DETECTABLE STRIPS AND SWING GATES.
   D. SIGNAGE, DETECTABLE STRIPS, SWING GATES AND CHANNELIZATION.

Figure 4-4. Pedestrian-Rail Grade Crossing Design Consideration Flowchart

5.0 GRADE SEPARATIONS

A “grade separation” is a means of separating the highway or pedestrians from the railroad tracks. Pedestrian grade separations are discussed briefly in Section 4 of the Manual. These may be accomplished with an underpass (the highway or pedestrian pathway passes under the railroad) or an overhead (the highway or pedestrian pathway crosses over the railroad). Outside of full highway-rail grade crossing closure, this is the most effective means of eliminating hazards related to these types of crossings. If a highway-rail grade crossing or pedestrian-rail grade crossing is to be grade separated, the design of the grade separation shall meet the requirements of SCRRA’s Grade Separation Criteria per Chapter 12.4 of the SCRRA Design Criteria Manual.

Before implementing, modifying, improving, or expanding an at-grade crossing, consider a crossing closure or full/partial grade separation of the new rail mode’s tracks and/or pedestrians.

SCRRA’s system currently consists of at-grade crossings mainly with single or two-track configurations. The addition of a track(s) to a two-track highway-rail grade crossing will increase the risk for motorists and pedestrians that utilize the crossing due to longer crossing distances and increased train volumes. Grade separations of all highway-rail grade crossings would be ideal (and is supported by SCRRA’s Board per Resolution 91-3 and 98-21 in Appendix G) for all highway-rail grade crossings. However, it may not always be practical and feasible in a real-world setting. **All projects that propose an additional track (of any type and operation including, but not limited to, Commuter, Freight, Light Rail Transit, High Speed Rail, and Diesel Multiple Units), that increases the track count of a highway-rail grade crossing to three (3) or more main line tracks, will require a comprehensive analysis as detailed in the Section 5.1 and shall involve the full and joint participation of all key grade crossing stakeholders (SCRRA, Highway Agency or Agencies, CPUC, FRA, etc.) in all phases of the analysis**.

5.1 ANALYSIS FOR GRADE SEPARATION CONSIDERATION

The Analysis for Grade Separation Consideration is summarized in 3 key steps as shown in the flow chart in Figure 5-1 to decide if a crossing should be grade-separated if capital work is being proposed at a crossing:

Step 1 – Fill out Initial Factors Form to Evaluate the Crossing

Step 2 – Complete Detailed Analysis and Resolution

Step 3 – Address Risk, Indemnification, and Liability within Crossing Agreements

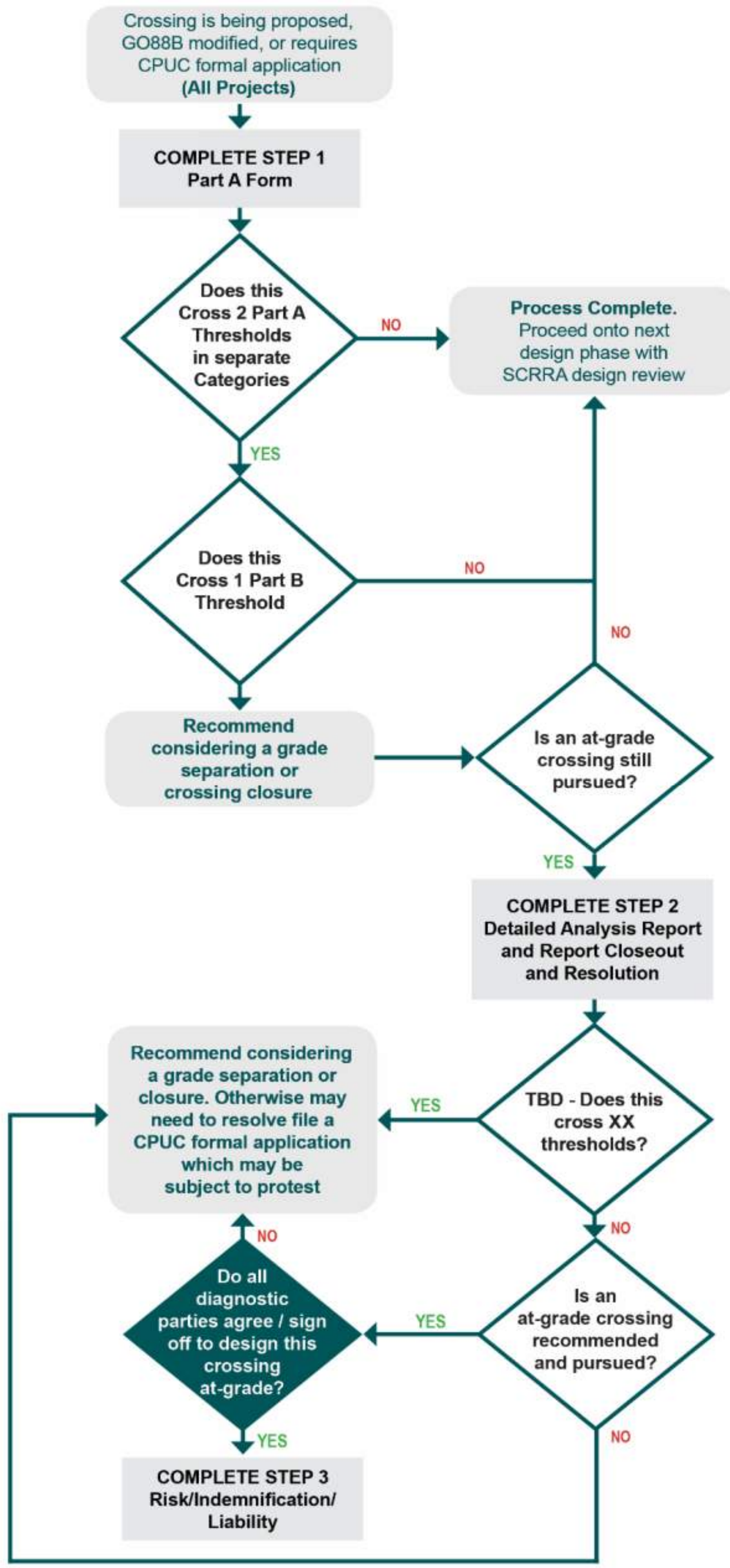


Figure 5-1. Grade Separation Analysis Flow Chart

Step 1 – Initial Factors Form

All SCRRA and third party projects shall complete the Step 1 Form when implementing, modifying, improving, or expanding an at-grade crossing. The results of Step 1 will be valid for a period of two years after completed for 5% design to be complete as defined by the SCRRA Design Procedures Manual. If a project experiences significant delays and after the 5% design level or major changes in the Step 1 assumptions, the Project Sponsor shall obtain current information and resubmit the Step 1 Form for SCRRA approval and signature. The Project Sponsor shall resubmit the Step 1 Form if any assumptions change and cause a new category to be "Yes" instead of "No" in the Step 1 Form.

Factors that affect the selection of the crossing alternatives are summarized in the Initial Factors Form, which can be found in Chapter 12 of SCRRA's Design Criteria Manual. This form will be completed as a part of Step 1 and will be submitted to SCRRA.

This Form is broken into two parts, Part A and Part B. Part A considers proximity of adjacent grade crossing(s), overall crossing length, distance between proposed tracks, overlap with any other future projects/adjacent crossing projects, train volume, new modes, formal applications, accident history, and vehicle ADT. Part B considers pedestrian traffic, gate down time, and any other issues of importance.

Step 2 – Detailed Analysis Report

If the thresholds from Step 1 are met, detailed analysis shall be performed to ensure that the safety is maintained for all crossing users and there are minimal delays to operations and travel times.

The latest FHWA Railroad-Highway Grade Crossing Handbook should be used as a reference while going through the detailed analysis report process.

The results of Step 2 will consider a full or partial grade separation of vehicles and/or pedestrians or if the crossing should be closed.

Full grade separations of all rail modes from all highway and pedestrian crossings is always the recommended alternative as it provides the highest level of crossing safety. If the analysis of an at-grade crossing shows indications that the at-grade crossing cannot be operated safely, effectively, and efficiently and a full grade separation is not implemented, then at a minimum, a partial grade separation of new mode tracks or pedestrians/bicyclists shall be considered. An example of a partial grade separation can be found on the SCRRA Pasadena Subdivision, SCRRA San Gabriel Subdivision, Bay Area Rapid Transit (BART) system between Oakland and Fremont, where the new passenger tracks are grade-separated over a highway crossing and the freight tracks remain at-grade.

If there are large pedestrian volumes over 50 per peak hour or 300 per day, consider a partial grade separation of the pedestrians if the vehicles are not grade-separated.

If a partial grade separation of additional train mode track(s) are implemented, the design of the partial grade separation shall consider a possible future full grade separation of all tracks and of all rail modes with the location of the abutments placed far enough from the roadway to allow a future full grade separation. A future full grade separation shall be evaluated through a preliminary design to ensure that a future full grade separation will not be extremely cost prohibitive due to the partial grade separation taking into account constructability issues, such as the need to construct shoo-flies for the existing rail service.

At-Grade Evaluation Criteria

Evaluation criterion, approved by SCRRA and the highway authority, shall be established to evaluate the safety and operation of each at-grade crossing. The evaluation criteria shall include all of the scope in the following pages, but not be limited to these factors. The evaluation criteria shall include fair and reasonable thresholds, as approved by SCRRA, to determine:

- If a full or partial grade separation is warranted of vehicles and/or pedestrians;
- If the crossing should be closed;
- If the crossing can safely remain at-grade with acceptable impacts to ALL diagnostic stakeholders and SCRRA on the operation of all rail, vehicular, and pedestrian modes utilizing the crossing.

The trade-offs between the cost and benefit of at-grade and grade-separated options should be reviewed and a Final Technical Recommendation for at-grade or grade separation operation should be made.

One report per grade crossing shall be developed evaluating all criteria included in the scope herein. If there are multiple crossings on a project that pass the Step 1, Part B thresholds, then a cumulative summary report shall also be prepared analyzing the cumulative impacts of these outcomes at-grade, grade-separated, or closed. The cumulative summary report will also include calculating and ranking adjacent crossings within project limits using the following methods:

- CPUC Section 190 Grade Separation Program formula – input the same cost values for all crossings such that these can be compared based on the other factors within this formula
- USDOT hazard index formula

If a crossing is not closed, a conceptual five (5) percent design alternative of both an at-grade crossing configuration and a grade-separated crossing will be included for each grade crossing that goes through the Detailed Analysis Report process. The five (5) percent design shall be per the SCRRA Design Procedures Manual requirements.

The final Detailed Analysis Report shall be signed and stamped by a licensed Professional Engineer.

Scope of Grade Crossing Analysis

The following scope should be used when evaluating the highway-rail grade crossing.

1. FHWA Closure Thresholds

Highway-rail crossings should be considered for closure and physically removed from the railroad right-of-way whenever one or more of the following apply:

1.1. An engineering study determines a nearby crossing otherwise required to be improved or grade-separated already provides acceptable alternate vehicular and pedestrian access

1.2. If an engineering study determines any of the following apply:

- Average Annual Daily Traffic (AADT) less than 3,000
- Acceptable alternate access across the rail line exists within one (1) mile measured along the track
- The median trip length normally made over the subject crossing would not increase by more than 2.5 miles

1.3. If railroad operations will occupy or block the crossing for extended periods of time on a routine basis and it is determined that it is not physically or economically feasible to either construct a grade separation or shift the train operation to another location, and an engineering study determines that such a crossing should be closed to vehicular and pedestrian traffic. Such locations would typically include the following:

- In or adjacent to rail yards and locations near industrial spur tracks where trains pick up or set out blocks of cars or switch local industries
- Passing tracks primarily used for holding trains while waiting to meet or be passed by other trains
- Locations where train crews are routinely required to stop for crew changes or for cross traffic on intersecting rail lines
- In the proximity of stations where trains dwell for extended periods of time and block the crossing

It may be advisable to investigate whether to construct alternative roadway access in conjunction with closing the crossing when the subject crossing is currently the only access to a community.

2. FHWA Grade Separation Thresholds

Highway-rail grade crossings should be considered for grade separation or otherwise eliminated across the railroad right-of-way whenever one or more of the following conditions exist:

2.1. The posted highway speed equals or exceeds 55 mph

2.2. AADT exceeds 30,000 in urban areas or 20,000 in rural areas

2.3. Maximum authorized train speed exceeds 79 mph

2.4. An average of 30 or more trains per day

2.5. An average of 75 or more passenger trains per day in urban areas or 30 or more passenger trains per day in rural areas

2.6. An average of 150 or more transit trains per day in urban areas or 60 or more passenger trains per day in rural areas

2.7. Freight Train Crossing Exposure (the product of the number of trains per day and AADT) exceeds 900,000 in urban areas or 600,000 in rural areas

2.8. Passenger Train Crossing Exposure (the product of the number of passenger trains per day and AADT) exceeds 2,250,000 in urban areas or 600,000 in rural areas

2.9. Transit Train Crossing Exposure (the product of the number of transit trains per day and AADT) exceeds 4,500,000 in urban areas or 1,200,000 in rural areas

2.10. The expected accident frequency for active devices with gates, as calculated by the USDOT Accident Prediction Formula including five-year accident history, exceeds 0.5 (per year). If the highway is a part of the designated National Highway System, the expected accident frequency for active devices with gates, as calculated by the USDOT Accident Prediction Formula including five-year accident history, exceeds 0.2 (per year).

2.11. Vehicle delay exceeds 30 vehicle hours per day with consideration for cost effectiveness

2.12. Whenever a new grade separation is constructed, whether or not it replaces an existing highway-rail crossing, consideration should be given to the possibility of closing one or more adjacent crossings. In addition, the railroad should be consulted prior to starting design to determine the railroad's future clear span requirements for the tracks crossed.

2.13. Utilize Table 5-1 for LRT separations.

TABLE 5-1. LRT GRADE SEPARATION THRESHOLD

Trains per Hour	Peak-Hour Volume (Vehicles Per Lane)
60	200
40	400
20	600

3. Vehicle Movements

3.1. Existing and Future ADT Volumes

3.1.1. Future Volumes Need to Consider Traffic a Minimum of 10 Years After Project Completion

3.1.2. Recent or Future Planned Developments Near the Crossings that will Affect Future Traffic Volumes at the Crossings

3.1.3. Immediate and Near Future (Post-Construction) Impacts and Changes to Traffic Patterns at and Near the Crossings

3.2. Existing and Future Peak-Hour Volumes

3.2.1. Future Volumes Need to Consider Traffic a Minimum of 10 Years After Project Completion

3.2.2. Recent or Future Planned Developments Near the Crossings that will Affect Future Traffic Volumes at the Crossings

3.2.3. Immediate and Near Future (Post-Construction) Impacts and Changes to Traffic Patterns at and Near the Crossings

3.3. Vehicle Delay Times/Gate Crossing Down Time

3.3.1. Effects of Warning Devices from Trains Dwelling at a Station

3.3.2. A gate down analysis will be required for both peak hour and daily total time. Analysis shall factor in crossing operations for multiple trains on approach and if the gates will remain down between trains. If gates will only ascend for a few seconds before descending again, then assume the worst-case and include the gate down time between train approaches

3.4. Future Delay Times (peak hour and per day)

3.5. Distances Between Existing and Current Traffic Signal Locations/Storage Lengths for Design Vehicles

3.6. Traffic Queues, Queue length, and Impacts of Upstream and Downstream Intersections, including traffic simulation and modeling

3.7. Available storage length

3.8. Effects on Level of Service

3.8.1. Effects Due to Gate Down Time: A longer gate down time would degrade an adjacent intersection vehicle level of service at some locations and should be included in this analysis. This will also affect a pedestrian’s ability to continue along their route without being delayed.

3.9. Special Route Through Crossing:

3.9.1. School Route

3.9.2. Transit and School Bus Routes

3.9.3. Truck Route

- 3.9.4. Hazardous Material Truck Route
- 3.9.5. Emergency Services Route

3.10. Geometric Configuration of Approaches
- 3.10.1. Number of vehicular lanes
- 3.10.2. Vehicular crossing length
- 3.10.3. Vehicle Circulation Through Crossing
- 3.10.4. Proximity of Lane Additions/Reduction to Crossing
- 3.10.5. Right-Turn Only Lanes Through Crossing

3.11. Vehicle Circulation Through Crossing
- 3.11.1. Evaluation of Sight Distances: Stopping Sight Distance, Clearing Sight Distance, Corner Sight Distance

3.12. Deploy video to observe crossing for seven (7) days and analyze violations, behavior, near misses, etc.

4. Pedestrian Movements and Associated Walking Times

4.1. Existing and Future Pedestrian and Bicyclist Volumes and consideration of station proximity on volumes
- 4.1.1. Future Volumes need to Consider Pedestrian and Bicyclist Volumes a Minimum of 10 Years after Project Completion
- 4.1.2. Pedestrian and Bicyclist Volumes from Adjacent or Nearby Transit Stations/Bus Stops
- 4.1.3. Recent or Future Planned Developments Near the Crossings that will Affect Future Traffic Volumes at the Crossings
- 4.1.4. Immediate and Near Future (Post-Construction) Impacts and Changes to Traffic Patterns at and Near the Crossings

4.2. Pedestrian Circulation Through Crossing
- 4.2.1. Evaluation of Crossing Times to Cross All Tracks or Reach a Refuge Area
- 4.2.2. Walking speed shall be calculated using 3.5 feet/second unless slower moving pedestrians are anticipated at the crossing which warrants a slower walking speed of 2.8 feet/second.
- 4.2.3. Walking Speed for crossings shall be evaluated independently for each individual crossing and shall consider facilities in proximity of the crossing that generate pedestrians with slower walking speeds.
- 4.2.4. Length of Crossing Between Pedestrian Gates
- 4.2.5. Need for Refuge Areas Between Tracks

5. Train Operations – all train modes

5.1. Number of Tracks

5.1.1. Evaluate the complexity of designing a safe crossing as each additional track is added and the ability to operate it safely, efficiently, and effectively.

5.2. Number of Trains

5.3. All of Train Modes (LRT, LRT Trams, HSR, Commuter, Freight, DMU, EMU/ZEMU, Long Distance Passenger Trains (Amtrak), etc.)

5.4. Frequency of Trains and string line diagrams/train operations modeling

5.4.1. Including lowest planned design headways for all train modes

5.5. Speed of All Train Modes (Min, Max, Average)

5.5.1. Including future express service potential and lowest planned design headways for all train modes

5.6. Distances Between Tracks

5.7. Train Stopping Characteristics Between Each Rail Mode

5.8. Consider proximity of adjacent stations, yards, and switching moves to the crossing and additional crossing activations as well as longer gate down time. Include in the analysis how this impacts a driver's crossing perception and impatience.

5.8.1. The nature of new mode operations places stations in closer proximity to each other than commuter rail operations. As such, a new mode train may be stopped at a station while commuter operations continue to pass by. The lead Engineer shall analyze crossings near and adjacent to stations, where new modes and SCRRA operations are closely related yet mutually exclusive, for safety, efficiency, and effectiveness of remaining at-grade.

5.9. Evaluation of the gate down time for the longest, worst-case train arrival sequence based upon current schedules and anticipated future schedules.

5.10. Additional safety devices shall be considered when multiple trains are passing simultaneously, including, but not limited to: additional signage such as a "second train coming" activated blankout sign, use of channelization with gates, preemption of traffic signals, extended advance warning times, pedestrian gates, extra channelization for pedestrians, etc.

6. Positive Train Control (PTC), Rail Signal and Communications

6.1. Ability to Safely and Effectively Operate PTC or the equivalent for LRT, DMU, EMU, and/or HSR

6.2. Grade Crossing Near-side Signal Stop

6.3. Simultaneous Approach of 2 or More Trains at the Crossing

6.4. Sequential Approach of 2 or More Trains at the Crossing

6.5. Differences in Approach Warning Detection for Prediction (Fixed Distance vs. Constant Warning Time)

7. Safety Factors

7.1. Accident History including an Analysis of all FRA reportable Accident History

7.2. Trespassing History

7.3. ROW Security

7.4. Performance and Reliability of Active Warning Devices with Increased Volume of Crossing Activations (75 activations/day).

7.5. Illumination Levels

7.6. Possible Confusion/Impatience of Motorists/Pedestrians of Long Gate Down Times Due to Multiple Train meets at Crossing once you exceed 15 minutes in the peak hour and 20 minutes in non-peak hours.

7.7. Sight Distances for Motorist, Pedestrians, and Cyclists to all Warning Devices, Traffic Signals and Approaching Trains

7.8. Pedestrian and Vehicular Warning times

8. Community Factors

8.1. Right-of-Way Impacts

8.2. Existing Infrastructure that Generate Pedestrian Movement Near the Crossing: Schools, Hospitals, Medical Clinics, Senior Facilities, Shopping Centers, Recreation Centers, Parks, and Stations/Bus Stops

8.3. Quality of Life with Increased Train Traffic and Horns/Bells at the Crossing

8.4. Cost analysis showing the full costs to grade-separate all tracks, costs of grade separating only the new LRT or HSR tracks, and the cost-benefit analysis to maintain an at-grade crossing for the next 50+ years compared to the grade separation costs. This cost analysis should include a conceptual plan and profile of all tracks and a plan and profile of the roadway to accompany the cost analysis.

9. Economic Benefit-Cost Analysis

Perform an economic benefit-cost analysis in accordance with the FHWA Highway-Rail Crossing Handbook (2019 or latest). Benefit-cost analysis requirements are contained in 23 CFR 924. The benefit-cost analysis should be performed using a Life-Cycle (25+ years from today) Basis, which considers both the initial cost to construct the at-grade or grade-separated crossing as well as its ongoing operating and maintenance costs.

23 CFR 924: (https://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0924.htm)

An economic analysis may be performed to determine possible alternative improvements that could be made at a highway-rail crossing. The FHWA Highway Safety Benefit Cost Analysis Guide and companion Highway Safety Cost Analysis Tool and support material available at the FHWA Highway Safety Improvement Program (HSIP) website can add guidance while preparing the benefit-cost analysis portion of the Detailed Analysis Report.

FHWA Highway Safety Benefit Cost Analysis Guide:
(https://safety.fhwa.dot.gov/hsip/docs/fhwasa18001.pdf)

Highway Safety Cost Analysis Tool:
(https://safety.fhwa.dot.gov/hsip/docs/bcatool030118_finalv2.0.xlsm)

FHWA Highway Safety Improvement Program (HSIP) website:
(https://safety.fhwa.dot.gov/hsip/planning.cfm)

Practitioners need to assemble information on the following elements, using the best available facts and estimates:

- Collision costs
- Service life
- Initial improvement costs
- Maintenance costs
- Salvage value
- Traffic growth rates

Other considerations include the effectiveness of the improvement in reducing collisions and the effects on travel, such as reducing delays.

The selection of collision cost values is of major importance in economic analyses. Considerable care should be used in establishing values for these costs. The following are the two most common sources of collision costs:

- National Safety Council (NSC)
- National Highway Traffic Safety Administration (NHTSA)

The NSC costs include wage losses, medical expenses, insurance administrative costs, and property damage. The NHTSA includes the calculable costs associated with each fatality and injury plus the cost to society, such as consumption losses of individuals and society at large caused by losses in production and the inability to produce. Many states have developed their own state-specific values. Whichever is selected, the values should be consistent with those used for other safety improvement programs. An appropriate method of discounting should be used to account for inflation and opportunity cost. The selected discount rate should be informed by current practices and should be documented as part of the analysis.

The service life of an improvement should be equal to the time that the improvement can affect collision rates. Both costs and benefits should be calculated for this time. Hence, the service life is not necessarily the physical life of the improvement. For highway-rail crossings, however, it is a reasonable assumption that the improvement would be equally effective over its entire physical life. Thus, selecting the service life equal to the physical life would be appropriate.

The selected service life can have a profound effect on the economic evaluation of improvement alternatives; therefore, it should be selected using the best available information.

Project costs should include initial capital and maintenance costs and should be considered life-cycle costs; in other words, all costs are distributed over the service life of the improvement. The installation cost elements include the following:

- Preliminary engineering
- Labor
- Material
- Lease or rental of equipment
- Miscellaneous costs

The maintenance costs are all costs associated with keeping the system and components in operating condition.

The salvage value may be an issue when a highway is upgraded or relocated, or a railroad line is abandoned. Salvage value is defined as the dollar value of a project at the end of its service life and, therefore, is dependent on the service life of the project. For crossing signal improvement projects, salvage values are generally very small. Due to the characteristics of crossing signals and control equipment as well as the liability concerns that arise from deploying signal equipment that has already been used, it is assumed that there is zero salvage value after ten (10) years.

10. Federal Railroad Administration GradeDec Software

Perform an analysis with the FRA GradeDec Software per FHWA Highway-Rail Crossing Handbook (2019 or latest) Chapter 3: Treatment Selection Guidance – FRA GradeDec Software.

FRA developed the GradeDec.NET (GradeDec) highway-rail grade crossing investment analysis tool to provide grade crossing investment decision support. The GradeDec provides a full set of standard cost-benefit metrics for a rail corridor, a region, or an individual grade crossing. Model output allows a comparative analysis of grade crossing alternatives designed to mitigate highway-rail grade crossing collision risk and other components of user costs, including highway delay and queuing, air quality, and vehicle operating costs. The online application can be accessed via FRA's Website at https://gradedec.fra.dot.gov/. More information can be found in the FHWA Highway-Rail Crossing Handbook (2019).

Step 2 Report Resolution

Based on the results of Steps 1 and 2, if a crossing has "yes" answers for 2 of the categories below, the Project Sponsor should consider a grade separation. If it has "yes" answers in all 3 of the categories below, the Project Sponsor should strongly consider a grade separation.

- Category A – Does it meet any of the FHWA criteria for grade separation in the 2019 FHWA Highway-Rail Grade Crossing Handbook, Chapter 3, Treatment Selection Guidance - Technical Working Group Guidance (which were evaluated during the Step 2 Detailed Analysis Report scope)?
- Category B – Will this crossing have additional passenger train modes beyond SCRRA and Amtrak? Freight traffic already exists on all SCRRA subdivisions.
- Category C – Are there 4 “yes” answers from 4 separate categories in Step 1 - Initial Factors Form (cumulative total from both Part A and Part B)?
- The City(ies), Project Sponsor, SCRRA, Member Agency, Key Project Stakeholders, etc. must:
- Review and participate in collaborative project team comment resolution sessions together.
- **Sign off**: Comment review meetings shall be required on the draft analysis performed and all diagnostic team stakeholders (SCRRA, Highway Authority(ies), CPUC, other operating railroads, FRA, etc.) must be present. All diagnostic team stakeholders are required to formally sign off on the outcome of the report, whether the crossing will be at-grade or grade-separated via signature page(s).
- CPUC must be provided a copy of the report and diagnostic team Step 2 signature page(s).
- If agreement of the involved parties cannot be obtained, then a formal Application must be filed with the Commission’s Docket Office to gain Commission approval for the proposed modifications.
- All of this must occur prior to proceeding with the final design on the project.

The final decision on the crossings will be based upon all of the technical input into the process including the Final Technical Recommendation; however, SCRRA recognizes that the ultimate decision will involve institutional consideration of the proposed crossing treatments and will require third party approvals, primarily consisting of approval of the crossings by the CPUC under the provisions of all CPUC General Orders.

Step 3 - Risk/Indemnification/Liability

Agreements including those to obtain necessary right-of-way, and for identifying any sharing of construction and/or maintenance costs will need to be addressed as part of this analysis.

Upon a decision for the crossing, should the crossing remain at-grade, the key parties (SCRRA, the highway authority and/or member agency) need to address the risk, indemnification, and liability within the C&M agreement for this crossing.

The location of adjacent track(s) owned and operated by another railroad company creates conditions that need to be evaluated during the design of warning devices for vehicles and pedestrians. The responsibility of installing and maintaining warning devices at the crossing will fall on the railroad that owns and operates the part of the crossing on which the warning devices are required. In such cases, there may be two separate crossing warning systems, one from SCRRA and one from the new rail mode, at the crossing that must be interconnected to work in conjunction with each other. Coordination with the new rail mode must be done throughout the design stages to ensure that adequate warning devices are installed at the highway-rail grade crossing and will work in conjunction with one another.

5.2 PARTIAL GRADE SEPARATIONS

Full grade separations of all rail modes from all highway crossings is always ideal but may not always be possible on large projects with multiple crossings. If the analysis of a shared highway-rail grade crossing shows good indications that the shared highway-rail grade crossing cannot be operated safely, effectively, and efficiently and a full grade separation is not possible, then at a minimum, a partial grade separation of different rail modes shall be constructed.

If there are large pedestrian volumes or long pedestrian crossings that increase the amount of total approach time beyond 50 seconds (See Section 3.14.10), consider a partial grade separation of the pedestrians if the vehicles are not grade-separated.

If a partial grade separation of different rail modes is implemented, the design of the partial grade separation shall consider a possible future full grade separation of all tracks of all rail modes and the location of abutments shall be placed far enough from the roadway to allow a future full grade separation. A future full grade separation shall be evaluated through a preliminary design; taking into account constructability issues, such as the need to construct shoofly tracks for the existing service; to ensure that a future full grade separation will not be cost prohibitive due to the partial grade separation.

6.0 RAILROAD ACTIVE WARNING AND TRAFFIC SIGNAL SYSTEM INTERCONNECTION CIRCUITS

6.1 INTERCONNECTION DESIGN

6.1.1 Background

Knowledge in the field of traffic signal preemption continues to evolve. Before designing a traffic signal preemption circuit, the lead Engineer should review the latest guidelines regarding traffic signal preemption as prepared by the Institute of Transportation Engineers, AREMA, CA MUTCD, CPUC, and other knowledgeable parties. Circuits described below are based on fail-safe closed loop methodology. A vital serial data circuit in accordance with IEEE Standard 1570-2002 may be used in lieu of the referenced circuits. Design and testing of traffic signal preemption interconnection circuits must be coordinated with the railroad and the agency having jurisdiction.

6.1.2 Interconnection Circuits

Older style Traffic Signal Interconnection schemes used a simple two wire circuit between the traffic signal cabinet and the railroad crossing warning equipment to notify or issue a call for traffic signal preemption. This scheme was generally used with simultaneous preemption and a very basic traffic management program. Modern Traffic Signal Interconnect designs use multiple circuits to provide a cable integrity check, system health status and the position of both Entrance and Exit gate mechanisms.

If there is a break in either or both wires of the interconnection circuit (as, for example, when an excavation contractor inadvertently breaks the wires or cable), the traffic signal controller unit would respond as if a train were approaching and clear vehicles off the tracks—even though a train may not be approaching. The traffic signals remain in the preemption mode as long as the circuit remains open. If a train approaches during this scenario, the railroad active warning devices will activate, however the traffic signal preemption will not be reinitiated to clear vehicles off the tracks and may inadvertently cause vehicles to be stopped on the track(s).

One potential problem with the two wire/cables interconnection is a short in the circuits. If the wires/cables between the traffic signal control cabinet and the railroad active warning system cabinet became shorted together, the preemption relay in the traffic control signal cabinet could be falsely energized, even if the railroad relay contact opened. In this case, the active warning devices would operate, but the traffic signal controller unit would not receive the preemption input. To address these potential problems, a supervised double-break, double-wire circuit shall be installed between the railroad and the traffic signal control system.

<u>Short/Cut Circuit Interconnection Fault Protection</u>

It is important that a potential short or cut in the interconnection circuit between the railroad and traffic signal equipment be detected. The states of the two inputs can be monitored by the traffic signal equipment in the form of an "Exclusive-OR" logic, which can detect if there is a short or cut in the interconnection circuit. As shown in Table 6-1, the "true" states are the normal and preempt operations, while the "false" states are the other states of the input, which are considered "fault" conditions that will set the traffic signal into an "all-red-flashing" operation.

Table 6-1. Supervised Preemption Circuit Logic

Supervised Preemption Circuit Logic		
Inputs		Traffic Signal Operation
Primary	Secondary	
High	Low	Normal
Low	High	Preempt
High	High	Fault
Low	Low	Fault

In order to detect a shorted or open interconnection circuit, two additional wires are used to provide a supervised circuit. The energy source originates at the traffic signal controller: two wires provide a return path, verifying the railroad preemption control relay is energized and there is no call for preemption. The two additional wires verify circuit integrity when the railroad issues a call for preemption. The circuit logic is “Exclusive OR.” One circuit must be energized and the other de-energized. If both circuits are shown to be energized or both appear de-energized, it indicates a problem with the interconnect circuit. In that case, the traffic signal controller should assume a state known to be safe and issue a notification that there is a circuit deficiency.

Gate-Down Circuits

A preemption trap condition occurs when the track clearance green time ends before the flashing-light signals start to flash and gates start to descend. It can occur with advance preemption, see Section 3.14.7.

One of the solutions to avoid preemption trap is to use a “gate down” circuit as required by the CA MUTCD, Section 8C.06 (16). The purpose of the “gate down” circuit is to prevent the traffic signal from leaving track clearance green time until it is determined that all gates on approach to the intersection are fully lowered. The “gate down” circuit notifies the traffic signal controller unit when the gates controlling access over the tracks on the approach to the intersection have either fully lowered or the train has occupied the crossing. At the beginning of preemption, the traffic signal controller unit shall change to the track clearance green time as usual, but shall dwell in the track clearance green time until the “gate down” confirmation is received, or until a user-defined maximum time has expired.

Traffic Signal Health Check Circuits

A health check circuit provides an indication to the railroad active warning system cabinet when the traffic signals are in flashing mode or dark, such as when the controller is in failure. This health check circuit requires additional wires/cables between the traffic control signal cabinet and the railroad active warning system cabinet. Consideration should be given to a fail-safe design for the health check circuit so that there shall be no case in which the circuit shall remain energized while the traffic signals are flashing or dark.

Interconnection Circuits

The Signal Engineering design process will determine the specific Traffic Signal Interconnection circuit to be used at specific crossing locations. The design of the interconnection circuits shall be reviewed and approved by the Highway Agency and SCRRA before any new systems are installed or changes to existing systems are made.

6.1.3 Total Approach Time for Traffic Signals

Total Approach Time (as defined in Section 3.14.5.7) for traffic signals, shall be limited to a maximum time of 50 seconds. Requests for additional traffic signal preemption time will be submitted, through a Special Design Consideration, to SCRRA's PTC, C&S Engineering Services Department for review and approval. Request for additional preemption time under an Advanced Pedestrian Preemption (APP) operation and circuitry shall be made using a special design consideration form submitted to SCRRA's PTC, C&S Engineering Services Department for evaluation and consideration.

6.1.4 Second Train Logic

Where there is more than one track, a second train can approach at any time. If there is an advance preemption interconnection between the traffic signals and the railroad, the appearance of a second train can hold the traffic signals in preemption and have the gates rise momentarily, allowing vehicles to pull up onto the tracks. Where second train logic is employed, if a second train is detected on the outer approach, the gates shall remain down until after the second train passes. Second train logic may be employed where no traffic signals are present if circumstances warrant.

7.0 HIGHWAY-RAIL GRADE CROSSING PROJECT IMPLEMENTATION

7.1 HIGHWAY-RAIL GRADE CROSSING DESIGN PROCESS

The process for the proper analysis and design of highway-rail grade crossing improvements involves several different engineering disciplines, as well as the highway agency, SCRRA, and the CPUC in regulatory roles. A typical highway-rail grade crossing design considers motorist and pedestrian behavior; civil, railroad, and railroad signal design; safety and risk analysis; land use and right–of-way issues; traffic engineering; and application of SCRRA, AREMA, CPUC, FRA and CA MUTCD regulations and standards. This design process involves all engineers and other professionals that participate in the ultimate configuration of the crossing, from the onset of design. The process is outlined in Figure 7-1.

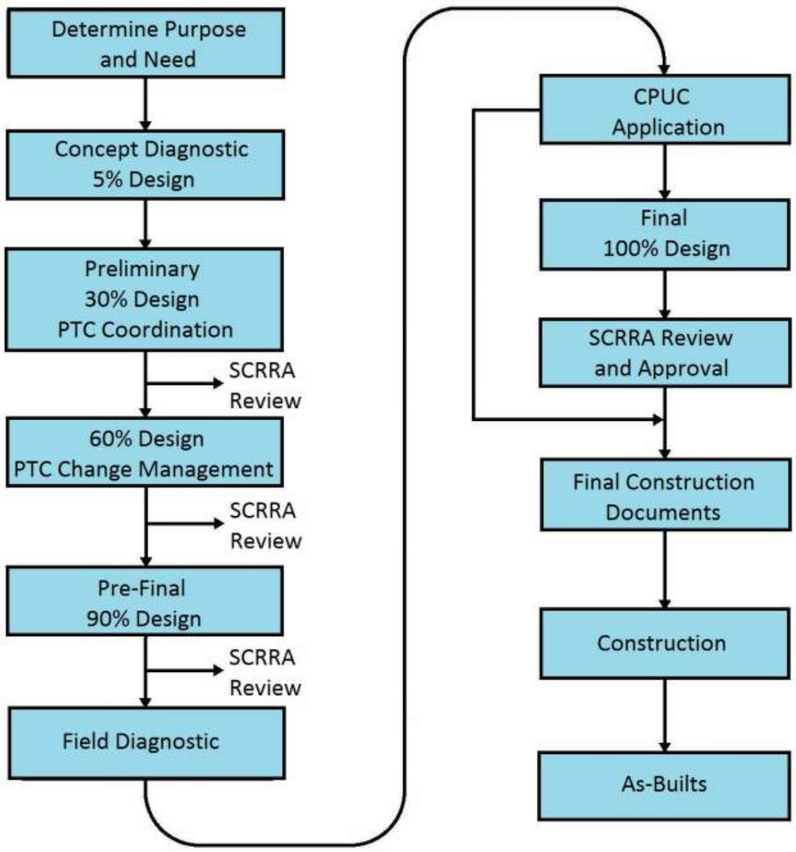


Figure 7-1. Highway-Rail Grade Crossing Design Process Flow Chart

The design of the highway-rail grade crossing is a dynamic and iterative process, with the design continually evolving as different levels of design are reached. The ultimate configuration of the highway-rail grade crossing may be significantly different from the initial concept.

Modifications of all highway-rail grade crossings or proposals for new highway-rail grade crossings shall be subject to the CPUC approval process. A diagnostic team consisting of representatives from SCRRA, CPUC, highway agency, and all other stakeholders will evaluate the proposed changes to the highway-rail grade crossing to determine the safety needs of the crossing. The lead Engineer should allow ample time (at least four weeks) in the design process for Conceptual Diagnostic (5% Engineering) and Final Diagnostic (90% Engineering) reviews by the diagnostic team (see Section 7.3). All major elements including rail and traffic signals of highway-rail grade crossing project shall be at the at the 90% level before conducting the Final Diagnostic review. After the Final Diagnostic review, the ultimate scope of the project, and ultimately the final design scope, will be “locked down”. These diagnostics are an important part of the design process and require the necessary input from all stakeholders to determine the effectiveness of the proposed changes. The lead Engineer shall take note of the results of the diagnostic meetings, record all comments, and incorporate the appropriate recommendations and changes into the design.

If there are any Positive Train Control (PTC) critical features that will be modified on the project, the lead Engineer should also take into account the time needed to coordinate and incorporate changes to the PTC system with SCRRA’s PTC Technical Services Group. The coordination for PTC Change Management should begin during the 30% design phase to ensure that funding is included in the project budget for changes to the PTC system and for PTC support during design and construction. See Section 8.9 for further discussion on PTC Change Management.

The design of the highway-rail grade crossing shall be circulated for review and approval within SCRRA to include the input received from various departments or functional groups (signals, track, safety, rail crossings) within SCRRA, as well as from the highway agency and CPUC. The overall functionality and effectiveness of a highway-rail grade crossing shall be determined by operational and maintenance needs as well as engineering design needs. The input from these departments early in the engineering process shall provide important information that shall affect the overall design of the crossing. Designs that do not give adequate attention to SCRRA inter-departmental input often fall short of meeting the overall goals of the project, and often require substantial rework to accommodate those needs. SCRRA shall be included as an active participant in the design process to ensure that the requirements in this Manual and the input of SCRRA are adequately addressed.

A Highway-Rail Grade Crossing Design Checklist is included in Appendix F and shall be signed by the lead Engineer in responsible charge for the design of the project. This checklist defines what is expected to have been included in each of the design level submittals and shall be submitted with each of the submittals listed on Figure 7-1. In general:

- Project Concept & Design Criteria (5% Design) submittal will incorporate alternative design solutions, program cost estimates, and confirm the correctness and completeness of project objectives.
- Preliminary Design (30% Design) submittal will advance the design to a level in which: potential impacts to the environment, utility lines, and drainage can be identified; traffic and pedestrian counts, and traffic engineering analysis have been performed; construction staging and sequencing alternatives have been identified; and a preliminary engineer’s estimate can be provided. A C&M Agreement may be developed and executed between the 30% and 90% designs. Coordination with SCRRA’s PTC Technical Services Group will be required if there are any proposed changes to existing or addition of new PTC critical features.

- If any changes are proposed to existing PTC critical features or any new PTC critical features are proposed, a change request shall be submitted to SCRRA's PTC Technical Services Group during the 60% design phase to start the Change Management process to ensure that the necessary modification to the PTC systems will be made to accommodate the changes proposed by the project. Any issues with the proposed improvements and PTC system will need to be flushed out as the design is progressed to final design.
- Pre-Final Design (90% Design) submittal will incorporate comments and advance the design to the near-completion level. Designs for all functional areas, including highway, traffic signals, track, signals, utilities, and right-of-way, will be complete and coordinated. The design scope should be "locked down" at this point: the method of contract delivery has been identified; the roles and responsibilities of the parties have been determined; and a realistic funding plan developed. Only minor revisions should be expected in response to comments at this level.
- Final Design (100% Design) submittal incorporates the 90% comments and will be signed and sealed by a registered engineer. Comments may be generated and must be incorporated and resubmitted to SCRRA as Camera Ready Bid Documents.
- Typically, the railroad signal (active warning device) design for a highway-rail grade crossing shall be performed by a different design firm than the civil design. The signal design will often lag the civil design. However, at the Pre-Final (90%) and Final (100%) design phases, both civil, traffic and signal design shall be at the same level of completion.

7.2 DESIGN GOALS

The purpose of, and need for, the modifications should be set forth at the start of design. This will form the basis for the overall design of the project and set the ultimate goals for the improvements. The purpose and need of the project will be developed taking into consideration the overall safety aspects of the crossing, as well as its operational and maintenance aspects. In addition, the source of funding for the improvements and the stakeholders involved with the project, will be defined. The evolving diagnostic process may define changes in those ultimate goals, changes that shall ultimately decide the outcome of the final design.

During the development of the overall scope of the improvements, the lead Engineer should know the extent of work that will be necessary to implement the improvements. For example, the addition of a lane shall require the widening of the overall crossing. It may be necessary to require the complete reconstruction of the highway-rail grade crossing to ensure that the ultimate construction does not create other impacts or maintenance concerns.

The initial efforts in the design shall include:

- Meetings and field surveys with SCRRA engineering and maintenance staff to determine existing conditions of the project site that could affect the construction of the proposed improvements.

- Performing traffic counts at the grade crossing and two adjacent crossings if no traffic counts have been performed within the last five years. This provides a basis of design for the crossing and associated temporary impacts during construction.
    - Traffic count information (within the last 5 years) is also a CPUC requirement.
- Determination and understanding of the site characteristics and condition of the railroad facilities, including track, crossing and wayside signals, and the railroad operating environment.
    - The railroad operating environment (train speeds, number of trains, train operating patterns) may have a major impact on the means and methods for construction and any proposed permanent grade crossing improvements.
    - In addition, coordination with SCRRA's ongoing maintenance plan so the construction schedule can be incorporated into a regular maintenance cycle. This is especially important in areas where heavy rail traffic minimizes opportunities to remove tracks from service to perform construction and maintenance.

7.3 DIAGNOSTICS

7.3.1 Introduction

To make improvements to a crossing, construct a new crossing, or close a crossing, a series of field diagnostic reviews shall be performed. As shown in Figure 7-1, before commencement of design, an initial field diagnostic meeting shall be completed with the purpose of understanding the existing conditions of the crossing and to determine a conceptual plan for the improvements needed. After the 30% Design, but before the Pre-Final 90% Design can be approved, a second field diagnostic meeting shall be completed to predict how the proposed changes would affect and improve the crossing.

The second field diagnostic meeting will have the benefit of having the site survey and investigation work done, along with much of the design completed. During the second field diagnostic meeting, any significant changes from the assumptions or recommendations in the first field diagnostic meeting and any proposed requests for waivers from the Manual should be discussed. After completion of the design and construction, a final field diagnostic site meeting shall be completed to verify that the new improvements allow the highway-rail grade crossing to function as intended.

Information from SCRRA, FRA, inventories, and accident summaries—as well as information from local highway traffic departments—can help to create a clearer picture of how a highway-rail grade crossing functions and what problems need to be addressed. The diagnostic processes use a simple survey procedure, utilizing individuals in various areas of expertise to analyze the crossing. The diagnostic team consists of knowledgeable representatives of stakeholders in a highway-rail grade crossing.

Using highway-rail grade crossing safety management principles, the team evaluates conditions at a highway-rail grade crossing to make determinations or recommendations concerning safety needs. At a minimum, this diagnostic team shall include:

- Representative(s) of the highway agency
- SCRRA
- CPUC
- Other participants in the diagnostic team may include the BNSF or UPRR railroads, FRA, and representatives of SCRRA member agencies, as necessary

The diagnostic team needs to be interdisciplinary to ensure that all factors relating to the operational and physical characteristics of the highway-rail grade crossing are properly identified, analyzed, and mitigated as necessary. The team shall have the expertise to provide a thorough engineering analysis of the physical and operational aspects of the highway-rail grade crossing and provide input into the overall effectiveness and safety of the proposed design of the crossing.

Consultation with all stakeholders is required to ensure that the design of the highway-rail grade crossing shall, to the extent possible, comply with the standards and criteria in this Manual.

In addition to the engineering expertise that should be included in the diagnostic, any stakeholder with an interest in the highway-rail grade crossing, or with information regarding the highway-rail grade crossing, should be included. The diagnostic team is responsible for bringing all factors affecting the design and ultimate operation of the highway-rail grade crossing into the discussion of the overall design.

7.3.2 Diagnostic Process

The diagnostic process necessary to begin and complete the design of the highway-rail grade crossing is a several-step process that is outlined in Figure 7-2.

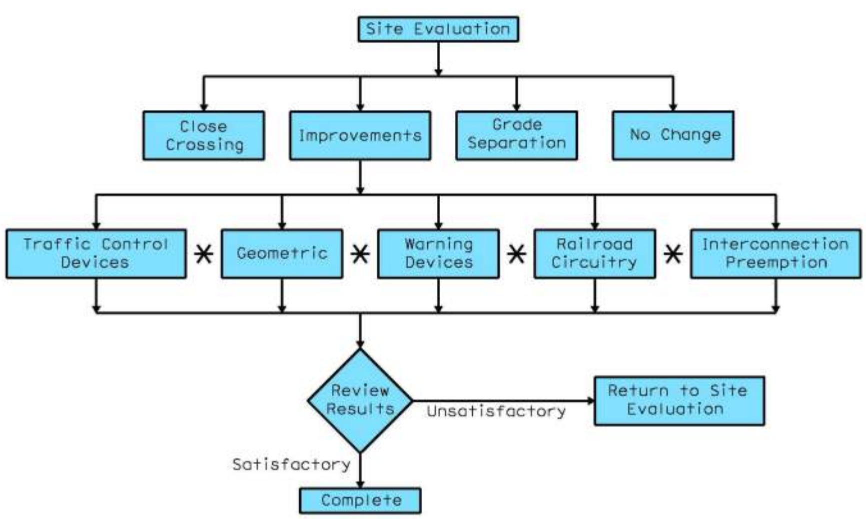


Figure 7-2. Diagnostic Meeting Process

The roles and responsibilities of each organization represented at the diagnostic review shall be established prior to the commencement of the diagnostic process. The diagnostic team should analyze the highway-rail grade crossing at various steps along the way to assess the progress of the overall design. Before starting the diagnostic process, the following should be addressed:

- Purpose of and need for improvements
- Existing conditions
- Existing deficiencies from the requirements in the Manual
- Funding
- Lead agency
- Roles and responsibilities

Defining the purpose of, and need for, the improvements will set the stage for the overall diagnostic process. The engineering team, working on an established purpose and need, shall analyze the reasons for the proposed improvements and develop the overall strategy on the design of the improvements and the development of engineering solutions.

While funding is not a determining factor in developing the overall safety improvements at a crossing, it does affect the overall approach to the design, construction, and maintenance of the crossing. In many cases, the purpose of the modifications is directly related to funding sources and requirements that define the process. These responsibilities and funding sources for the project should be determined at the onset of the design process.

Once the above-mentioned issues have been addressed, the team begins the diagnostic process in accordance with Figure 7-2. As shown, the first steps are deciding upon:

- Whether the highway-rail grade crossing can be closed
- Whether the highway-rail grade crossing should be grade separated
- Whether no changes should be made
- Whether improvements are to be proposed

In general, the proposed improvements should bring the highway-grade rail crossing in compliance with the requirements in the Manual. Once the team decides improvements are needed at the crossing, each of the elements (comprising the second level of the figure) is discussed, and improvements, if any, are proposed. Upon completion of the first diagnostic site meeting, the conceptual scope of the improvements is agreed upon between the stakeholders and the design phase of the project can begin.

In order to incorporate current conditions at an existing, or proposed, highway-rail grade crossing into the conceptual design of a highway-rail grade crossing, field observations are needed to record key factors that may affect the capabilities and success of the design. At this stage of the project general observations should be recorded; including, but not limited to, factors such as:

- Types of warning devices
- Vehicle and pedestrian conditions
- Vehicle-train and pedestrian-train conflict points
- Highway-rail grade crossing surface conditions
- Adjacent intersection and driveway conflicts
- Train speed
- Train density
- Train operating patterns
- School bus volumes
- Location of schools in the vicinity
- Location of stations
- Illegal/risky vehicle and pedestrian maneuvers
- Sight distances
- Pavement striping

The next level of the figure, “review results”, represents the design diagnostic stage, and builds on the information gathered in the concept diagnostic by facilitating a more in-depth analysis, from which final design recommendations for highway-rail grade crossing improvements are achieved. This diagnostic occurs after design has begun, usually following the completion of the 90% Design but sometimes as early as the 65% Design, but only after unique information regarding the conditions at the highway-rail grade crossing has been determined. This information may include, but is not limited to, factors such as:

- Additional traffic behavior
- Utility information
- Drainage information
- Other civil-related information that will affect the overall design and operation of the crossing

At this stage in the design, additional detailed data regarding design vehicles, current preemption phasing, current intersection phasing, annual average daily traffic (AADT), train speeds, train types, number of trains per day, train detection type, and the percent of trucks using the highway-rail grade crossing may be necessary.

The design diagnostic gives the design team a foundation to proceed with their highway-rail grade crossing improvement design.

The post-construction diagnostic site meeting also is representative of the “review results” level of the diagnostic process figure, in that the project is not satisfactorily completed until this process is completed and all the stakeholders agree on the results of the improvements.

7.3.3 Diagnostic Form

The diagnostic form is used by the diagnostic team as a representative checklist of existing highway-rail grade crossing conditions, noticeable conflicts, necessary changes required, etc. Appendix C and C-1 show SCRRA's diagnostic form and instructions for its effective use. The diagnostic form is structured to allow users to easily gather pertinent information about the crossing. The form also accommodates extra notes and diagrams that help to clarify the current conditions at the crossing.

7.4 NEW HIGHWAY-RAIL GRADE CROSSINGS

Refer to Appendix G for SCRRA's Board adopted policy on new crossings. *Before considering a new highway-rail grade crossing, the first alternative that should always be considered is a grade-separated crossing. It is SCRRA's policy, as well as State and National policy, to discourage the construction of new at-grade highway-rail grade crossings.* However, there are instances where the additional highway-rail grade crossings are in the public's best interest, and where the construction of a grade separation is not feasible for a variety of reasons. In most cases, the construction of a new highway-rail grade crossing must be offset by the closure of one or more nearby existing and in-service crossing(s).

A proposed new highway-rail grade crossing shall only be permitted if there is a clear public need, funding is sufficient, and the appropriate measures have been taken to mitigate the hazards associated with the new crossing. The CPUC will ultimately determine whether a new grade crossing is warranted and should be contacted very early in the process to consider any new highway-rail grade crossing. A new highway-rail grade crossing must go through an environmental study (either a negative declaration, or environmental impact report), proper diagnostics, engineering, and a regulatory process for approval. Prior to beginning the planning for a new crossing, a Letter Agreement to reimburse SCRRA for its review and participation in the conceptual planning process should be developed; if design is required, a Design Services Agreement with SCRRA shall be executed. The agency initiating the highway-rail grade crossing shall have in place a fully executed C&M Agreement with SCRRA before any construction begins. Refer to Section 2.5 for further information regarding C&M Agreements, rights-of-entry, and right-of-way procedures related to the construction of new crossings or the modification of existing highway-rail grade crossings.

All costs related to the construction of the new crossing, including those borne by SCRRA for design or programming, shall be the responsibility of the initiating agency. When no highway-rail grade crossing closures are included in the project, the involved parties must agree on the assignment of responsibility for providing financing for ongoing maintenance of the highway-rail grade crossing surface and traffic control devices. Closing one or more adjacent crossings shall be considered whenever a new highway-rail grade crossing is initiated.

7.5 HIGHWAY-RAIL GRADE CROSSING ENHANCEMENTS

An existing highway-rail grade crossing may be modified through the engineering of improvements that enhance the overall safety and operation of the crossing. Enhancing the safety of a crossing will be best achieved by incorporating the standards and criteria in this Manual.

7.6 HIGHWAY-RAIL GRADE CROSSING CLOSURE

Closure of a highway-rail grade crossing is accomplished by eliminating highway access to the crossing. Because a highway-rail grade crossing closure is a method of eliminating hazards at a highway-rail grade crossing, closures costs may qualify for funding through the Section 130 Program. Refer to Section 7.11.2 for additional information regarding the Section 130 Program. Closure of a highway-rail grade crossing shall always be considered as an alternative to the modification of an existing crossing.

Closure of an existing highway-rail grade crossing will typically require a public process, an environmental process, and “street vacation” to address the property rights.

A highway-rail grade crossing closure may be the result of a corridor highway-rail grade crossing consolidation project. In this case, several crossings may be consolidated into fewer crossings, thereby minimizing the relative hazards within the corridor.

7.7 SEALED CORRIDORS

SCRRA’s Sealed Corridor Program is a comprehensive strategy to minimize access to the railroad corridor. Some examples of sealed corridor enhancements are as follows:

- Exit gates
- Median separators and raised islands
- New signs and pavement markings
- Advanced highway-rail grade crossing signal analyzers
- Locked right-of-way gates and fencing
- Highway-rail grade crossing geometry improvements
- Grade separation or closing of crossings
- Advanced traffic signal technology
- Advanced pedestrian treatments

Where applied at multiple crossings, a system of prioritization shall be adopted in order to equitably apply sealed corridor technology within the design.

7.8 QUIET ZONES

A “quiet zone” is an area that qualifies under the FRA regulation on the use of locomotive horns at highway-rail grade crossings; Title 49 CFR, Part 222, “Use of Locomotive Horns at Public Highway-Rail Grade Crossings”. This regulation is intended to maintain public safety while responding to concerns of communities that have sought relief from unwanted train horn noise. Areas that may qualify for quiet zones are those in which the placement of traffic warning devices and civil upgrades, such as medians, have been approved as providing enough safety protection, which is at or better than sounding the locomotive horn, so that sounding of a locomotive horn is unnecessary.

A quiet zone is created upon notification of establishment by the requesting agency, usually the local municipality. The process of creating and authorizing a quiet zone is defined in Title 49 CFR, Part 222.43. The FRA shall determine that a quiet zone exists after they have reviewed, qualified, and approved the highway-rail grade crossing improvements. Local public authorities are the only entities that can designate or apply for quiet zone status. *The highway agency who owns the highway shall also bear the initial and recurring costs when SCRRA is required to install and maintain additional equipment.* SCRRA has adopted procedures for the pursuit of a quiet zone within SCRRA's system. Also, additional information regarding the creation of quiet zones can be found on the FRA website at http://www.fra.dot.gov.

It is also important to note that in designated "Quiet Zone" areas, the Train Engineer is required to blow the train horn if certain safety hazards are observed along the right-of-way. Some of these safety hazards include, but are not limited to:

- People and equipment observed working along the railroad right-of-way
- Pedestrians observed along the right-of-way
- Vehicles observed on the right-of-way or in close proximately to the tracks at grade crossings
- Animals observed on the tracks
- Emergency situations in which sounding the horn can prevent imminent injury, death, or property damage

All projects that improve an existing public or private highway-rail grade crossing or group of crossings shall require that each improved crossing include an approved Supplementary Safety Measure (SSM) as defined by Appendix A of Title 49 CFR, Part 222. This will allow the crossing(s) to be included in a quiet zone established under 49 CFR §222.39 paragraph (a)(1). This will also ensure that each of the modified crossings has a calculated quiet zone risk index (QZRI) that is less than the calculated risk index with horns (RIWH); allowing the crossing(s) to be included in a quiet zone established under 49 CFR §222.39 paragraph (a)(2) without negatively impacting the FRA quiet zone calculations. Alternative Safety Measures (ASM) as defined in 49 CFR §222 Appendix B may also be required in conjunction with the approved SSM and will be determined by the diagnostic team on a case by case basis.

All SCRRA highway-rail grade crossings that have been upgraded to meet current standards will include active warning devices and gates, "full pedestrian treatments", railroad signal constant warning time, and signal house power out indicators. Thus, highway-rail grade crossings that conform to SCRRA standards and include an SSM will require only minor future modifications in order to be included in the establishment of a new quiet zone. SCRRA considers these crossings to be "Quiet Zone Ready".

In areas outside of the limits of quiet zones, Engineers must sound locomotive horns 15-20 seconds prior to entering the highway-rail grade crossing, but not if the train is more than a quarter-mile away from the crossing. Most state laws and railroad operating rules require the Engineer to sound the locomotive horns when within a quarter-mile of the grade crossing, and continue sounding the horn until the highway-rail grade crossing is occupied by the locomotive.

7.9 WAYSIDE HORNS

Prior to installation of wayside horns, the crossing shall be upgraded to meet current SCRRA highway-rail grade crossing standards. This includes include active warning devices and gates, “full pedestrian treatments”, railroad signal constant warning time, signal house power out indicators, and improvements as necessary to upgrade the crossing to “Quiet Zone Ready” status as discussed in Section 7.8.

Wayside horns in conformance to the requirements stated in Appendix E of 49 CFR Part 222 may be installed on the Metrolink System, however SCRRA discourages the use of wayside horns due to it not being a fail-safe system. A wayside may be used in lieu of a locomotive horn at any highway-rail grade crossing. A wayside horn may also be installed within a quiet zone. For purposes of calculating the length of a quiet zone, the presence of a wayside horn at a highway-grade crossing within a quiet zone shall be considered in the same manner as a grade crossing treated with an SSM. A grade crossing equipped with a wayside horn shall not be considered in calculating the Quiet Zone Risk Index or Crossing Corridor Risk Index.

If the highway agency proposes to install a wayside horn at a highway-rail grade crossing, the wayside horn shall be owned and maintained by the highway agency. The highway agency shall coordinate any access needs for maintenance of the wayside horns with SCRRA’s Signal Maintenance Department.

7.10 SUBMITTALS

7.10.1 Engineering Drawings and Specifications

Project plans, specifications, and estimates shall be submitted to SCRRA at each submittal stage, in accordance with SCRRA Engineering Standards. The approved size for documents shall be 11" × 17" scaled for contract drawings, originally submitted plans for shop drawings, high-resolution color electronic files on read-only compact discs, and for photographs; all other documents should be 8½" × 11".

7.10.2 Traffic Preemption Calculations and Drawings

Traffic signal design, drawings, installation procedures, preemption timing calculations, and preemption sequences shall be signed and stamped by a registered professional Engineer (civil or traffic) licensed to practice in the State of California. The design drawings shall show intersection plan and details, phase diagrams, signal standard schedules, conductor schedules, estimated material, and construction notes, as per Caltrans’s standard drawing format. The highway agency shall also complete and submit the following:

- SCRRA Highway-Rail Grade Crossing Traffic Signal Preemption Request Form (see Appendix D).
- The completed “LADOT Railroad Preemption Form” (see Appendix D-1) showing calculations for each approach to the crossing.
- A study of the variation in total warning time and advance preemption time as a result of railroad operations and variation in traffic signal operation. Both the “worst case” (maximum right-of-way transfer time) scenario and the “best case”

(minimum right-of-way transfer time) scenario shall be considered for the determination of the maximum highway traffic signal preemption time and the design of preemption sequences.

Traffic Inner-connect designs and Preemption Worksheets must be reviewed and approved by the SCRRA PTC, C&S Engineering Services Department.

Total Traffic Signal Preemption time shall be limited to 50 seconds or less, see Section 6.1.3. Requests for additional traffic signal preemption time will be submitted, through a special design consideration, to SCRRA's PTC, C&S Engineering Services Department for review and approval.

7.10.3 Design Phase

The highway agency shall submit Preliminary Design (30% Design), Interim Design (60% Design), Pre-Final (90% Design), and Final Design (100% Design) documents to SCRRA.

Five (5) 11"x17" sets of plans and specifications shall be submitted to SCRRA during the design phase. Four weeks will be allowed for each review. If a consultant is used for the review process, the consultant and the lead Engineer shall be free to communicate and resolve all design issues.

Any special design consideration from this Manual shall be considered by SCRRA through the submittal of a Request for Special Design Consideration Form, included in Appendix E.

7.10.4 Construction Phase

For any project that infringes on SCRRA or member agency right-of-way, the initiating agency shall obtain a right-of-entry agreement as detailed in Section 2.5.2. The highway agency shall submit for review: two sets of drawings showing details of construction affecting the tracks and property; specifications; and plans and procedures for excavation, demolition, falsework, sheeting and shoring, drainage, and temporary traffic control.

7.10.5 Project Walk-Through and Acceptance Phase

At the end of all construction projects, when work has been substantially completed**,** a Signal Maintenance and acceptance walkthrough will be held to facilitate handling the grade crossing warning system over to the Signal Maintenance group. Representatives of the following groups will be in attendance: SCRRA Signal Maintenance Department; SCRRA PTC, C&S Engineering Department; SCRRA Engineering Design contractor; and Signal Construction contractor. Documents to be produced as a result of this meeting:

1. Correctable Items Punch List
2. Sight or project specific As-In-Service Signal Circuit Plans
3. All required 49CFR Part 234 Test and Inspection Documents
4. Signal and Grade Crossing Predictor unit(s) software

5. Sight Specific Crossing Predictor programming or "Pack" files
6. At the conclusion of the Project Walk-Through process, As-Built documentation shall be submitted to the PTC C&S Technical Services Group for inclusion into SCRRA's Configuration Management.

7.10.6 As-Built Phase

The highway agency shall submit five (5) hardcopy sets, and one (1) electronic set using MicroStation CAD software, of As-Built documents to SCRRA at the completion of the project, and prior to closing of the project.

7.10.7 CPUC Form G

Within 30 days of completion of the project, the highway agency shall submit a completed CPUC Standard Form G to the CPUC to notify them of the completion of the project. See the CPUC's website for more information and the latest version of the form:

http://www.cpuc.ca.gov/Crossings/

7.11 FUNDING

7.11.1 Introduction

Any party that is interested in creating or modifying a highway-rail grade crossing may be responsible for financing of the highway-rail grade crossing enhancements. However, financing can be funded by the Federal Aid At-Grade Highway-Rail Grade Crossing Program (Section 130 Program). Funding for grade separations is also available under the Section 190 Program. Additional funding may be available through other state or federal programs.

Both programs are administered by the CPUC and Caltrans. Additional information can be found on the CPUC website at http://www.cpuc.ca.gov

7.11.2 Section 130

Section 130 of the United States Code, Title 23 (23 U.S.C. 130), provides federal funds for the elimination of hazards at existing highway-rail grade crossings. The purpose of the Section 130 Program is to reduce the number, severity, and potential of hazards to motorists, bicyclists, and pedestrians at highway-rail grade crossings. This program is a cooperative effort between the FHWA, Caltrans, the CPUC, railroad companies, and highway agencies. Additional information can be found on the FRA website at http://www.fra.dot.gov.

In order to improve the highway-rail grade crossing under the Section 130 Program, the highway-rail grade crossing must go through a series of diagnostic reviews initiated by the CPUC (in association with the highway agency, railroad(s), and Caltrans), and be eligible to receive funding. Not all highway-rail grade crossings are eligible to be financed by the Section 130 Program. Highway-rail grade crossings that are not eligible for the Section 130 Program are as follows:

- Pedestrian-rail grade crossings solely for the use of pedestrians or bicyclists, including station crossings
- Highway-rail grade crossings used by light rail vehicles, either solely, or in conjunction with freight operation
- Private highway-rail grade crossings
- Existing grade-separated crossings

The submittal of a highway-rail grade crossing for Section 130 funding shall include the documented record of a thorough diagnostic process. This is accomplished at the concept level of engineering for programming into the system. It is important to consider the timeline associated with the programming of Section 130 associated modifications. The normal programming of Section 130 funding occurs several years in advance of construction. Because of this, it is important to allow for this time within the implementation schedule for the proposed enhancements.

In order to be considered for Section 130 funding, a complete engineering analysis of the highway-rail grade crossing is required. As part of this analysis, a hazard analysis is necessary to properly determine the level of highway-rail grade crossing improvements to be installed under the plan. Further work involves prioritization of the funding request with requests from other crossings throughout California. During the early stages of the project, it is important for the involved parties to consider the sources of funding and the requirements associated with that funding. In addition, the purpose and need of the proposed improvements should be considered for eligibility under the Section 130 Program.

7.11.3 Section 190

The State of California has instituted the Section 190 Program to provide funding to highway agencies to separate public highway-rail grade crossings, eliminate existing highway-rail grade crossings, or provide funds to highway agencies to grade separate existing crossings. This funding is based upon a priority list developed by analyzing the hazards related to the crossing. Factors such as traffic demands and accident history play a significant role in this prioritization. When the entire cost of the grade separation is considered, this funding may be a small percentage of the construction costs for the project.

8.0 SPECIAL ISSUES

8.1 ADJACENT TRACKS

The location of adjacent track(s) owned and operated by another railroad company creates conditions that need to be evaluated during the design of warning devices for vehicles and pedestrians. The responsibility of installing and maintaining warning devices at the crossing will fall on the railroad that owns and operates the part of the crossing on which the warning devices are required. In such cases, there may be two separate crossing warning systems, one from SCRRA and one from the foreign railroad, at the crossing that must be interconnected to work in conjunction with each other. Coordination with the foreign railroad must be done throughout the design stages to ensure that adequate warning devices are installed at the highway-rail grade crossing and will work in conjunction with one another.

8.2 LIGHT RAIL TRANSIT AND HIGH-SPEED RAIL

As the population of Southern California continues to grow, demand for alternate public transportation modes, such as Light Rail Transit (LRT) and High-Speed Rail (HSR) systems, have increased to help relieve the congestion on freeways. With land in Southern California mostly developed, these alternate transportation modes are constrained to using existing railroad corridors to provide an efficient and practicable route. Currently, SCRRA's System includes a limited LRT system on the SCRRA Pasadena subdivision that does not share the rail corridor with Metrolink trains, but with the demand for alternate public transportation modes increasing, there is potential for an LRT and/or HSR system to utilize any of SCRRA's other subdivisions along with Metrolink trains.

8.2.1 Applicability of Manual for Shared Corridors

All planned and future shared corridors with LRT and HSR tracks will be subject to all of the standards and criteria of this Manual.

Due to the safety concerns of intermixing different modes of rail, the FRA and FTA issued a joint policy statement on how agencies will coordinate their safety authority. This joint policy can be found on the Federal Register, Vol. 65, No. 132, Monday, July 10, 2000, pp. 42526-42528.

LRT and HSR systems operate very differently from commuter and freight rail systems. The close proximity of these LRT and HSR systems to SCRRA's system warrants special attention at highway-rail grade crossings due to various factors that affect the safety and operation through the crossing for both rail vehicles and highway vehicles/pedestrians. If an at-grade crossing is acceptable per the analyses required in Section 5.1, then LRT and HSR crossings adjacent to SCRRA crossings shall be addressed individually from the beginning of the project to ensure safe operation of all modes (railroad and highway users) utilizing the crossing.

8.3 ADJACENT DEVELOPMENT

Redevelopment and new developments have afforded the opportunity to control the location of driveway approaches that are close to the highway-rail grade crossing (see

Section 3.6). The lead Engineer shall review the development plans, coordinate with the highway agency, and ask the agency to impose "conditions for development approval" relative to development street access.

Adjacent residential and commercial development to highway-rail grade crossings may substantially increase the volume of highway traffic over a crossing. This may occur during certain times of day, such as during peak rush hour periods, or during certain times of the year. Schools near highway-rail grade crossings may generate increased volumes of vehicular and pedestrian traffic before and after school hours. Likewise, certain entertainment/sporting venues may increase vehicular and pedestrian traffic before, and after, an event. Observations of a highway-rail grade crossing during different times of the day and year should take place to understand how the dynamics of adjacent development affect a highway-rail grade crossing. The selection of appropriate traffic control/warning devices shall be installed to mitigate these affects.

8.4 LANDSCAPING

It is important that landscaping not decrease the level of safety at a highway-rail grade crossing by impeding the visibility of any active or passive warning signals or signage for motorists, bicyclists, pedestrians, or train engineer.

SCRRA has developed Landscaping Design Criteria to provide uniform and consistent standards for landscaping during design, construction, and maintenance on commuter and freight railroad rights-of-way. These criteria are intended to provide minimum standards and general requirements for the design, construction, and maintenance of landscaping in a manner compatible with safe operation of railroad corridors and with the rail capacity expansions envisioned.

See Chapter 26, "Landscaping Design Criteria" in the SCRRA Design Criteria Manual.

8.5 BIKEWAYS AND TRAILS

The addition of bikeways and trails within, or adjacent to, the railroad right-of-way presents a challenge to both the highway agency and railroad operators. (See Figure 8-1 for an example of a bikeway adjacent to active railroad tracks). Of particular concern to SCRRA is the activity of pedestrians and bicyclists within the right-of-way. Also, the incorporation of a bike path that is adjacent to the highway-rail grade crossing intersection introduces another element to be accounted for within the analysis and determination of preemption requirements for the highway-rail grade crossing. Refer to Section 6, for provisions governing the design of the interconnection of the traffic signal system with the railroad signal system. SCRRA has developed Rail with Trail Design Criteria that shall be referred to whenever a bikeway is to be constructed within railroad right-of-way. The highway agency shall follow this procedure in the development of the trail, including improvements to site within and adjacent to the railroad right of way, and may include the installation of additional fencing and channelization, modified traffic signals, pedestrian treatments, and additional highway-rail grade crossing warning devices. The initiating agency shall facilitate a diagnostic review and highway-rail grade crossing design process to mitigate these effects. See Chapter 27, "Rail-with-Trail" in SCRRA's Design Criteria Manual.

Figure 8-1. Bikeway and Trail Separation

8.6 FENCING AND SECURITY GATES

It is SCRRA's desire to keep trespassers out of the operating railroad corridor. The design of the travel way shall incorporate adequate fencing to limit access by trespassers onto SCRRA railroad right-of-way and tracks. This fence shall be tubular steel fencing or welded wire mesh fencing as per SCRRA Engineering Standards. The fence shall be located at the edge of the trail and along the railroad right-of-way.
A three split-rail fence, in combination with landscaping that can serve as a positive barrier between the track and any bike/pedestrian trail, may be used in rural or environmentally sensitive areas, if approved by SCRRA and the member agency. Since newly planted landscaping may take a few years before it becomes an effective barrier, suitable temporary measures may be required until the landscaping has sufficiently matured. Any landscaping must be maintained so it does not impede the visibility of any active or passive warning devices—or signage—by trains, pedestrians or engineers.

It is SCRRA's policy to maintain access along its right-of-way for maintenance and inspection. The travel way fencing shall not be constructed so as to limit this access. Should access points be necessary, the fencing shall incorporate gates at locations as per SCRRA Engineering Standards or locations requested by SCRRA maintenance crews. These gates shall be secured with SCRRA locks. The highway agency shall install "No Trespassing" warning signs, as per SCRRA ES 5214.

The height of the fence within 150 feet of highway-rail grade crossings shall be four (4) feet. The height of the fence in the balance of the right-of-way shall be at least six (6) feet.

All access points to SCRRA rights-of-way at highway-rail grade crossings shall utilize a chain link gate in accordance with SCRRA ES 4011 – ES 4016. These gates are to be installed in accordance with these drawings, as follows:

- The gate shall be placed to allow a maintenance vehicle to park prior to opening the gate.
- Gate shall swing away from the tracks.
- The installation of the gate shall be incorporated into the proposed fencing plan to adequately secure the right-of-way.
- Bollards, K-Rails, or other substantial barriers shall be used with the right-of-way gates to provide a maximum level of security.

8.7 LIGHTING

The highway agency shall provide and maintain lighting for the travel-way to maintain a safe environment for the users. Local, state, and federal guidelines, as well as industry standards for lighting, shall be incorporated into the design. Electric power supplied to these lights must not utilize the same electric meter service or power source as that supplied to the railroad grade crossing warning equipment. All lighting equipment, including light poles and foundations must be installed to provide a minimum of thirty (30) feet clearance between the light foundation and the nearest running rail of the track and such that no part of the lighting system will block access to the railroad right-of-way.

8.8 VITAL EQUIPMENT PLACEMENT AND MAINTENANCE ACCESS

Whenever a highway-rail grade crossing is being modified, placement of vital equipment and maintenance access must be considered and evaluated. When evaluating the crossing to place vital equipment, such as signal houses and cabinets, the highway geometry should be reviewed to determine which quadrant would be the best to place vital equipment to avoid being damaged from errant vehicles. As an example, in Figure 8-2, the highway-rail grade crossing is adjacent to a “T”-intersection where there is a high potential for errant vehicles to overrun the “T”-intersection into quadrant 1 and possibly damage any railroad equipment. Vital equipment, such as a signal house, should be placed in the least accident-prone quadrant of the highway-rail grade crossing, when possible. If vital equipment is placed in a location that has a high potential of being hit by errant vehicles, the vital equipment shall be protected with bollards or guard-railing to prevent or minimize damage to the vital equipment.

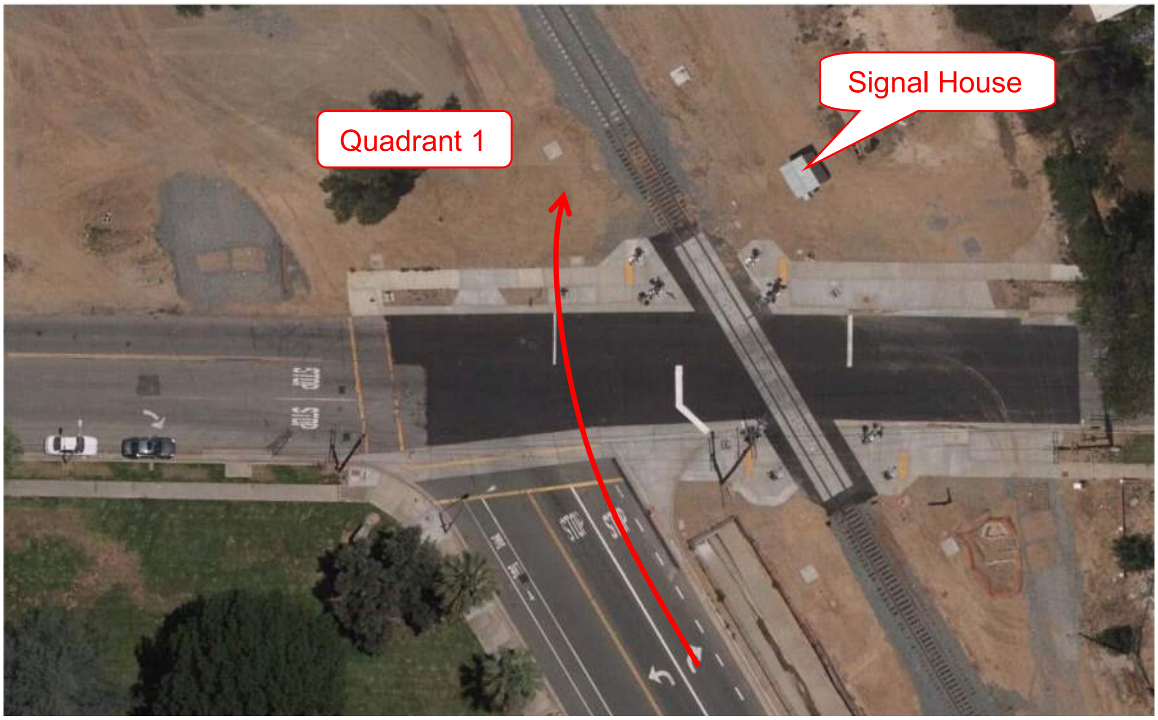


Figure 8-2. Possible Errant Vehicle Path

Maintenance access to the railroad signal devices and railroad right-of-way must also be provided whenever a highway-rail grade crossing is modified, to allow SCRRA's maintenance forces to perform maintenance (either at the grade crossing, signal houses, or along the track). Providing maintenance access can be a challenge with pedestrian channelization devices due to limited right-of-way. Coordination with the SCRRA is required to ensure that the pedestrian channelization devices, to the extent possible, does not block or impede maintenance access to railroad signal devices and railroad right-of-way.

8.8.1 Maintenance Access to Railroad Warning Devices

All pedestrian channelization devices must be designed to provide a minimum of 24” of clearance between any part of the railing structure and any active warning devices.

8.8.2 Maintenance Access to Railroad Right-of-Way

Maintenance access to the railroad right-of-way must be provided outside the limits of the crossing gates to allow safe entry of maintenance personnel to the railroad right-of-way. Maintenance access to the railroad right-of-way can be either a driveway that meets the Highway Agency's standard or a 4” mountable curb with proper transition to full height curb as noted in SCRRA's Engineering Standards. An access gate, wide enough to accommodate a maintenance vehicle, shall also be provided to seal off the railroad ROW from the public, while allowing access to only authorized personnel. See Figure 8-3 and SCRRA ES 4011 – ES 4016 for examples of maintenance access at highway-rail grade crossings.

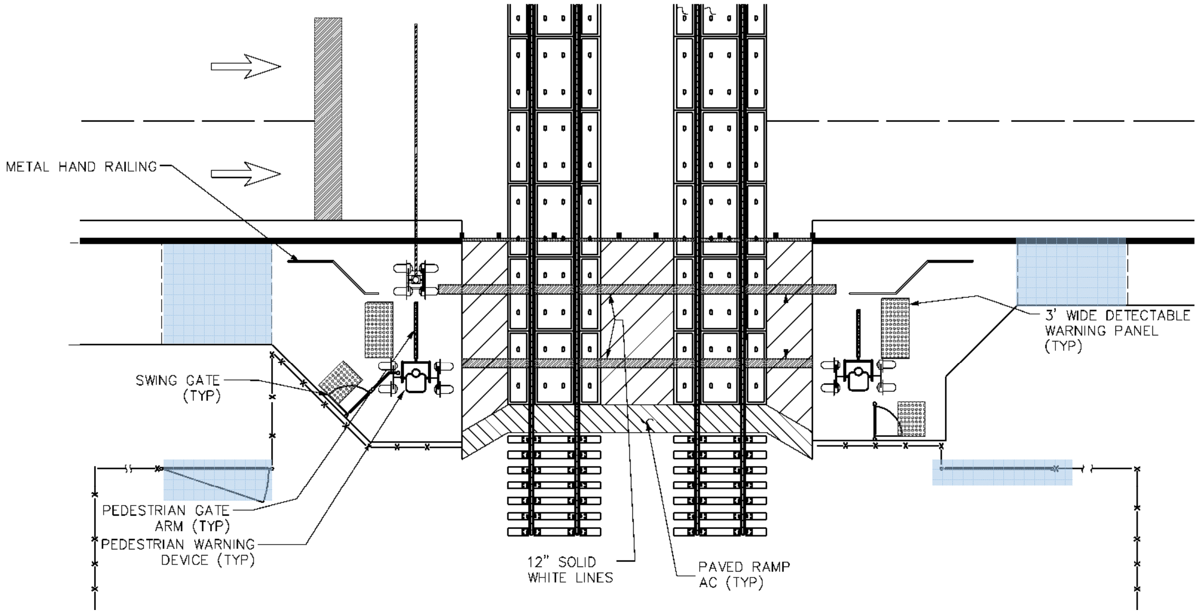


Figure 8-3. Maintenance Access at Highway-Rail Grade Crossings

8.9 POSITIVE TRAIN CONTROL CRITICAL FEATURES

Positive Train Control (PTC) is a system that automatically stops a train to prevent certain accidents from occurring, such as:

- Train to Train Collisions
- Excessive Speed
- Train Movements onto Unauthorized Tracks/Work Zones

PTC does not prevent accidents that may occur with vehicles at highway-rail grade crossings. Even though the operation of a highway-rail grade crossing is not affected by the PTC system, there are certain features associated with a highway-rail grade crossing that affects the PTC system. These features that affect the PTC system are known as PTC critical features. Any modifications to a highway-rail grade crossing that includes modification to existing or addition of new PTC critical features shall be coordinated with SCRRA's PTC Technical Services Group, see Section 7.1. Figure 8-4 shows items that are considered PTC critical features.

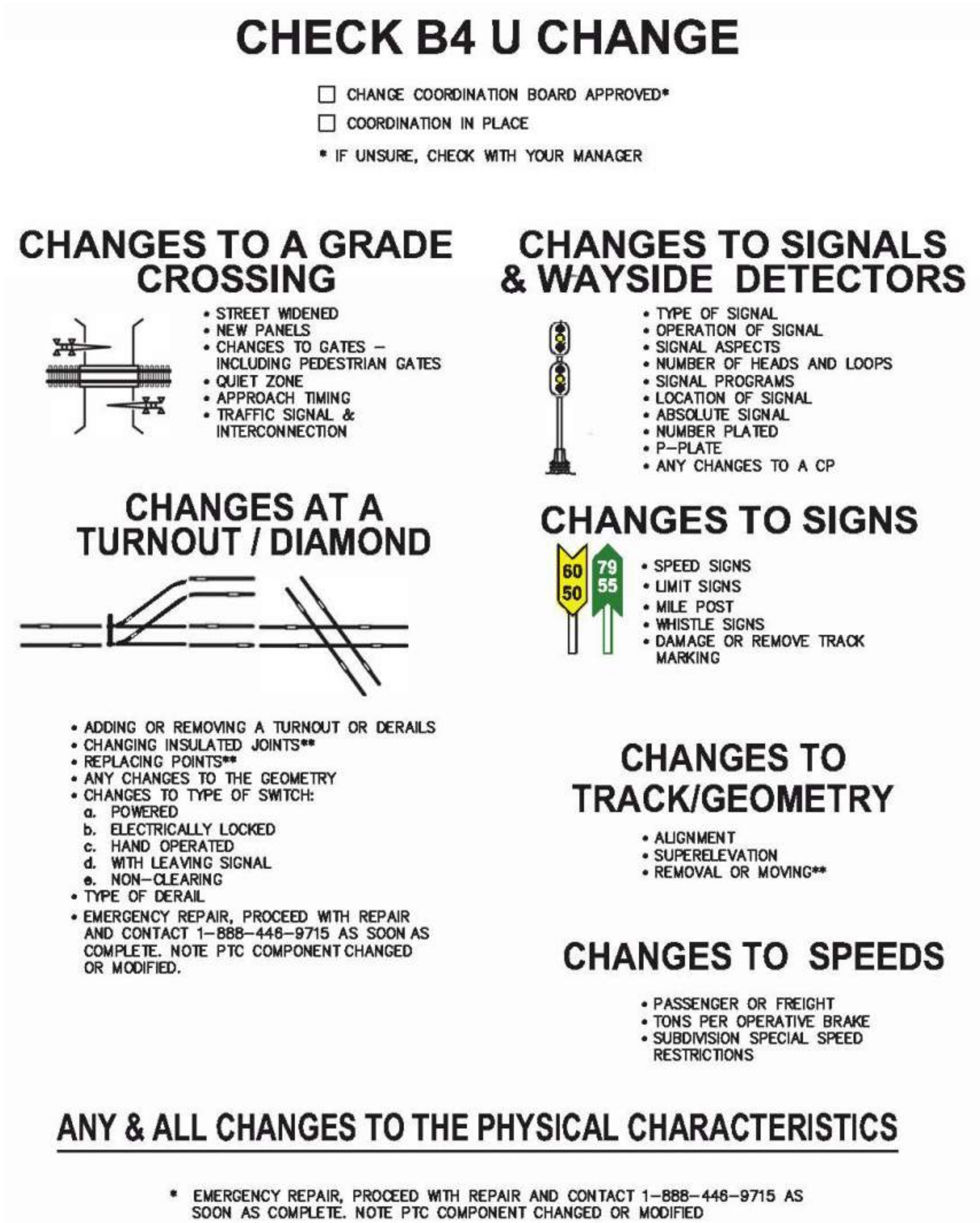


Figure 8-4. Positive Train Control Critical Features

8.9.1 Commissioning of PTC with Changes to PTC Critical Features

Prior to placing a new or modified highway-rail grade crossing into service, the physical characteristics of the crossing must be surveyed and incorporated into the PTC Subdivision (Subdiv) file. The changes to the SubDiv file must then be verified by on-site measurement and verification per the SCRRA prescribed Verification and Validation (V&V) Process. The SubDiv file must also be verified by lab testing through SCRRA's

PTC Technical Services Group. Only after these processes have been successfully completed and documented can the crossing commissioning process be moved forward. The lead Engineer responsible for the crossing design must coordinate with SCRRA's PTC Technical Services Group in order to establish schedule and budget for accomplishing these sub-tasks.

9.0 CONSTRUCTION

9.1 GENERAL

As mentioned in Section 2.5, construction cannot begin until a C&M Agreement and a SCRRA Form No. 6 (Temporary Right-of-Entry Agreement) have been executed by SCRRA, and workers have completed railroad safety training. The construction shall meet requirements stated in SCRRA's Standard Specifications, Design Criteria, and Engineering Standards. It shall also meet applicable AREMA and highway agency requirements.

Any damage to rails, ties, structures, embankments, third-party property, signal and communications equipment, or any other facility shall be repaired, at the highway agency's or its contractor's expense, to a condition equal to or better than the condition prior to entry (and to a level accepted by SCRRA). The highway agency or its contractor agrees to reimburse SCRRA, and any affected operating railroads, for any and all costs and expenses incurred as a result of their work, which may result in the following:

- Unscheduled delay to the trains, or interference in any manner with the operation of trains
- Unscheduled disruption to normal train operation
- Unreasonable inconvenience to the public or private users of the system
- Loss of revenue
- Alternative method of transportation for passengers

The **highway agency and its contractors shall comply with the rules and regulations contained in the current editions of SCRRA's documents** (listed below) **during construction of the project.** These SCRRA documents are available on SCRRA's website:

https://www.metrolinktrains.com/about/agency/engineering--construction

- Temporary Right-of-Entry Agreement (SCRRA Form 6).
- Rules and Requirements for Construction on Railroad Property (SCRRA Form 37).
- General Safety Regulations for Third Party Construction.
- Applicable SCRRA Engineering Standards and Specifications.

The highway agency shall notify SCRRA 30 working days prior to beginning work on the right-of-way and secure any protection SCRRA deems necessary. The highway agency shall be responsible for reimbursing SCRRA the actual costs and expenses incurred by SCRRA for all services and work performed in connection with the highway-rail grade crossing project, including a computed surcharge representing SCRRA's costs for administration and management.

The latest version of SCRRA Standard Specifications for work within rights-of-way operated and maintained by SCRRA shall be included within the contract documents.

The list of these specifications and the latest electronic version of these specifications is available on SCRRA's website:

https://www.metrolinktrains.com/about/agency/engineering--construction

9.2 EXCAVATION AND BACKFILL

The excavation and backfill shall meet all the requirements shown in SCRRA Standard Specification 31 20 00, Earthwork. Excavation for construction of footings, piers, columns, walls, or other facilities that require shoring to support active tracks shall comply with Chapter 15, "Excavation Support Criteria" of SCRRA's Design Criteria Manual and AREMA requirements and standard specifications. The contractor shall perform excavation and grading so that the finished surfaces are in uniform planes, with no abrupt breaks in surface, and have positive drainage on the right-of-way away from the track structure**.**

9.3 EROSION CONTROL

The general plans for the bridge shall indicate the proposed methods of erosion control, and must specifically address means to prevent silt accumulation in ditches and culverts and prevent fouling the track ballast, sub-ballast, and existing drainage systems. Existing track ditches shall be maintained at all times throughout the construction period. After construction has been completed, all erosion control devices and all deposits of silt shall be removed, and affected ditches restored. Approval of the erosion control plan does not relieve the submitting agency, consultant, or contractor of the ultimate responsibility and liability for a satisfactory erosion control plan.

9.4 TEMPORARY TRAFFIC CONTROL

Chapter 29, "Temporary Traffic Control" of SCRRA's Design Criteria Manual shall be referenced for further information on definitions, referenced standards, traffic control plans, submittals, traffic control elements, and responsibility/authority for temporary traffic control at highway-rail grade crossings. The chapter provide acceptable alternatives and procedures to prescribe appropriate temporary traffic control measures at highway-rail grade crossings.

The construction of a new highway-rail grade crossing, or the modification of an existing crossing, shall require temporary traffic control. A temporary traffic control plan, including traffic detours, shall be prepared in accordance with Part 6 of the CA MUTCD, the WATCH Manual, and the highway agency's requirements. **When a highway-rail grade crossing exists either within, or in the vicinity of, a temporary traffic control zone; lane restrictions, flagging, or other operations shall not be performed in a manner that would cause vehicles to stop on the railroad tracks unless a law enforcement officer or qualified flagger is provided at the highway-rail grade crossing to minimize the possibility of vehicles stopping on the tracks.** This applies even if automatic warning devices are in place.

SCRRA shall be contacted when the initial planning begins for any temporary traffic control zone that may, directly or indirectly, influence the flow of traffic over highway-rail grade crossings. Responsible agencies (along with others affected, such as emergency services and businesses) should meet to plan appropriate traffic detours and the necessary signing, marking, and flagging requirements for operations during temporary traffic control activities. Consideration should be given to:

- Length of time the highway-rail grade crossing will be closed
- Highway classification
- Type of vehicle and traffic affected
- Time of day
- Materials and techniques of repair

Temporary traffic control operations should minimize the inconvenience, delay, and crash potential related to affected traffic. Temporary traffic control activities should not be permitted to extensively prolong the closing of a crossing.

Temporary traffic control shall be used when a maintenance or construction activity is located on the railroad right-of-way, or when activity in the vicinity of a highway-rail grade crossing could result in queuing of vehicles across the railroad tracks. The issue of temporary traffic control shall be addressed within the project specifications.

9.5 UTILITY ADJUSTMENTS

The existing utilities shall be located prior to commencing any excavations. *Approval of the project by SCRRA does not constitute a representation as to the accuracy or completeness of location or the existence or non-existence of any utilities or structures within the limits of the project.*

The appropriate regional notification center [Underground Service Alert (DIGALERT) at (800) 227-2600], railway companies, and utility companies shall be notified prior to performing any excavation close to any underground pipeline, conduit, duct, wire, or other structure.

SCRRA is not a member of DIGALERT. Therefore, it is necessary to call SCRRA's signal department to mark, at highway agency's or contractor's expense, signal and communication cables and conduits. In case of signal emergencies or highway-rail grade crossing problems, the contractor shall call SCRRA's 24-hour signal emergency number. Refer to SCRRA's website for the latest contacts and phone numbers.

https://www.metrolinktrains.com/about/agency/engineering--construction/

If utilities cannot be located, potholing shall be done to locate the utilities. SCRRA and appropriate utility owners shall be notified immediately when utility lines not known or indicated on the drawings are encountered. No service shall be disrupted until the utility owner and SCRRA have determined the required action on such lines.

10.0 OPERATION AND MAINTENANCE

The design and operation of a highway-rail grade crossing requires the coordination of maintenance between the agency and SCRRA, as defined in the C&M Agreement. The complexity of this interaction increases when traffic signals and preemption are incorporated into the crossing design. In cases when the efficient operation of the traffic signals and other highway agency-controlled devices provide an important element in the overall safety of the crossing, the following procedures should be used.

10.1 HIGHWAY AGENCY INSPECTIONS

The **highway agency shall independently inspect the preempted traffic signals intersection a minimum of every three (3) months and shall report the results of this inspection to the SCRRA Signal Maintenance Department. If the crossing is a joint crossing, the highway agency shall also report the results to the other owner(s) of the joint crossing.** A general review of the highway intersection and highway-rail grade crossing for proper signing, pavement marking, sight distances, vegetation, visibility and changes in conditions should be made. Independent inspection and testing should include at least the following:

- Ensure the timing design parameters are recorded
- Simulate the preemption signal input from the highway-rail grade crossing warning system while confirming the railroad interconnect is connected to the highest priority control unit input
- Confirm preemption activation of traffic signals, including any associated pre-signals or active signs, and confirm that the devices are operating as designed
- Confirm that the standby battery power operates as designed
- Ensure all warning labels are clearly visible and legible
- Ensure all advance warning signals and signs are clearly visible, and that any trimming of vegetation or trees is done as necessary

10.2 JOINT INSPECTIONS

Highway-rail grade crossings with preempted traffic signals shall be jointly inspected on an annual basis with SCRRA. If the crossing is a joint crossing, the joint inspection will also include all other owner(s) of the joint crossing. SCRRA will schedule a Joint Traffic Signal Preemption meeting a minimum of 30-days in advance of each inspection. A representative from SCRRA's Signal Maintenance Department and Maintenance Contractor will be present during each inspection. The inspection shall include the observance of at least one train passing through the crossing on each Main Track in each direction of approach to the crossing. During joint inspections, a general review of the highway intersection and highway-rail grade crossing for proper signing, pavement marking, sight distances, and changes in conditions, should be made. Joint inspection and testing shall include, but not be limited to, the following:

- Confirm timing design parameters, including maximum preemption time and gate lowering times

- Verify all timing parameters and traffic signal preemption design is correctly reflected on the sight specific Signal Circuit Plans
- Verify the operation and functionality of each relay within the traffic signal preemption circuit
- Confirm interconnection circuit wires are free of grounds or foreign currents, and that the system fails in a safe mode
- Confirm the preemption signal from SCRRA is connected to the highest priority preemption input
- Identify whether special features are included, and functioning as designed
- Activate the highway-rail grade crossing warning system and confirm that preemption activation of traffic signals responds during all phases of the traffic controller unit
- Confirm that the pedestrian clear-out time matches the design timing
- Document the results of the joint inspection on the SCRRA Traffic Signal Preemption Annual Joint Inspection Form (See Appendix H)

10.3 HIGHWAY-RAIL GRADE CROSSING CONDITION CHANGES

Any changes to railroad or highway traffic conditions discovered during routine inspection and tests shall be reported to each party. The relevance of these observed changes may trigger an engineering safety evaluation of the site. The following are examples of reportable changes at the preempted site:

- Changes to railroad operation or speed
- Changes to vehicle traffic or speed
- Changes to the preemption, related signal settings, or related traffic signal placements
- Spotting of vehicles queuing onto the highway-rail grade crossing area
- Vehicles having difficulty stopping safely when a train approaches and activates the warning system

APPENDICES

APPENDIX A

Definitions of Key Terms and Standard Abbreviations

APPENDIX A
Definitions of Key Terms

Advance Preemption	The notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly by railroad equipment in advance of the activation of the railroad warning devices.
Advance Preemption Time	The period of time that is difference between the required maximum highway traffic signal preemption time and the activation of the railroad warning devices.
Buffer Time	The railroad's additional warning time for train handling to ensure that a required minimum warning time for track clearance is provided. Buffer time is discretionary and is added to the required 20-second minimum time.
Cantilever Signal Structure	A structure that is rigidly attached to a vertical pole and is used to provide overhead support of signal units.
Clearance Time	Additional time that must be provided in excess of the minimum time to account for wide crossings or crossing conditions that may slow the vehicle movement through the crossing. Clearance time is added at a rate of one (1) second for each 10 feet (or fraction thereof) of minimum track clearance distance greater than 35 feet.
Clear Storage Distance	The distance available for vehicle storage measured between six (6) feet from the rail nearest the intersection to the intersection stop line or the normal stopping point on the highway. At skewed highway-rail crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail, either along the centerline or the edge line of the highway, as appropriate, to obtain the shorter clear distance. Where exit gates are used, the distance available for vehicle stoppage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and not perpendicular to the highway, as appropriate, to obtain the shorter distance.
Constant Warning Time Train Detection	A means of train detection that provides relatively uniform warning time for the approach of a train that is not accelerating or decelerating after being detected.

Contractor	The individual, firm, partnership, corporation, joint venture, or combination thereof that has entered into a construction contract with the legal entity for which the work is being performed. For purpose of these guidelines, a contractor also includes any subcontractor, supplier, agent, or other individuals entering the railroad right-of-way during performance of the work.
Design Vehicle	The longest vehicle permitted by statue of the road authority (state or other) on that roadway.
Diagnostic Team	A group of knowledgeable representatives of the parties of interest in a highway-rail crossing or a group of crossings, who, using crossing safety management principles, evaluate conditions at a grade crossing to make determinations or recommendations concerning safety needs at the crossing.
Engineering Study	The comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, engineering judgment, experience, education, discretion, standards, guidance, and practices, for the purpose of deciding upon the applicability, design, operation, or installation of traffic control device. An engineering study shall be performed by a registered civil or traffic engineer, or by an individual working under the supervision of said engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented.
Dynamic Exit Gate Operating Mode	A mode of operation where the exit gate operation is based on the presence of vehicles within the minimum track clearance distance.
Equipment Response Time	The time elapsed between when the train enters the track circuit and when the train equipment (circuitry, relays, mechanisms, etc.) provides preemption notification to the traffic signal controller or the railroad warning devices.
Exit Gate Clearance Time	For four-quadrant gate systems, the exit gate clearance time is the amount of time provided to delay the descent of the exit gate arms after the entrance gate arms begin to descend.
Exit Gate Operating Mode	For four-quadrant gate systems, the mode of control used to govern the operation of the exit gate arms.

Fail-Safe	A design philosophy applied to safety-critical systems such that the result of a power failure, hardware failure, or the effect of software error shall either prohibit the system from assuming or maintaining an unsafe state, or shall cause the system to assume a state known to be safe.
Flangeway	The area adjacent to the rail that allows the flange of the wheel of the locomotive and rail cars.
Flashing-Light Signals	A warning device consisting of two red signal indications arranged horizontally that are activated to flash alternately (45 to 65 times per minute) when a train is approaching or present at a highway-rail crossing.
Four-Quadrant Gate	Train-activated warning gates that, when lowered, fully block highway traffic from entering the crossing. Gates lower across both approach and departure lanes on both sides of the crossing.
Grade Separation	A crossing of a highway and a railroad at different levels.
Highway	The roadway, road, street, approach road including any pedestrian or bicycle paths and including medians, lighting, fencing, landscaping, sidewalks traffic signs, traffic striping, drainage facilities and all other related highway improvements.
Highway Agency	The Public Agency or Private Entity that owns and maintains the property or has an easement or license for the highway improvements at and approaching the highway-rail grade crossing. The highway agency will typically be a local municipality (a City, a County, or the State or for a private crossing a private party).
Highway-Rail Grade Crossing	The general area where a highway and a railroad cross at the same level, within which are included the railroad, highway, and roadside facilities for traffic traversing that area. Highway-rail grade crossing will also mean the same as rail-grade crossing, rail crossing, at-grade crossing, or crossing.
Highway Traffic Signals	A power-operated traffic control device by which right-of-way is sequentially provided for various traffic movements at an intersection. These devices do not include power-operated signs, illuminated pavement markers, barricades,

	warning lights, or steady burning electric lamps.
Hold State	That portion of the preempt sequence in which the traffic signal controller will provide green indications to vehicle movements that do not approach the highway-rail crossing.
Interconnection	The electrical connection between the railroad active warning system and the traffic signal controller unit for the purpose of preemption.
Left Turn Trap	A condition whereby motorists turning left in one direction are shown a circular yellow indication while conflicting through-traffic in the opposite direction is shown a circular green indication. This situation should be avoided to prevent any motorists from turning left in front of oncoming traffic.
Main Track	A track designated in SCRRA's Timetable and General Code of Operating Rules as a track extending through yards and between stations that must not be occupied without authority or protection.
Manual	SCRRA's Highway-Rail Grade Crossings Design Standards and Criteria Manual.
Maximum Highway Traffic Signal Preemption Time	Maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the right-of-way transfer, queue clearance time, and separation time.
Median	The portion of a divided highway separating the travel ways for traffic in opposite direction.
Member Agency	Any county transportation agency whose property is directly affected by the project. The SCRRA member agencies are the Los Angeles County Metropolitan Transportation Authority (METRO), the Orange County Transportation Authority (OCTA), the Riverside County Transportation Commission (RCTC), the San Bernardino County Transportation Authority (SBCTA), and the Ventura County Transportation Commission (VCTC).
Minimum Track Clearance Distance	For standard two-quadrant railroad warning device control, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the highway stop line for the highway-rail crossing,

	warning device, or 12 feet perpendicular to the track centerline, to six (6) feet beyond the tracks, measured perpendicular to the far rail, along the centerline, or along the edge line of the highway, as appropriate, to obtain the longer distance. For four-quadrant gate systems, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the highway stop line or entrance warning device, to the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the centerline or edge of the highway, as appropriate, to obtain the longer distance.
Minimum Warning Time	Through train movement - The least amount of time the railroad active warning devices shall operate prior to the arrival of a train at a highway-rail crossing. Minimum warning time consists of the “minimum time” and the “clearance time” if the railroad warning system is interconnected with the highway traffic signal.
Minimum Time	The minimum 20-second time that the flashing-light signals operate before the arrival of any train in a crossing.
Monitored Interconnected Operation	An interconnected operation that has the capability to be monitored by the railroad or highway authority at a location away from the highway-rail crossing.
Overhead	A grade separated highway over a railroad.
Pedestrian Change/Don’t Walk Interval	An interval during which the flashing upraised hand signal indication is displayed. When a verbal message is provided at an accessible pedestrian, the verbal message is “wait.”
Pedestrian-Rail Grade Crossing	A Highway-Rail Grade Crossing that is used by pedestrians but not by vehicles.
Pedestrian Clearance Time	The time provided for a pedestrian crossing in a crosswalk, after leaving the curb or shoulder, to travel to the farside edge of the traveled way or to a median that has sufficient storage area for a pedestrian to wait.
Preemption	The transfer of normal operation of highway traffic signals to a special mode.

Preempt Trap	The condition where the traffic signals track clearance green interval of the queue clearance phase at the intersection ends before the railroad warning lights start to flash.
Pre-signal	Supplemental highway traffic signal faces operated as part of the downstream highway intersection traffic signals to stop traffic before it crosses the railroad. The purpose is to prevent vehicles from queuing across the crossing and then finding themselves stopped on the tracks in the area known as the minimum track clearance distance.
Private Rail –Grade Crossing	A Highway-Rail Grade Crossing that is on a privately-owned roadway used only by the private property owner or licensee.
Public Agency	The federal government and any agencies, departments, or subdivisions thereof; the State of California; and any county, city, city and county district, public authority, joint powers agency, municipal corporation, or any other political subdivision or public corporation therein; responsible for traffic control or law enforcement at the highway-rail grade crossing and requesting and sponsoring the projects. For the purposes of this Manual, SCRRA is not considered as a Public Agency.
Queue Clearance Time	The time required for the design vehicle stopped within the minimum track clearance distance to start up and move through the minimum track clearance distance and through the downstream intersection if there is not enough clear storage distance for the design vehicle. If pre-signals are present, this time shall be long enough to allow the vehicle to move through the intersection, or to clear the tracks if there is sufficient clear storage distance. If a four-quadrant gate system is present, this time shall be long enough to permit the exit gate arm to lower after the design vehicle is clear of the minimum track clearance distance.
Quiet Zone	A segment of rail line, with one or a number of consecutive public highway-rail crossings at which locomotive horns are not routinely sounded per 49 CFR Part 222.
Railroad Corridor	The corridor that includes the railroad right-of-way and adjacent constituent areas that contributes to the operation, maintenance, and safety of the railroad.

Right-of-Way	A strip of land, real estate or property of interest, under the ownership or operating jurisdiction of SCRRA or member agency on which railroad tracks, other structures and facilities are constructed.
Right-of-Way Transfer Time	The maximum amount of time needed for the worst-case condition, prior to display of the track clearance green interval. This includes any railroad control equipment response time to react to a preemption call, and any traffic signal green, pedestrian walk and clearance, yellow change, and red clearance intervals for conflicting traffic.
SCRRA Standards	The SCRRA Engineering Standards and/or the SCRRA Standard Specifications for any of several elements of track, roadbed, structure, signal, or related facilities.
Separation Time	The component of maximum preemption time minus the right-of-way transfer time and the minimum track clearance distance (MTCD) queue clearance time. It is the additional time during which the MTCD time ends and prior to the arrival of the train.
Short/Cut Circuit Interconnection Fault Protection	A method by which the integrity of the interconnection between the railroad circuits and the traffic control circuits is monitored. This method utilizes two relays in the traffic signal cabinet. The preempt relay is energized when the active railroad control devices are off. The supervisory relay is energized only when the active railroad control devices are operating. If both are energized or de-energized at the same time (a malfunction), the traffic controller will recognize a malfunction and enter the all flash mode of operation. When the malfunction is recognized, if there is a health status furnished to the railroad, the health status relay will de-energize and both systems will operate in a restrictive mode until the problem is corrected.
Simultaneous Preemption	Notification of an approaching train that is forwarded to the highway traffic signal controller unit and railroad active warning devices at the same time.
Station Crossing	A crossing that is located within the limits of a station and associated with a station platform.
Stop Line	A solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made.

Third Party	An individual, firm, partnership, or corporation, or combination thereof, private or public, requesting and sponsoring a project. “Third party” also includes the federal government and any agencies, departments or subdivisions thereof; the State of California; and any county, city, public authority, joint powers agency, municipal corporation, or any other political subdivision or public corporation therein requesting and sponsoring a project. Utilities are considered a third party. For the purpose of this Manual, the SCRRA is not considered a third party.
Timed Exit Gate Operating Mode	A mode of operation where controlled descent of the exit gate of a four-quad gate is based on a predetermined time interval.
Track Clearance Green Time	The time assigned to clear the design vehicles stopped at the highway-rail crossing stop line from the track area on approach to the signalized highway intersection. This does not include the yellow and all red intervals for the queue clearance.
Traffic Signal	A power-operated traffic control device by which traffic is regulated, warned, or alternately directed to take specific actions.
Underpass	A grade separated highway under a railroad.
Vehicle Intrusion Detection Device	A detector or detectors used as a part of a railroad warning system incorporating processing logic to detect the presence of vehicles within the minimum track clearance distance, and to control the operation of the exit gates.
Wayside Equipment	The signals, switches, and/or control devices for railroad operations housed within one or more enclosures located along the railroad right-of-way and/or on railroad property.

Standard Abbreviations

AASHTO	American Association of State Highways and Transportation Officials
ADA	Americans with Disabilities Act
AREMA	American Railway Engineering and Maintenance of Way Association
ASM	Alternative Safety Measure
Caltrans	California Department of Transportation
CA MUTCD	Manual of Uniform Traffic Control Devices, California Supplement
CPUC	California Public Utilities Commission
CTCDC	California Traffic Control Device Committee
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GO	General Orders of the CPUC
IEEE	Institute of Electrical and Electronics Engineers, Inc.
METRO	Los Angeles County Metropolitan Transportation Authority
NEMA	National Electrical Manufacturers Association
OCTA	Orange County Transportation Authority
OSHA	Occupational Safety and Health Administration
RCTC	Riverside County Transportation Commission
SBCTA	San Bernardino County Transportation Authority
SCRRA	Southern California Regional Rail Authority
SSM	Supplemental Safety Measure
SSPWC	Standard Specifications for Public Works Construction
USDOT	United States Department of Transportation
VCTC	Ventura County Transportation Commission

Abbreviations for Preemption

APT	Advance Preemption Time
BT	Buffer Time
CT	Clearance Time
CSD	Clear Storage Distance
ERT	Equipment Response Time
MHTSPT	Maximum Highway Traffic Signal Preemption Time
MT	Minimum Time
MTCD	Minimum Track Clearance Distance
MWT	Minimum Warning Time
QCT	Queue Clearance Time
RTT	Right-of-Way Transfer Time
ST	Separation Time
TAT	Total Approach Time
TWT	Total Warning Time

APPENDIX B

References

APPENDIX B

References

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APPENDIX C

Diagnostic Form Instructions

APPENDIX C

Diagnostic Form Instructions

1. General

The diagnostic form is used by the diagnostic team as a checklist of existing crossing conditions, noticeable conflicts, necessary changes required, etc. Appendix E provides a copy of the SCRRA diagnostic form. The diagnostic form is structured to allow users to easily gather pertinent information about the crossing. The form also accommodates extra notes and diagrams that help to clarify the current conditions at the crossing.

The information contained on the form can be efficiently completed at different stages. The on-site diagnostic review meeting is a very busy event, with little time available for the completion of the statistics for the form. The initiator of the diagnostic process should follow these steps in completing the form:

Step 1: Research available traffic and railroad data.
Step 2: Perform advance field work to document the characteristics of the crossing.
Step 3: Complete the form prior to the diagnostic meeting (except for the conclusions and observation team input).
Step 4: Conduct the diagnostic field meeting, taking notes on the discussion and observations that arise at the meeting, to be published later as minutes to the meeting.
Step 5: Complete the form after the diagnostic meeting is conducted, and send a copy, along with the meeting minutes, to all individuals present at the diagnostic review meeting.

It is important to complete as much of the form as possible prior to the diagnostic meeting in order to maximize the utility of the meeting.

In addition to filling out the diagnostic form, the facilitator of the diagnostic meeting should provide adequate drawings showing the condition of the crossing and the planned improvements. Aerial photographs should include adjacent signals and property uses in order to adequately identify the issues affecting the crossing. In addition, the facilitator should provide a legend of symbols and identifiers of the quadrants associated with the crossing. It would also be helpful to mark the drawing to indicate the railroad direction related to SCRRA operations. The facilitator shall also provide the track chart related to the crossing. In cases where the crossing is located at the edge of the track chart, the adjacent page should be provided as well.

Previous crossing inventories and accident reports for all existing public crossings are available on the FRA website at www.fra.dot.gov.

2. Participants

Parties required to attend a diagnostic include SCRRA, engineering consultant(s), CPUC, involved city and/or county agencies, other operating railroads, and other stakeholders approved by the team. Collectively, the above-mentioned parties are a multidisciplinary entity referred to as the diagnostic “team”.

Roles

The initiating, or lead, agency shall have at least one representative at each diagnostic. With the assistance of the consultant/subconsultant, the initiating agency shall provide diagnostic review materials, facilitate the diagnostic, and provide copies of completed diagnostic forms and meeting minutes to participants following the diagnostic.

- SCRRA, as the maintainer of tracks and crossing devices, shall have a representative from the Rail Corridor C& E Division and the Signal and Communication Division at each crossing diagnostic meeting. In addition, other disciplines should be available in order to ensure that engineering issues, right-of-way problems, operations, and warning device maintenance are referenced during the diagnostics.
- The initiating agency is responsible for facilitating the diagnostic process. This includes taking notes, photographing key items, and identifying issues of special concern, as verbalized in the diagnostic. The consultant and subconsultants will provide support for any specific engineering questions, as appropriate. The consultant and subconsultants shall provide exhibits and working drawings of the crossing and surrounding area. In addition, the initiating agency shall provide copies of completed diagnostic forms and meeting minutes to participants following the diagnostic.
- The CPUC shall provide safety oversight.
- Other railroad companies operating on the corridor should have representatives present to provide operational information.
- Representatives from the city or county serving as the maintainer of the roadway in which the crossing is located will provide relevant information related to the effects of local traffic.
- Property owners of land where crossings are located may provide comments on the design of the crossing, if their participation is approved by the team.

All participants meeting within the railroad right-of-way are required to wear protective safety equipment including hard hats, safety boots, orange vests, and safety glasses. All vehicles and participants are required to be a minimum of 25 feet away from active tracks.

3. Crossing Inventory and Existing Features

Existing Warning Devices

The diagnostic team should locate all active and passive warning devices, including existing gates, flashing lights, bells, and signing and striping that control traffic through the crossing. If required warning devices are not present at the crossing, if warning devices obstruct driver visibility, or if warning devices are out of sight due to overgrown vegetation, the diagnostic team should note these problems to resolve the issues in the design phase. The diagnostic team should also note how the warning devices function when the crossing is in use by a train, and whether the warning devices negatively affect traffic flow and safety. Refer to Section 3.0 for additional information on highway-rail crossing devices.

Traffic Signals and Signs

If the railroad tracks parallel a roadway with an intersection adjacent to the crossing, the diagnostic team should note whether the appropriate warning devices are present. It shall be appropriate for the diagnostic team to observe and record the phasing sequence of the adjacent intersection when the train occupies the crossing, as well as when the crossing is open to regular traffic use. The diagnostic team should also note the operation of vehicles through the intersection when a train is approaching the crossing, and determine whether queuing occurs over the crossing. If the distance between the intersection and closest track is less than 50 feet (75 feet for crossings with heavy multi-unit vehicles) pre-signals should be considered.

Utilities

The diagnostic team should locate all visible utility markers in the vicinity of the crossing and note if aboveground utilities, such as power poles, obstruct driver or pedestrian views. Since oil, gas, and fiber optics utility lines run along the right-of-way, damage to these lines can create hazardous situations. Existing utilities may also interfere with the construction of additional signal foundations, houses, or other facilities, and must be considered within the design.

Minimum requirements concerning the horizontal, and vertical, clearances between the railroad tracks and parallel, and undercrossing, pipelines carrying gas, water, electrical wires, and cable are covered in Part 5 of the latest version of the AREMA Document.

Railroad Features

The diagnostic team should note any pedestrian crossings at stations that allow for access between platforms or access to station parking lots. The diagnostic team should also note if pedestrians use the station crossings as shortcuts between landmarks. Illegal trespassing anywhere inside the railroad right-of-way to access the station or to use the station as a throughway-should be noted so that preventive measures can be developed during the design phase.

The diagnostic team should note whether there are any stations in the vicinity of a street crossing. If so, the diagnostic team should record whether regular station operation affects the crossing. For example, the diagnostic team should note if gates remain lowered at a crossing when a train is idle at an adjacent station due to the location of the crossing circuitry. The diagnostic team should also observe and note pedestrian activity, estimating pedestrian volumes at crossings adjacent to stations to verify whether any unsafe activities occur when trains are occupying or approaching the crossing.

Signal Facilities

Existing signal facilities should be noted during the diagnostic meetings. The locations, if known, of these devices should be noted on the drawings, with particular consideration given to conduit runs to proposed or existing signal devices.

The diagnostic team should note whether the signal facility (house) adjacent to the crossing restricts sight distances, is accessible for maintenance and inspection, and is in good condition.

Track Structure

The diagnostic team should note whether the track structure affects regular traffic flow due to the crossing condition or the transition between street grades and track grades. The diagnostic team should also note if the crossing condition affects regular pedestrian movement due to non-uniform crossing surfaces, and whether the crossing surface is compliant with the current Americans with Disabilities Act (ADA).

Operations

The diagnostic team should observe regular train operations through the crossing and note whether crossing conditions, traffic conditions, and construction may affect regular railroad operations.

Adjacent Turnouts and Crossovers

Additional railroad-related activities adjacent to the crossing should be noted during the diagnostic review. The location of railroad facilities such as turnouts and crossovers, industry leads, and yards should be carefully documented. The diagnostic team should note how adjacent turnouts and crossover use may affect the crossing. The diagnostic team should observe and record whether train switching triggers active warning devices at crossings, and if traffic is adversely affected by this occurrence.

Fencing

The diagnostic team should note if illegal trespassing occurs in the railroad right-of-way, and if fencing is needed to prohibit unsafe pedestrian activity near the railroad tracks. If fencing is already in place at the crossing, the diagnostic team should also note if sight distances of train conductors, drivers, and pedestrians are affected. In addition, the effectiveness of the fencing in minimizing the opportunities for pedestrians to proceed in an unsafe manner should be noted.

Roadway Geometry

The diagnostic team should note whether the geometry of the roadway affects traffic movements through the crossing. The crossing should be as level as possible to promote good sight distances, enhance ride ability, allow safe braking distances, and permit smooth acceleration, as well as to accommodate low-clearance vehicles. For hump crossings, the diagnostic team should determine whether trucks are at risk of becoming caught over the crossing (which could result in a truck-train collision).

Visibility

The diagnostic team should note if any visibility conflicts exist at the crossing between signals, signs, utilities, vegetation, fencing, development, or warning devices and driver sight lines. The diagnostic team should also observe if adequate reflection and illumination are available at the crossing during nighttime train service.

4. Crossing Characteristics

Traffic Counts

The diagnostic team should have access to the latest traffic counts to better understand current conditions at the crossing.

Train Counts

The diagnostic team should contact the appropriate agency/company to obtain up-to-date train counts to better understand the current operating conditions at the crossing.

Pedestrian Activity

The diagnostic team should note pedestrian activity at the crossing, including the number of pedestrians using the crossing to travel between landmarks (e.g., bus stops, residential neighborhoods, and commercial developments); whether the crossing conditions affect the ability of pedestrians to cross easily; and whether dangerous, illegal trespassing occurs. Of particular note are paths or trails that show evidence of high pedestrian activity. The diagnostic team should note whether the crossing is constructed so as to force pedestrians out into the flow of traffic in order to traverse the crossing.

Vehicle Activity

The diagnostic team should note driver behavior at the crossing, including queues extending over the crossing, drivers illegally maneuvering their vehicles around crossing gates or median islands, articulated public transit buses or school busses using the crossing, and the possibility of buses queuing into the dynamic envelope of the crossing. The diagnostic team should also inspect the crossing during peak travel times to observe worst-case scenarios. Adjacent driveway access is important to note during the diagnostic. Adjacent freeway traffic queuing should be noted as well.

The diagnostic team should note the behavior and type of trucks using the crossing. Trucks operating near the crossing (even those that are not using it directly) can also have a significant effect on the traffic at the crossing.

Right-of-way

The diagnostic team should note whether existing right-of-way is adequate to accommodate crossing improvements such as pedestrian crossing gates, swing gates, refuge areas, and ADA-compliant walkways. Breaches in right-of-way fencing and potential trespassing points should also be noted.

Emergency Services

The diagnostic team should note whether any fire stations, police stations, or hospitals create queuing problems over the crossing, and if emergency vehicles use the crossing on a main/preferred route.

Schools

During the beginning, and end, of school operation hours, the diagnostic team should observe if students use the crossing to reach final destinations, and if queuing over the tracks, abrupt stops, or double-parked vehicles occur as a result. The diagnostic team should also note whether students trespass into the railroad right-of-way.

The team should also note whether school buses use the crossing, and whether school buses come to a stop and open the door to allow the bus driver to observe whether a train is coming from either direction.

Meeting Notes

The facilitator of the diagnostic review is responsible for ensuring that all meeting notes are produced and forwarded to all participating parties.

Diagnostic Form Instructions

The initiating agency or its representative shall be responsible for completing the diagnostic form. When using the FRA crossing inventory, ensure that the information is accurate with current conditions by contacting the railroad company/authority.

The date of diagnostic review, street/road name, subdivision, USDOT number, and CPUC number should be recorded on the top of each page of the Diagnostic Form.

- Date of Diagnostic Review
  - Enter the date that the diagnostic review was performed.
- Street/Road Name
  - Enter the street or road name of the crossing.
- Subdivision
  - The railroad subdivision
- USDOT No.
  - Enter the unique identification number of the crossing assigned by the FRA, which consists of 7 characters (6 numerical characters followed by 1 letter, e.g. 123456A).
- CPUC No.
  - Enter the identification number assigned by the CPUC, which identifies railroad, subdivision, branch/line, milepost, and type of crossing.

Section 1 Diagnostic

This section should be completed prior to the diagnostic review.

Diagnostic Review

- Funded By
  - Check the appropriate box indicating the funding agency.
- Initiated By
  - Check the appropriate box indicating the initiating agency.
- Purpose of Diagnostic
  - State why a diagnostic review is being performed.
- Mtg Beg Time
  - Enter the start time of the diagnostic review.
- Mtg End Time
  - Enter the end time of the diagnostic review.
- Date Initiated
  - Enter the date that the diagnostic review was initiated.
- Level of Diagnostic
  - Check the appropriate box indicating the level of the diagnostic review.
    - Concept
    - Design
    - Design Revision
    - Final

Section 2 Railroad Data

This section outlines the railroad information necessary for the completion of the diagnostic process and should be completed with assistance from the railroad prior to the diagnostic review.

Location Data

- Railroad (R.R)
  - Enter the operating railroad that is responsible for maintaining the crossing.
- State
  - Enter the state in which the crossing is located.
- County
  - Enter the county in which the crossing is located.
- City (In or Near)
  - Enter the city in which the crossing is located or near.
- R.R. Line/Branch
  - Enter the particular line or branch that may run on the same route as other lines of a subdivision but eventually terminate at different locations.
- Nearest R.R. Timetable Station
  - XX
- R.R. Milepost
  - Refer to the railroad track charts for this information.

Railroad Data

- Daily Train Movement
  - Enter the number of passenger and freight trains that pass through the crossing during a 24 hour period beginning at 12:00 A.M. in the appropriate fields.
- Check if Less Than One Movement per Day
  - Check the box if trains pass through the crossing on a non-daily basis.
- Maximum Speed of Train
  - Enter the maximum speed allowable for passenger and freight trains in the appropriate fields.
- Crossing Angle
  - Enter the crossing angle between the track and roadway. The crossing angle is the angle between the curb line and the rail crossing the street, taken from the side of the tracks where vehicles approach the tracks. In a four quadrant application it would be the entrance gate side of the street.
- Type and Number of Tracks
  - Enter how many tracks are located at the crossing. Specify any non-mainline types of tracks.
- Can Two Trains Occupy the Crossing at the Same Time?
  - Check Yes or No if two trains are able to pass each other in opposing directions through the crossing.

- Can One Train Block the Motorist's View of Another Train at the Crossing?
  - Check Yes or No if one train can block the view of motorist from seeing other oncoming trains.
- Crossing Surface: Track
  - Enter the track
- Crossing Surface: Type
  - Enter the drivable crossing surface type (i.e. concrete panels, asphalt concrete, rubber panels, or wood) for each railroad track.
- Crossing Surface: Width
  - Enter the width of each crossing from edge of panel to edge of panel.
- Crossing Surface: Condition
  - Enter the condition at each railroad track.
- Location Relative to Station
  - Enter the location of the crossing relative to the nearest passenger station.
- Location Relative to Rail Operation Facilities
  - Enter the location of the crossing relative to rail operation facilities, i.e. industry switching or yard switching.

Five-Year Accident Data

The evaluator may contact the railroad company/authority to complete this section of the form or log on to http://safetydata.fra.dot.gov/officeofsafety and click the "Accident" field under "Report Type" to obtain FRA accident/incident reports. When using the FRA accident/incident report, ensure that the information is accurate with current conditions by contacting the railroad company/authority.

- Total Accidents
  - Enter the number of accidents that occurred at the crossing within the last five years.
- Number of Personal Injuries
  - Enter the number of personal injuries that were a result of accidents at the crossing within the last five years.
- Number of Fatalities
  - Enter the number of fatalities that were a result of accidents at the crossing within the last five years.
- Property Damage Only
  - Enter the number of accidents that occurred at the crossing, within the last five years, that caused only property damage.
- Personal Injury Accidents
  - Enter the number of accidents that resulted in personal injury.
- Fatal Accidents
  - Enter the number of accidents that resulted in fatalities.
- Have any near misses occurred?
  - Check Yes or No if train-vehicle or train-pedestrian accidents almost occurred at the crossing. Explain what occurred. This information is available from SCRRA.

Adjacent Railroad Facilities

- Adjacent Railroad Crossings within 1 Mile: USDOT No.
    - Enter the USDOT identification number of each of the adjacent crossings assigned by the FRA.
- Adjacent Railroad Crossings within 1 Mile: Street/Road Name
    - Enter the Street or road name of each of the adjacent crossings.
- Adjacent Railroad Crossings within 1 Mile: Warning Devices
    - Enter the types of existing warning devices at each of the adjacent crossings.
- Adjacent Railroad Crossings within 1 Mile: ADT
    - Enter the average daily traffic through the each of the adjacent crossings in a 24 hour period.
- Is there adequate access from this crossing to railroad facilities?
    - Check Yes or No if adequate access points exist for vehicles and/or workers to inspect, maintain adjacent crossings, signal houses and train yards.
- Description of how crossing is affected by adjacent railroad facilities
    - Describe the railroad activities over the crossing.

Section 3 Grade Crossing Inventory

This section should be completed prior to the diagnostic meeting.

Existing Warning Devices

Passive warning devices include different types of warning and regulatory signs, as well as pavement striping in conformance with the CA MUTCD. To correctly account for all types of signs, refer to the attachment labeled “Typical CA MUTCD Signs Used at Highway-Rail Grade Crossings” to match sign type with CA MUTCD coding.

Active warning devices include devices that are, in most cases, activated by a train approaching the crossing. This includes mast mounted flashing lights with or with out entrance/exit gates, cantilever flashing lights, back lights, side lights, pedestrian swing gates, bells, and blank out signs. Configurations of flashing light/gate/cantilever systems must be in conformance with the latest version of the CPUC G.O. 75. To correctly account for all types of blank out signs, refer to the attachment labeled “Typical CA MUTCD Signs Used at Highway-Rail Grade Crossings” to match blank out sign type.

- Type of Passive Warning Device: Qty
    - Enter the total quantity of each type of sign that control traffic through the crossing.
- Type of Passive Warning Device: NB, SB, WB, EB
    - Enter the total amount of each type of sign that control traffic through the crossing in each direction. If the roadway that crosses the tracks is closer to a north/south direction, than NB and SB should be used. If the roadway that crosses the tracks is closer to a west/east direction, than WB and EB should be used. If the crossing is very close to 45 degrees, than a choice should be made to use either NB/SB or WB/EB and should

be consistent with all other crossings along a project. This should be identified on the comprehensive sketch.

- Is the crossing illuminated?
  - Check Yes or No if the street lighting adjacent to the crossing provides sufficient light to the crossing.
- Pavement Striping: Stop Bars
  - Check Yes or No if two parallel stop bars are located ahead of the crossing gates to inform drivers to stop behind the gates. If Yes, enter the number of pairs of stop bars.
- Pavement Striping: RxR
  - Check Yes or No if RxR pavement markings exists upstream of the crossing to inform drivers of a crossing downstream. If Yes, enter the number of RxR a pavement markings.
- Pavement Striping: Dynamic
  - Check Yes or No if dynamic envelope pavement markings exists parallel to the tracks throughout the crossing. If Yes, enter the number of sides with dynamic envelope pavement markings.
- Pavement Striping: No Passing
  - Check Yes or No if no passing pavement markings exists at the crossing. If Yes, enter the number of approaches with no passing pavement markings.
- Pavement Striping: Lane Lines
  - Check Yes or No if lane line pavement markings exist on the approaches to the crossing. If Yes, enter the number of lane line pavement markings on all approaches.
- Pavement Striping: Other
  - Check Yes or No if other types of striping control traffic through the crossing. If Yes, specify the type and enter the number of the other type of striping.
- Type of Active Warning Devices: 8”, 12”; Incandescent or LED (Light Emitting Diode)
  - The different type of flashing lights that control traffic through the crossing.
    - 8” flashing lights
      - Incandescent
      - LED
    - 12” flashing lights
      - Incandescent
      - LED
- Type of Active Warning Devices: Mast Mounted Flashing Lights
  - Check Yes or No if dual flashing lights are mounted on the mast control traffic through the crossing. If Yes, enter the 8”, 12”, LED, and total number of individual lights mounted on the mast.
- Type of Active Warning Devices: Cantilever Flashing Lights
  - Check Yes or No if coupled lights are mounted on the cantilever, which is extended over the traffic lanes from the top of the mast control traffic through the crossing. If Yes, enter the 8”, 12”, LED, and total number of individual lights mounted on the cantilever.
- Type of Active Warning Devices: Back Lights

  - Check Yes or No if coupled lights are mounted on the mast or cantilever in the opposite direction of traffic control traffic through the crossing. If Yes, enter the 8", 12", LED, and total number of individual lights mounted on the mast or cantilever in the opposite direction of traffic.
- Type of Active Warning Devices: Side Lights
  - Check Yes or No if coupled lights mounted on the mast or cantilever not in conformance with CPUC G.O. 75 control traffic through the crossing. If Yes, enter the 8", 12", LED, and total number of individual lights mounted on the mast or cantilever.
- Type of Active Warning Devices: Entrance
  - Check Yes or No if entrance gates exist upstream of the crossing prohibit cars from entering the crossing while a train is passing. If Yes, enter the number of entrance gates, as well as corresponding gate lengths and locations at the crossing.
- Type of Active Warning Devices: Exit
  - Check Yes or No if exit gates exist downstream of the crossing prohibit drivers from maneuvering around the gates in the down position. If Yes, enter the number of exit gates, as well as corresponding gate lengths and locations at the crossing.
- Type of Active Warning Devices: Pedestrian
  - Check Yes or No if pedestrian gates exist upstream and downstream of the crossing prohibit pedestrians from entering the crossing while a train is passing. If Yes, enter the number of pedestrian gates at the crossing.
- Type of Active Warning Devices: Pedestrian Swing
  - Check Yes or No if pedestrian swing gates upstream and downstream of the crossing allow pedestrians trapped in crossing while the gates are activated to exit the crossing area. If Yes, enter the number of pedestrian swing gates at the crossing.
- Type of Active Warning Devices: Bells
  - Check Yes or No if advanced warning bells exist at the crossing. If Yes, enter the number of bells at the crossing.
- Type of Active Warning Devices: R3-1 Blank Out Sign/R3-2 Blank Out Sign/R3-5 Blank Out Sign
  - Check Yes or No if either type of blank out sign exist at the crossing. If Yes, enter the number of each type of blank out sign.
- Type of Active Warning Devices: Modified Blank Out Sign w/ Train Indicator
  - Note any other devices.
- Type of Active Warning Devices: Other
  - Check Yes or No if any other types of active warning devices exist at the crossing. If Yes, specify the type and enter the number of other active warning devices at the crossing.
- Type of Active Warning Devices: Are there any broken gates at the crossing?
  - Check Yes or No if gates no longer serve their original purpose due to malfunction or damage. If Yes, enter the number of broken gates at the crossing.

Traffic Signal Interconnection and Preemption

Explanation of fields:

- Are highway traffic signals interconnected?
  - Check Yes or No if traffic signal phasing changes to accommodate train traffic.
- Do pre-signals exist at the crossing?
  - Check Yes or No if signals placed either upstream or downstream of the crossing stop traffic behind the stop bars when a train is passing.
- Is preemption existent at the crossing?
  - Check Yes or No if crossings adjacent to parallel roadways utilizes preemption and the traffic signals clear out the storage area between the intersection and crossing and also prohibit turns towards the storage areas between the intersection and crossing.
- Exiting Warning Time
  - Enter the actual amount of time a driver or pedestrian is given before a train arrives at the crossing.
- Desired Warning Time
  - Enter the preferred amount of time a driver or pedestrian is given before a train arrives at the crossing.

Closure

- Can roadway realignment be accomplished to allow consolidation of crossings?
  - Check Yes or No if the possibility to close the crossing is feasible, which would shift traffic to the surrounding crossings. If Yes, provide sketch of traffic movements due to crossing closure.
- Impact of closure
  - Explain the effects from the closure of the crossing due to increased traffic at upstream and downstream crossings and decreased access to businesses and residences.

Section 4 Highway Information

This section should be completed in advance of the diagnostic meeting.

Other agencies and/or companies may have to be contacted to obtain the amount of school buses and hazardous material vehicles travel over the crossing each day. School bus information is usually obtained from the school district in the area.

Roadway Data

- Agency Having Jurisdiction
  - Enter the government entity, whether it is city, county, or state that is responsible for maintaining the roadway that runs through the crossing.
- Highway Type
  - Enter the type of road that runs through the crossing such as arterials, collector roads, local roads, and cul-de-sacs.

- ADT
    - Enter the average daily traffic (ADT) that travels through the crossing in a 24 hour period.
- Percent Trucks
    - Enter the ratio of trucks to cars that use the crossing each day.
- Speed of Vehicle
    - Enter the maximum and typical range of speeds through the crossing from the most previous traffic study.
- School Bus Operation
    - Check Yes or No if school buses travel through the crossing. If Yes, enter the number of school buses that travel through the crossing on a daily basis.
- Hazardous Materials
    - Check Yes or No if hazardous material vehicles travel through the crossing. If Yes, enter the number of hazardous material vehicles that travel through the crossing on a daily basis.
- Pedestrians
    - Check Yes or No if pedestrians utilize the crossing.
- Curb & Gutter
    - Check Yes or No if curb and gutter exist at the crossing.
- Roadway Surface
    - Enter the type of roadway material used adjacent to the crossing surface.
- Roadway Width
    - Enter the distance from edge of curb to edge of curb of the crossing.
- Roadway Condition
    - Enter the state that the roadway is in during diagnostic review (i.e. poor, good, or excellent).
- Shoulder
    - Check Yes or No if a shoulder exists through the crossing.
- Shoulder: Width
    - Enter the width of the shoulder from the edge of the traveled way to the edge of curb.
- Is the Shoulder Surfaced?
    - Check Yes or No if the shoulders are improved.
- Shoulder Surfaced: Width
    - Enter the width of the improved shoulders.
- Is Sidewalk Present?
    - Check Yes or No if a concrete sidewalk exists to allow pedestrians, including the handicapped, the elderly, and children, to pass through the crossing easily.
- Sidewalk: Width
    - Enter the width of the sidewalk through the crossing.
- Special Conditions Required as a Result of Nearby Highway Intersections
    - Note any special conditions that exist.

<u>Type of Development</u>

- Open Space
    - Check box if surrounding area of the crossing is primarily undeveloped.

- Industrial
  - Check box if surrounding area of the crossing is primarily industrial businesses.
- Residential
  - Check box if surrounding area of the crossing is primarily homes and apartments.
- Institutional
  - Check box if surrounding area of the crossing is primarily campus types of development (i.e. schools, prisons, and hospitals).
- TOD
  - Check box if surrounding area of the crossing is a Transit Oriented Development (TOD) including residences, businesses, and retail.
- Commercial
  - Check box if surrounding area of the crossing is primarily retail businesses.
- New Developments that could affect ADT
  - Check Yes or No if new developments in the surrounding area may increase the amount of vehicles traveling through the crossing. If Yes, explain how the crossing is affected by this increase in traffic.

<u>Pedestrian and Bike Data</u>

- Crossing Information: Is the Crossing Surface Smooth?
  - Check Yes or No if the crossing surface type (i.e. concrete panel, asphalt concrete, rubber, wood) has a smooth even finish and transitions smoothly with the existing sidewalk.
- Crossing Information: Is Adequate Lighting Available?
  - Check Yes or No if adequate lighting is available to allow a pedestrian or biker to cross safely and easily.
- Crossing Information: Does Crossing Panel Extend 1' Behind Back of Path?
  - Check Yes or No if the crossing panels extend one foot from the back of the sidewalk towards the railroad right-of-way.
- Crossing Information: Is Path Width Adequate? 36" Minimum
  - Check Yes or No if minimum sidewalk width allows pedestrians, especially wheelchair users, to move through the crossing easily.
- Crossing Information: Are Flange Gaps 2½" or less, or Flange Fillers Used
  - Check Yes or No if the gap between the track and crossing surface allows for train movement. Flange fillers decrease the size of the flange gap while still allowing the train to move through the crossing.
- Type of Crossing: Shared
  - Check the applicable box if bikers and pedestrians are allowed to use the crossing.
- Type of Crossing: Bike
  - Check the applicable box if only bikers are allowed to use the crossing.
- Type of Crossing: Pedestrian
  - Check the applicable box if only pedestrians are allowed to use the crossing.
- Other Crossing Users: Disabled/Wheelchair
  - Check the appropriate boxes if disabled people or people in wheelchairs travel through the crossing.

- Other Crossing Users: Senior Citizens
    - Check the appropriate boxes if senior citizens travel through the crossing.
- Other Crossing Users: Children
    - Check the appropriate boxes if children travel through the crossing.
- Pedestrian and Bike Information: Pedestrian ADT
    - Enter the most recent pedestrian average daily traffic value.
- Pedestrian and Bike Information: Bicycle ADT
    - Enter the most recent bicycle average daily traffic value.

Section 5 Passenger Station

- Is the Crossing Adjacent to a Station?
    - Check Yes if a station is directly upstream or downstream of the crossing.
- Sketch Access from Station
    - Prepare a graphic presenting how pedestrians, bikers, and vehicles access the station and how these movements affect the crossing.

Section 6 Summary

This section should be completed by the user, with input and direction from the diagnostic team.

Comprehensive Sketch

- Comprehensive Sketch
    - Prepare a graphic presentation which includes all elements of the crossing including, but not limited to, track/s, dimensions, location of warning devices, adjacent roads, adjacent developments and access points, adjacent passenger stations, the crossing angle, and locations and numbering of photos taken. Show compass north and railroad destination for each direction of train movement.

Section 7 Conclusion

This section should be completed by the user, with input and direction from the diagnostic team. If a topic is not labeled in the type of improvement section, it should be added to the comments section.

Recommendations

- Are Improvements to the Crossing Recommended?
    - Check Yes if improvements are recommended
        - Continue to complete “Type of Improvement Section”
    - Check No if improvements are not recommended
        - If No, explain why there are no recommendations
- Type of Improvement: Sight Improvement
    - If the sight distance needs to be improved, explain here.
- Type of Improvement: Crossing Surface
    - If the crossing surface needs to be improved, explain here.

- Type of Improvement: Roadway Approaches
  - If the crossing surface needs to be improved, explain here.
- Type of Improvement: Highway Traffic Signs
  - If the highway traffic signs need to be improved or updated, explain here.
- Type of Improvement: Crossing Signals
  - If the crossing signals need to be improved or updated, explain here.
- Type of Improvement: Crossing Closure
  - If the crossing needs to be closed, explain here.
- Comments
  - Record all other comments here.

Section 8 Contact Information

This section should be completed by the user, with input and direction from the diagnostic team.

- Diagnostic Team Name
  - Enter the first and last name of the each diagnostic team participant.
- Affiliation
  - Enter each participant's affiliation (i.e. organization, agency, company they represent) in the corresponding field.
- Phone No.
  - Enter each participant's phone number in the corresponding field.
- E-Mail
  - Enter the participant's e-mail in the corresponding field.

<u>Contacts</u>

- School District
  - Enter the contact information of the school district liaison in the field, including contact name, district name, department name and/or number, work address, work phone number, and work e-mail address.

- Other (Specify)
  - Enter the contact information of any other type of liaison by specifying their role in the diagnostic review. Include the contacts name, agency or company name, department name and/or number, work address, work, phone number, and work e-mail address.

APPENDIX C-1

Diagnostic Forms

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

			Date of Diagnostic Review:
Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 1: DIAGNOSTIC

DIAGNOSTIC REVIEW				
Funded By:	☐ RAILROAD ☐ STATE ☐ LOCAL ☐ OTHER ________	Purpose of Diagnostic:		
Initiated By:	☐ RAILROAD ☐ STATE ☐ LOCAL ☐ OTHER ________	Beg Time:	End Time:	Date Initiated:
Level of Diagnostic:	☐ PRE-DESIGN ☐ DESIGN ☐ DESIGN REVISION # ____ ☐ FINAL			

SECTION 2: RAILROAD DATA

LOCATION DATA			
Railroad (R.R.):	State:	County:	City: *(In or Near)*
R.R. Line/Branch:	Nearest R.R. Timetable Station:	R.R. Milepost:	

RAILROAD DATA						
DAILY TRAIN MOVEMENT*		MAXIMUM SPEED OF TRAIN*		TYPE AND NUMBER OF TRACKS*		
PASSENGER		PASSENGER	mph	MAIN		If Other, Specify:
FREIGHT		FREIGHT	mph	OTHER		
CHECK IF LESS THAN ONE MOVEMENT PER DAY*	☐	CROSSING ANGLE:		Can two trains occupy crossing at the same time? ☐ Yes ☐ No		
				Can one train block the motorist's view of another train at the crossing?	☐ YES ☐ NO	If Yes, explain:

Note: Attach track chart to back of this diagnostic form

Crossing Surface	TRACK	TYPE	WIDTH	CONDITION

Location Relative to Station:	Location Relative to Rail Operation Facilities:

FIVE-YEAR ACCIDENT DATA*					
TOTAL ACCIDENTS		**Number of Personal Injuries**		**Number of Fatalities**	
Property Damage Only		Personal Injury Accidents		Fatal Accidents	
Have any near misses occurred? ☐ Yes ☐ No Explain:					

ADJACENT RAILROAD FACILITIES			
Adjacent Railroad Crossings within 1 Mile			
DOT No.	**Street/Road Name**	**Warning Devices**	**ADT***

Is there adequate access from this crossing to railroad facilities?	☐ Yes ☐ No	Is yes, which crossing?
Description of how crossing is affected by adjacent railroad facilities?		

***Contact the appropriate agency and/or railroad company to complete this section of the Diagnostic form.**

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

Date of Diagnostic Review:

Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 3: GRADE CROSSING INVENTORY

EXISTING WARNING DEVICES

Type of Passive Warning Device[#]

Type	Qty	NB	SB	WB	EB	Type	Qty	NB	SB	WB	EB
☐ R15-1						☐ R1-2					
☐ R15-2						☐ W3-2					
☐ W10-1						☐ R8-10					
☐ W48 (CA)						☐ R10-6					
☐ W10-2						☐ W10-5					
☐ W10-3						☐ W10-11					
☐ W10-4						☐ W10-12					
☐ R8-8						☐ R15-8					
☐ R1-1						☐ W10-9					
☐ W3-1						Note: Choose direction that is closest to direction of traffic flow over crossing.					

Is the crossing illuminated? ☐ Yes ☐ No

Pavement Striping

Yes	No	Qty.	Type	Location/s
			Stop Bars	
			RxR	
			Dynamic	
			No Passing	
			Lane Lines	
			Other	

Yes	No	Qty.	LENSES 8”	LENSES 12”	LED	Type of Active Warning Device	
						Mast Mounted Flashing Lights	
						Cantilever Flashing Lights	Length:
						Back Lights	
						Side Lights	

Yes	No	Qty.	Gate Type	Gate Length	Location/s
			Entrance		
			Exit		
			Pedestrian		
			Pedestrian Swing		

Yes	No	Qty.	Type	Location/s
			Bells	
			R3-1 Blank Out Sign[#]	
			R3-2 Blank Out Sign[#]	
			R3-5 Blank Out Sign[#]	
			Modified Blank Out Sign w/ Train Indicator	
			Other	Specify:
			Are there any broken gates at the crossing?	

TRAFFIC SIGNAL INTERCONNECTION AND PREEMPTION

Are highway traffic signals interconnected?	☐ Yes ☐ No	Is preemption existent at the crossing?	☐ Yes ☐ No
Do pre-signals exist at the crossing?	☐ Yes ☐ No	Existing Warning Time	Desired Warning Time

CLOSURE

Can roadway realignment be accomplished to allow consolidation of crossings? If yes, provide sketch.	☐ Yes ☐ No	Sketch:
Impact of Closure:		

[#]**See “Typical CA MUTCD Signs at Highway-Rail Grade Crossings” attached to this form for sign code explanation. Refer to Part 8 of the CA MUTCD for requirements at highway-rail grade crossings.**

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

			Date of Diagnostic Review:
Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 4: HIGHWAY INFORMATION

ROADWAY DATA

Agency Having Jurisdiction (i.e. Caltrans):	Highway Type:	ADT*:	PERCENT TRUCKS*	%

Speed of Vehicle*	School Bus Operation*	Hazardous Materials*	Pedestrians	Roadway Surface:
				Roadway Width:
Max. m.p.h.	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	
Typical to m.p.h.	No./Day	No./Day	Curb & Gutter	Roadway Condition:
			☐ YES ☐ NO	

Shoulder: ☐ YES ☐ NO	If Yes, Width:	Is the Shoulder Surfaced? ☐ YES ☐ NO	If Yes, Width:	Is Sidewalk Present? ☐ YES ☐ NO	If Yes, Width:

Special Conditions Required as a Result of Nearby Highway Intersections:

TYPE OF DEVELOPMENT

☐ Open Space ☐ Residential	☐ TOD$	New developments that could affect ADT?	☐ Yes ☐ No
☐ Industrial ☐ Institutional	☐ Commercial	If yes, explain:	

PEDESTRIAN AND BIKE DATA

Yes	No	Crossing Information	Type of Crossing		Other Crossing Users
		Is Crossing Surface Smooth?	☐ Shared ☐ Bike		☐ Disabled/Wheelchair ☐ Senior Citizens
		Is Adequate Lighting Available?	☐ Pedestrian		☐ Children
		Does Crossing Panel Extend 1' Behind Back of Path?	Qty.	Pedestrian and Bike Information	
		Is Path Width Adequate? (36" Minimum)		Pedestrian ADT*	
		Are Flange Gaps 2½" or Less, or Flange Fillers Used?		Bicycle ADT*	

SECTION 5: PASSENGER STATION

☐ YES ☐ NO	Is the crossing adjacent to a station?

If yes, Sketch access from station

*Contact the appropriate agency and/or railroad company to complete this section of the Diagnostic form.

$TOD – Transit Oriented Development

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

			Date of Diagnostic Review:
Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 6: SUMMARY

COMPREHENSIVE SKETCH
(Include location of warning devices, nearby schools, emergency services facilities, and other landmarks)

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

			Date of Diagnostic Review:
Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 7: CONCLUSION

RECOMMENDATIONS			
ARE IMPROVEMENTS TO THE CROSSING RECOMMENDED?		☐ **YES** ☐ **NO**	If No, Explain:
If Yes, what improvements?			
Yes	**No**	**Type of Improvement**	**Describe**
		Sight Improvement	
		Crossing Surface	
		Roadway Approaches	
		Highway Traffic Signs	
		Crossing Signals	
		Crossing Closure	

Prepared By:	Title:	Date:

Comments:

DIAGNOSTIC TEAM

Highway-Rail Grade Crossing Evaluation Report

			Date of Diagnostic Review:
Street/Road Name:	Subdivision:	AAR/DOT No.:	CPUC No.:

SECTION 8: CONTACT INFORMATION

DIAGNOSTIC TEAM				
No.	Name	Affiliation	Phone No.	E-Mail
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

CONTACTS
(Contact name, agency or company, department, address, phone number, e-mail address)
School District:
Other (Specify):
Other (Specify):
Other (Specify):
Other (Specify):
Other (Specify):
Other (Specify):

Typical CA MUTCD Signs Used at Highway-Rail Grade Crossings

Regulatory Signs

R15-1
(drilled for 90-degree mounting)

R15-2

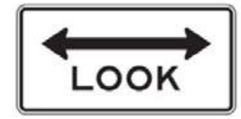
R1-1

R1-2

R8-8

R8-10

R10-6



R15-8

Warning Signs

W10-1

W48 (CA)


W10-2


W10-3


W10-4


W3-1*


W3-2*


W10-5

W10-9


W10-11


W10-12

*W3-1 and W3-2 are used in concurrence with R1-1 and R1-2, respectively.

Blank Out Regulatory Signs


R3-1
Activated Blank Out


R3-2
Activated Blank Out

R5-1
Activated Blank Out

APPENDIX D

SCRRA Highway-Rail Grade Crossing Traffic Signal Preemption Request Form

SCRRA Highway-Rail Grade Crossing Traffic Signal Preemption Request Form

The purpose of this form is to document the preemption operation and timing parameters being requested by the Highway Agency responsible for the traffic signal and convey the information to SCRRA. SCRRA recognizes that the Highway Agency is the final authority regarding the design and operation of the preemption system that is to be designed in accordance with the CA MUTCD Chapter 8C, Section 8C.09.

Please provide the following information:

Date of Request: ____________________ Highway Agency: ____________________

Requested by (Name/Title): ____________________

Phone: ____________________ Email: ____________________

Grade Crossing Information:

Crossing Street Name: ____________________

City: ____________________ County: ____________________

RR Subdivision: ____________________ Mile Post: ____________________

DOT #: ____________________

RR Interconnection Information:

1) Requested Interconnection Configuration: Single Break Circuit Double Break Circuit

2) Is this request for Simultaneous Preemption Operation? Yes / No — If "Yes" what is the requested Additional Warning Time? ________Sec

3) Is this request for Advanced Preemption Operation and Circuitry? Yes / No — If "Yes" what is the requested Additional Preemption Time (APT)? ________Sec

4) Is this request for Advanced Pedestrian Preemption (APP) Operation and Circuitry?* Yes / No — If "Yes" what is the requested Additional Pedestrian Preemption Time (APPT)? ________Sec

**Note: Request for APP Operation will* require *approval from SCRRA through a Special Design Consideration. Pedestrian Detection is required when using APP Operation.*

5) Indicate below which additional circuits are being requested:

a. Supervised Circuit Yes No
b. Gate Down Circuit Yes No
c. Crossing Active Circuit (XR) Yes No
d. Traffic Signal Health Circuit Yes No

6) Indicate the interconnection wire size and number of conductors:_______AWG and _______ conductors

Additional Info:

If you have additional or enhanced preemption operation/interconnect requirements, please submit a detailed description with this request form. A circuit drawing or additional information should be provided to assist SCRRA in accommodating your needs.

SCRRA will provide the railroad circuit design to Highway Agency for review prior to finalizing the railroad circuit design. Highway Agency agrees to provide traffic signal timing and wiring diagram for traffic controller unit to SCRRA.

Please sign and submit electronically along with support documentation to SCRRA.

____________________ ____________
Signature of Agency representative Date

____
Print or Type Name of Agency representative

APPENDIX D-1

LADOT Railroad Preemption Worksheet

The following LADOT Railroad Preemption Form is an example of the form that shall be used to submit requests for railroad preemption timing. This form must be filled out electronically, therefore the designer shall request an electronic copy of the form from SCRRA to be used for the project.

LADOT Railroad Preemption Form Instructions

The LADOT Railroad Preemption Form is entirely contained on one worksheet within an Excel workbook. If Additional approaches to the crossing are analyzed, the worksheet can be copied within the workbook to provide the appropriate analysis of the crossing.

Section 1 consists of the entries specific to the highway and traffic signal system.

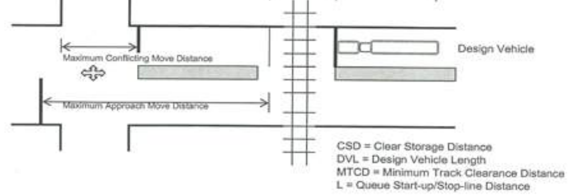
Part 1 contains entries for Maximum Approach Move Distance, Maximum Conflicting Move Distance, Minimum Track Clearance Distance (MTCD), Clear Storage Distance (CSD) and Grade. The Maximum Approach Move Distance is the distance (in feet) from the farthest intersection limit line towards the crossing. The Maximum Conflicting Move Distance is the longest distance (in feet) across the adjacent intersection that crosses the path of the track clearance phase. These are used to determine the time require for a design vehicle to clear the intersection prior to activation of the railroad warning devices or display of track clearance green. If these moves are on an uphill grade, enter the percent grade in the adjacent box labeled Grade. The MTCD is defined to be the distance (in feet) from the railroad warning device limit line or gate to a point 6 feet past the far rail. The CSD is the distance (in feet) from a point 6 feet past the far rail to the intersection limit line. The sum of the MTCD and CSD values determine the length (L). This is the total distance from the railroad warning device limit line or gate to the intersection limit line. If there is an uphill grade at the crossing, enter the percent grade in the adjacent box labeled Grade.

Part 2 contains information specific to the vehicle characteristics used in the calculation of the MTCD Queue Clearance Time. The default values provided on the form are standard for the types of vehicles shown. These should not be changed unless evaluation of specific vehicle lengths and heights is required. The information regarding the vehicle characteristics is used in the calculation of the vehicle times below the characteristic cells. These values are computed by the spreadsheet and cannot be changed by the user. The row beneath these calculated cells provides an “Include as Design Vehicle?” Yes/No selection for each vehicle type. If the roadway is restricted to certain classes of vehicles, the user may choose to not include a particular type of vehicle by selecting “No”. Typically, all vehicle types should be included in the calculations if they are permitted on the highway.

Part 3 contains the calculations for Green Track Clearance Time and MTCD Queue Clearance Time. These are displayed in the green and pink boxes immediately below the Part 2. These are the minimum amount of time necessary to display a track clearance green to clear the MTCD of a queue of vehicles.

Part 4 contains the entries specific to traffic signal timing.

a. The Minimum Walk time is the minimum amount of walk time that must be completed prior to entry into railroad preemption. This can be set to zero or more seconds based on the desired operation of the traffic signal during entry into preemption.
b. The Maximum Ped Clear is the longest pedestrian clearance time that must be completed prior to entry into preemption. This can be set to zero or more seconds based on the desired operation of the traffic signal during entry into preemption. This is typically the Flashing Don't Walk time setting in the controller.
c. The Minimum Green is the minimum amount of time a green signal must be displayed prior to entry into railroad preemption. This can be set to zero or more seconds based on the desired operation of the traffic signal during entry into preemption.



d. The Maximum Yellow + All Red is the maximum amount of yellow and all red time that must be displayed prior to entry into preemption. This must be set to 3.0 seconds or more based on the traffic signal controller time settings.
e. The Maximum RWTT (Right of Way Transfer Time) is calculated as the maximum amount of time it takes the controller to transfer from its current phase to the railroad track clearance phase based on the timing parameters entered above.
f. Separation Time (ST) is additional time that can be provided between the time the traffic clears the track and the train arrival at the crossing. This is determined by the engineering judgment, and can be set to zero or more second. Values of 4 to 8 seconds are typically used.
g. The Maximum Preemption Time (MPT) is calculated to be the total of MTCD Queue Clearance Time, Maximum RWTT and Separation Time (ST). This is how much time in advance of a train arriving at the crossing that the traffic signal needs to be notified to provide sufficient track clearance green time.

Section 2 consists of the entries specific to the railroad warning system. These can be obtained from the railroad at existing crossings or determined with the railroad for new designs.

a. The Lights Flash time is the amount of time the railroad warning lights flash once activated before the gates begin to descend. This must be set to at least 3 seconds and can be as high a 9 seconds.
b. The Gate Descent time is the amount of time it takes the entrance gates to move from the vertical position to the horizontal position. This must be set to at least 8 seconds and can be as high as 20 seconds.
c. The Minimum Time (MT) is the minimum amount of time the crossing warning system is activated prior to train arrival at the crossing. This must be set to at least 20 seconds.
d. Clearance Time (CT) is additional warning time provided for wide crossings or other site-specific conditions. This can be set to zero or more seconds. Based on the MTCD entered at the top of the form, a minimum suggested value will be displayed to the right of this entry. The suggested value is based on the requirement that crossings more than 35 feet wide need an one second of Clearance Time for each additional 10 feet of width.
e. Minimum Warning Time (MWT) is computed from these entries, which is the minimum amount of time that the warning system is activated prior to train arrival at the crossing.
f. Buffer Time (BT) is discretionary time added by the railroad to account for train handling. This can be set to zero or more seconds.
g. Total Warning Time (TWT) is obtained by adding Buffer Time (BT) to Minimum Warning Time (MWT), which is the normal amount of warning time in advance of a through train arriving at the crossing
h. The entry “Include vehicle-gate interaction check?” is a Yes/No selection that the user can choose to adjust the Advance Preemption Time (APT) so the largest design vehicle will not be hit by the gates. This check is optional, but highly recommended to ensure that the design vehicle has sufficient time to move out of the path of the descending gates.
i. The “Distance from gate to vehicle” is required with a “Yes” selection on item h. This is the distance between the side of the design vehicle and the center of gate mast. This must be set to at least 4 feet and can be as much as 20 feet depending on lane width and gate setback.

The resultant Advance Preemption Time (APT) is shown in the purple box, and represents the time before warning system activation that the traffic signal needs to be notified of an approaching train to provide sufficient queue clearance time. If the vehicle gate interaction check is set to No, then the Advance Preemption Time (APT) is the difference between the Maximum Preemption Time (MPT) and the Minimum Warning Time (MWT). If the vehicle-gate interaction check is set to “Yes”, then the Advance Preemption Time (APT) is calculated so the largest design vehicle has enough time to start up and move before the descending gate hits the vehicle. This will usually result in a larger Advance Preemption Time (APT) than when the vehicle-gate interaction check is not performed. This may adjust the Green Track Clearance time and the Separation Time (ST) to account for the additional Advance Preemption Time (APT). A note is shown in red on the form if an adjustment is made.

The last two railroad parameters are use to determine the length of approach circuits necessary to provide the calculated Advance Preemption Time (APT).

a. The Equipment Response Time (ERT) is the amount of time the railroad train detection equipment needs once a train has entered the track circuit before it can be acted upon. This can be set to zero or more seconds, and is typically between 2 and 5 seconds depending on the type of train detection equipment used.
b. Total Approach Time (TAT) is obtained by adding the Equipment Response Time (ERT) to the Total Warning Time (TWT)
c. Maximum Authorized Speed (MAS), is the highest speed trains are allowed to operate on the approach to the crossing. This must be set to at least 5 miles per hour and can be as high as 100 miles per hour.
d. The Total Approach Distance (TAD) is obtained by multiplying the Total Approach Time (TAT) by the Maximum Authorized Speed (MAS). This is the required length of the approach circuit.

Preemption Timeline

With the data entry completed, the Preemption Timeline will display the time relationships between the railroad Warning Device, Traffic Signal and the Design Vehicle. The timeline is read from right to left, with the leftmost time zero being train arrival at the crossing. The timeline is a graphical representation of the sequence of events leading up to the train arriving at the crossing, and can be used to determine if the preemption timings entered are adequate.

If a Phase Omit interval is shown on the Traffic Signal timeline, then the Maximum Approach Move Distance and/or the Maximum Conflicting Move Distance govern the advance preemption time at the intersection. This means that the traffic signal should not start the approach or conflicting moves during this time to prevent a design vehicle from being stopped at the crossing or blocking the track clearance phase. Appropriate settings in the traffic signal controller should be made to account for this situation at the start of the preemption.

Note that the Green Track Clearance time shown on the Preemption Timeline may be less than the value calculated on the form if it extends beyond the arrival of the train at the crossing. This can occur when a large Clear Storage Distance (CSD) exists, and the value shown on the form should be used for the track clearance green time. Also note that the MTCD Queue Clearance Time calculated on the form is shown in two parts on the preemption timeline: Queue Startup and Queue Clearance. This illustrates the portion of time that is needed before the last design vehicle within length begins to move as well as the time it takes the design vehicle to move through the MTCD. The sum of these two parts is equal to the MTCD Queue Clearance Time shown on the form.

Below the timeline is the “Preemption Timeline displays Minimum RWTT?” Yes/No selection box. Normally this is set to “No” and the preemption timeline displays the worst-case Maximum RWTT time that was used to determine the Advance Preemption Time (APT). Selecting “Yes” will cause the timeline to display the best-case Minimum RWTT time, and can be used to show the variability in preemption timing. Care should be taken when the Maximum RWTT time is large to ensure that track clearance green does not end prior to the warning system activation or vehicles may become trapped on the tracks. If the vehicle-gate interaction check is set to “Yes”, then track clearance green is automatically extended to the point when the gates are horizontal to specifically prevent vehicles from becoming trapped on the tracks. This requires either the programming of a longer track clearance green time, the use of a controller that is capable of dynamically adjusting the track clearance green time to account for RWTT variability, or an interconnection between the railroad system and the traffic signal that does not allow the track clearance green to end until the gates are down.

LADOT Railroad Preemption Form

Revised 1/25/2008

Street Name:	Crossing St	Crossing No:	

Section 1: Highway and Traffic Information

Part 1:

Maximum Approach Move Distance	90	ft	Grade	0.0	%
Maximum Conflicting Move Distance	145	ft	Grade	0.0	%
Minimum Track Clearance Dist, MTCD	35	ft	Grade	0.0	%
Clear Storage Distance, CSD	5	ft			
Queue Start-up/Stop line Distance, L	**40**	ft			

Part 2:

	Car	Truck	Bus	Semi	
Vehicle Length (ft)	15	30	40	65	
Vehicle Height (ft)	5	14	11	14	
Queue Space (ft/veh)	21	36	46	71	
Vehicles within L (veh)	1	1	0	0	
Start moving last vehicle in L (sec)	**3.9**	**3.9**	**2.7**	**4.0**	**4**
Move front of vehicle thru L (sec)	4.1	4.5	3.8	8.5	9
Move entire vehicle past gate (sec)	2.4	3.9	3.8	11.0	11
Move entire vehicle thru MTCD (sec)	**4.6**	**5.9**	**5.4**	**13.7**	**14**
Non-interaction gate descent time (sec)	10.1	2.9	4.0	2.9	3
Approach vehicle clearance time (sec)	8.9	9.6	8.6	17.0	17
Conflicting vehicle clearance time (sec)	11.2	12.7	11.4	24.1	24
Include as Design Vehicle?	**Yes**	**Yes**	**Yes**	**Yes**	Use

Part 3:

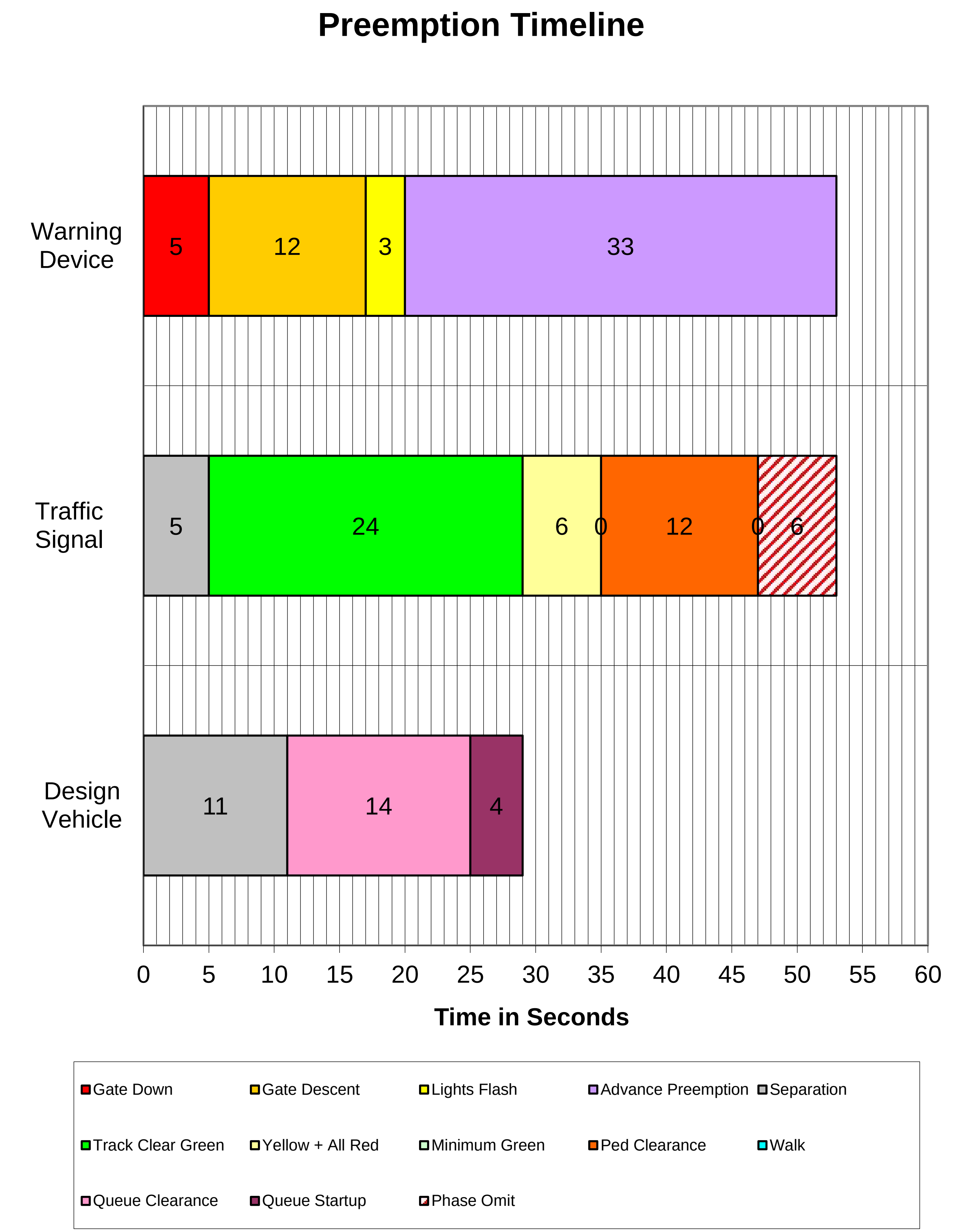
Green Track Clearance Time	**24**	sec	*Green Track Clearance extended to Gate Down*
MTCD Queue Clearance Time	**18**	sec	
Minimum Walk	0	sec	
Maximum Ped Clearance	12	sec	
Minimum Green	0	sec	
Maximum Yellow + All Red	6.0	sec	
Maximum RWTT	**18**	sec	
Separation Time, ST	5	sec	*See Preemption Timeline for actual Separation Time*
Maximum Preemption Time, MPT	**41**	sec	

Section 2: Railroad Information

Lights Flash	3	sec	
Gate Descent	12	sec	
Minimum Time, MT	20	sec	
Clearance Time, CT	0	sec	0 sec minimum
Minimum Warning Time, MWT	**20**	sec	
Buffer Time, BT	10	sec	
Total Warning Time, TWT	**30**	sec	
Include vehicle-gate interaction check?	**Yes**		
Distance from gate to vehicle	4	ft	
Advance Preemption Time, APT	**33**	sec	
Equipment Response Time, ERT	5	sec	
Total Approach Time, TAT	**68**	sec	
Maximum Authorized Speed, MAS	79	mph	
Total Approach Distance, TAD	**7879**	ft	

LADOT Railroad Preemption Form Revised 1/25/2008

Street Name:	Crossing St	Crossing No:	



Preemption Timeline Displays Minimum RWTT? **No**

APPENDIX E

SCRRA Design Exception Form

The following SCRRA Request for Special Design Consideration form (DPM-13) is an example of the form that shall be used to submit requests for variances to SCRRA criteria. This form is subject to frequent updates, therefore the designer shall request the latest version of the form from SCRRA to be used when a variances is needed for the project.

METROLINK

REQUEST FOR SPECIAL DESIGN CONSIDERATION FORM

Project Name: ______________________________ Location: ___________________________

Project No.: _________________ Contract No.: ____________________

Date: ______________ Reference No.:____________________ Revision:___________

Subject:____

Part 1: To be Completed by Originator

ORIGINATOR	Requested by: _____________________ Title: ________________________ Company: ____	
IMPACTS	Does this Special Design Consideration impact Safety and Operations?	☐ Yes ☐ No
	Does this Special Design Consideration impact Positive Train Control?	☐ Yes ☐No
	Does this Special Design Consideration conflict with any CPUC/CA MUTCD regulations and requirements?	☐ Yes ☐No
	Does this Special Design Consideration impact economic, social or environmental issues?	☐ Yes ☐No
SPECIAL DESIGN CONSIDERATION INFORMATION	Does this Special Design Consideration affect the following? Engineering Standards ☐ Yes ☐ No Specifications ☐ Yes ☐ No Design Criteria ☐ Yes ☐ No Manual Section ☐ Yes ☐ No	
	Description of Special Design Consideration: *(include location, extent of impact, affect on other operations)*	
	Rational for Special Design Consideration: *Reason the appropriate design criteria*	

	cannot be met (include explanation as to impracticality of compliance with SCRRA standards/criteria/instructions and demonstrate all attempts to comply)
	Mitigation Measures: *Any mitigation that will be provided to further support or justify the request (describe how purpose/intent of SCRRA standards/criteria/instructions will attempt to be met by alternative means)*
REASON FOR REQUEST	**Request for Special Design Consideration must address the following:** • *Established Design Criteria versus proposed and existing criteria* • *Justification for the proposed Criteria* • *Any background information which documents, support or justify the request* • *Safety implication of the request* • *The comparative cost of the full standard versus the lower design being proposed. Show what it would cost to meet the standard for which the Special Consideration is requested* • *Long term effect of the reduced design as compared to the full standard* *(attach additional pages if needed)*

ATTACHMENTS	*The completed Request for Special Design Consideration Form and all supporting documentation (drawings, reports, and calculations) shall be submitted with all requests for Special Design Considerations. This form (at the end of the last page) and all documentation attached with the request must be stamped and sealed by a Registered California Professional Engineer.* **List all attachments:**

This Request for Special Design Consideration has been prepared under the direction of the following registered professional engineer. The registered professional engineer attests to the technical information contained herein and the engineering data upon which recommendation, conclusion, and decisions are based.

____

Registered Professional Engineer *Date*

Project Name:______________________________ Subject:__________________________

Part 2: SCRRA Response

SCRRA RESPONSE		
	☐ Approved	*Additional SCRRA requirements upon which approval is granted:*
	☐ Resubmit	*Additional justification, explanation or information required:*
	☐ Rejected	*Reason:*

Part 3: SCRRA Approval Signatures

SCRRA APPROVALS	Name	Date
	Project Manager	
	Principal Engineer, Design and Engineering	
	Assistant Director, Design	
	Assistant Director, Project Management	
	Assistant Director, Stations and Structures	
	Assistant Director, PTC Technical Services	
	Assistant Director, Track and Structures	
	Chief, Program Delivery	
	Other:	

APPENDIX F

SCRRA Grade Crossing Design Checklist

DESIGN CHECK LIST

DATE: ___________

Reviewer: ______________________________ **Organization:** __________________ **Discipline:**_______________ **Project:** ______________________

Contract No.: ____________________________ **Contract Title:** __________________________ **Level of Submittal:** ____________ **Sheet** ___**of** ___

Submittal Level: **Preliminary (30%)___ ;** **In-Progress (60%) ___ ;** **Pre-Final (90%) ___;** **Final (100%) ___;** **Camera Ready (CR) ___**

		Checked		Findings		Notes and Remarks	Required at				
		Yes	No	Yes	No		30%	60%	90%	100%	CR
GENERAL ITEMS - Drawings											
1	Drawing Index - drawing numbers, sheet numbers, shown in order						X	X	X	X	X
2	Contract Number						X	X	X	X	X
3	Date							X	X	X	X
4	Meets Drafting Standards						X	X	X	X	X
5	Scale and Graphic Scale						X	X	X	X	X
6	Drawing Layout Index						X	X	X	X	X
7	Consultant Identification						X	X	X	X	X
8	Signatures (incl. PE Stamps)									X	X
9	Cross Referencing - Disciplines, Vendors Standards, Codes							X	X	X	X
10	Legend, Abbreviations and Notes						X	X	X	X	X
11	Title Block						X	X	X	X	X
12	Drawing Orientation						X	X	X	X	X
13	Meets: Fire Life Safety, Design Criteria, ADA and CPUC approvals							X	X	X	X
14	SCRRA Standards and Criteria Incorporated or Request for Special Design Consideration Submitted for Review and Approval						X	X	X	X	
15	North Arrow						X	X	X	X	X
16	Match Line Coordination						X	X	X	X	X
17	Resolution of review comments								X	X	X
18	Construction Staging							X	X	X	X
19	Existing and Future Land Use						X	X	X	X	X
20	Right of Way Requirements						X	X	X	X	X
21	Temporary Construction Detours										
22	Complies with Table 1-2, SCRRA Design Standards, Criteria, and Policies							X	X	X	X
23	Coordination with PTC Technical Services and Change Request Process							X	X	X	X

APPENDIX F

Highway-Rail Grade Crossings Design Standards and Criteria Manual Design Check List

DESIGN CHECK LIST **DATE: ____________**

Reviewer: ______________________________ Organization: ___________________ Discipline:_______________ Project: _______________________

Contract No.: ____________________________ Contract Title: __________________________ Level of Submittal: ____________ Sheet ___of ___

Submittal Level: Preliminary (30%)___ ; In-Progress (60%) ___ ; Pre-Final (90%) ___; Final (100%) ___; Camera Ready (CR) ___

		Checked		Findings		Notes and Remarks	Required at				
		Yes	No	Yes	No		30%	60%	90%	100%	CR
CIVIL/UTILITIES/TRAFFIC ITEMS											
1	City requirements incorporated into design documents, ie. Dwg. Format							X	X	X	X
2	Railroad track plan, profile & align.						X	X	X	X	X
3	Highway and approach highway geom.						X	X	X	X	X
4	Pedestrian-rail grade crossing designs						X				
	curb and gutter, drainage and rail grade										
	crossing surface						X	X	X	X	X
5	Drainage requirements met criteria						X	X	X	X	X
6	All existing utilities identified both within										
	public and railroad right of ways						X	X	X	X	X
7	Relocation of utilities well identified and										
	by whom							X	X	X	X
8	Identification of existing utility locations										
	from as-built or pothole data							X	X	X	X
9	Identification of utility conflicts							X	X	X	X
10	Plan and Profile's for:										
	Water							X	X	X	X
	Sanitary Sewer							X	X	X	X
	Storm Sewer							X	X	X	X
	Gas							X	X	X	X
	Telephone							X	X	X	X
	Electrical							X	X	X	X
	Street Lighting							X	X	X	X
11	Fencing						X	X	X	X	X
12	Pavement Marking							X	X	X	X
13	Signal design							X	X	X	X
14	Warning Devices							X	X	X	X
15	Warning and Regulatory Signage							X	X	X	X
16	Soil Boring Logs and Plan								X	X	X
17	Outline Specifications in CSI format						X				
18	Specifications							X	X	X	X
19	Right -of-way takes identified										
20	Preliminary/ concept diagnostic performed						X				
21	Final/90% Design Diagnostic performed								X		

APPENDIX G

SCRRA Board Grade Crossing Resolutions

RESOLUTION 91-3

OF THE SOUTHERN CALIFORNIA REGIONAL RAIL AUTHORITY PROMOTING THE ELIMINATION OF RAIL-HIGHWAY GRADE-CROSSINGS AND THE UPGRADE OF EXISTING WARNING DEVICES IN THE REGION'S PASSENGER RAIL CORRIDORS.

WHEREAS, the overall purpose of the Southern California Regional Rail Authority is to advance the planning, design, construction, and then to administer the operation, of regional passenger rail lines serving the counties of San Bernardino, Los Angeles, Ventura, Orange, and Riverside; and

WHEREAS, consistent with this purpose, the Southern California Regional Rail Authority is undertaking a comprehensive capital program to reduce train running times, add track capacity, improve safety, and increase ridership; and

WHEREAS, as part of this program, the Southern California Regional Rail Authority is undertaking a public safety program including the upgrading and/or elimination of existing at-grade rail-highway crossings and the construction of grade-separated rail-highway crossings in the region's passenger rail corridors; and

WHEREAS the Southern California Regional Rail Authority and its member agencies, along with the United States Department of Transportation, the Federal Highway Administration, and the Urban Mass Transportation Administration, are intensifying efforts to promote safety through the elimination of rail-highway grade crossings and the upgrade of existing warning devices, in accordance with the Federal Aid Highway Program Manual, the Federal Aid Highway Act of 1973, 1976 Guidelines and Recommendations, the Surface Transportation Assistance Act of 1987, and the 1989 Report to Congress;

NOW, THEREFORE BE IT RESOLVED that the Southern California Regional Rail Authority does hereby adopt the following policy guidelines concerning rail-highway grade-crossings:

1. The Southern California Regional Rail Authority shall support and promote the elimination of rail-highway grade crossings to the extent feasible on all regional passenger rail lines.

2. Upon the request of a county transportation commission, the Southern California Regional Rail Authority Board will consider exceptions on a case by case basis.

3. The Southern California Regional Rail Authority shall promote to the extent feasible the improvement of remaining grade-crossings in the region's passenger rail corridors through the upgrade of active and passive warning devices and crossing surfaces.

Jacki Bacharach
Chairman

October 11 1991
Date

RESOLUTION 98-21
OF THE SOUTHERN CALIFORNIA REGIONAL RAIL AUTHORITY REGARDING RAIL-HIGHWAY GRADE CROSSINGS

WHEREAS, the overall purpose of the Southern California Regional Rail Authority (SCRRA) is to design, build and operate a premier regional passenger rail system, including commuter and other passenger services, in Southern California; and,

WHEREAS, consistent with this purpose, SCRRA has undertaken a comprehensive capital program to provide mobility for the region, leading to more livable communities; and,

WHEREAS, as part of this program, SCRRA has adopted a strategic plan which includes eliminating or improving existing at-grade rail-highway crossings, and supporting regional, county and local efforts to build grade-separated rail-highway crossings in the region's passenger rail corridors; and,

WHEREAS, SCRRA and its member agencies, along with the Federal Highway Administration, the Federal Railroad Administration, the California Public Utilities Commission, and the California Department of Transportation cooperate on efforts to increase safety through the minimization and elimination of risks at rail-highway grade crossings, in accordance with Federal and state programs and nationally-recognized transportation and traffic engineering standards and practices;

WHEREAS, SCRRA recognizes that California Public Utilities Commission ultimately determines whether a new rail-highway grade crossing will be built.

NOW, THEREFORE BE IT RESOLVED that SCRRA does hereby adopt the following policy guidelines concerning rail-highway grade crossings;

1. SCRRA shall support and promote the elimination of rail - highway grade crossings to the extent feasible on all regional passenger rail lines.

2. SCRRA shall oppose the creation of new rail - highway grade crossings to the extent feasible on all regional passenger rail lines.

3. SCRRA shall support additional funding for grade separations.

4. Any request for an exception shall be presented by a SCRRA member agency; and, upon request, the SCRRA Board will consider exceptions on a case-by-case basis.

5. The SCRRA shall promote to the extent feasible the improvement of remaining grade crossings in the region's passenger rail corridors through the upgrade of active and passive warning devices and crossing surfaces.

6. The SCRRA would support the creation of a new rail-highway grade crossing only if improvements to other grade crossings, including elimination of grade crossing(s), are made part of the creation of the new grade crossing which together clearly improve public convenience and safety.

Chairman — 9-11-98 Date

APPENDIX H

SCRRA Traffic Signal Preemption

Annual Joint Inspection Form

METROLINK

Southern California Regional Rail Authority

Traffic Signal Preemption Annual Joint Inspection Form

Location Information

Location Name: ______________________ County: ______________________
Subdivision: ______________________ City: ______________________
Mile Post: ______________________ Date: ______________________
DOT # ______________________

Railroad Crossing Design Data

Crossing Type: ______________________ Number of Tracks: ______
Preemption Type: ______________________ AP Time (seconds): ______ WT (seconds): ______
Type of Signal Controller Interface: ______________ Date in Service: ______________________

Tests & Inspections Performed

Predictor Programming Correct: ______________ Circuit Plans Correct: ______________
ENS Signs: ______________ Roadway Signs: ______________
Any Obstructions Blocking Crossing Lights: ______________ Roadway Paint Markings: ______________

Verify RR equipment corresponds to traffic signal controller cabinet and as per design

TCR Relay ☐ Health Relay ☐
Entrance Gate Down Repeater Relay: ☐ Preemption Time Observed: ______ ______
Warning Time Observed: ______ ______ ______ ______ ______ ______
Trains Observed Through Crossing: ______ ______ ______ ______

Comments

Follow Up Required ☐
Comments:

Signatures

Traffic Signal Owner	Print Name	Email	Phone Number
Traffic Signal Contractor	Print Name	Email	Phone Number
MEC Maintenance	Print Name	Signature	Date
SCRRA	Print Name	Signature	Date