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CHAPTER 1 INTRODUCTION

1.1 GENERAL

The Utah Department of Transportation (UDOT), per Title 54 of the Utah State Code and Administrative Rule R930-5, is the governing agency that oversees all public grade crossings in the state of Utah. As the governing agency UDOT’s goal is threefold: 1) to improve the safety for all users of a crossing, 2) to provide for efficient operation of trains and vehicles, and 3) to provide non-motorized (pedestrian/bicycle) access through grade crossings. UDOT promotes the elimination of grade crossings, conducts annual reviews of all existing grade crossings in the state for safety deficiencies, evaluates and approves the location of new grade crossings, prescribes the type of improvements at grade crossings and determines the maintenance responsibilities for grade crossings.

Recent years have witnessed a significant expansion in light rail transit and commuter rail systems along the Wasatch Front and in the Salt Lake Valley. This expansion has resulted in increased pedestrian exposure to rail activity. Consequently there has been a greater interest in pedestrian control at grade crossings. This manual identifies some of the risk factors associated with pedestrian grade crossings and summarizes applicable best practices and mandatory controls that address these risk factors. This manual also presents a standard evaluation and implementation procedure intended to improve consistent application of devices to support pedestrian safety at grade crossings throughout the state.

Each grade crossing is unique; therefore it is not the intent of this manual to be all-inclusive nor is it the intent of this manual to present absolute standards. Unless specific standards are referenced, the best practices presented in this manual are presented as guidance for improving consistent application of devices to support pedestrian control at grade crossings. Individual grade crossings will need to be evaluated by a diagnostic team, as defined in the UDOT Railroad Coordination Manual of Instruction (MOI), to determine appropriate treatments to improve pedestrian safety at each location. The procedure defined in this manual is intended to aid in the evaluation process.

1.2 MANUAL ORGANIZATION

Chapter 1 Introduction, describes the purpose of the Pedestrian Grade Crossing Manual. It presents the manual’s organization and provides definitions and acronyms that are applicable to this manual.

Chapter 2 Best Practices/Design Elements, defines various devices and design elements compiled from a variety of sources. It includes discussion of MUTCD required and optional devices as well as best practices from around the country. The devices presented in this manual have been used successfully in other areas and can be used to improve pedestrian control at grade crossings in Utah. Many of the best practices
have been incorporated into the UDOT Standard Drawings GW 12 series, which defines standards for the application of pedestrian treatments at grade crossings.

Chapter 3 *Warrants and Safety Treatments*, identifies warrants for which the devices and design elements discussed in Chapter 2 may be applied. Furthermore, it highlights acceptable application of these devices and design elements through images, diagrams and references to applicable UDOT standard drawings.

Chapter 4 *Evaluation/Implementation Procedure*, presents a process that shall be followed when determining appropriate safety devices at pedestrian grade crossings. The process includes the use of the Diagnostic Team Checklist (see Appendix B) to evaluate potential pedestrian hazards at grade crossings. The Safety Treatment Flow Chart (see Appendix C) is provided to guide designers in determining potential treatments intended to mitigate potential hazards identified in the checklist. The checklist and flow chart are guidance tools to aid the designer in conducting the engineering study. Lastly, the process includes a recommended schedule for diagnostic team crossing reviews.

### 1.3 EXISTING DOCUMENTS

The information provided in this manual is a compilation of standards, conclusions, recommendations, and best practices from a variety of sources. Table 1 lists the standards and guidance documents that form the basis of this manual. When conflicts arrive these references should be referred to in the order listed. Table 2 presents the additional references, which were used for the development of this manual. A complete bibliography of all references is included in Appendix A.

#### Table 1: Standards and Guidance List

<table>
<thead>
<tr>
<th>Reference Title</th>
<th>Sponsoring Agency</th>
<th>Year Published</th>
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<tr>
<td><em>Utah Manual on Uniform Traffic Control Devices</em></td>
<td>UDOT</td>
<td>2013</td>
</tr>
<tr>
<td><em>Utah Administrative Rules R920 &amp; R930</em></td>
<td>State of Utah</td>
<td>2013</td>
</tr>
<tr>
<td>UDOT Pedestrian Grade Crossing Manual</td>
<td>UDOT</td>
<td>2013</td>
</tr>
<tr>
<td>UDOT Railroad Coordination Manual of Instruction</td>
<td>UDOT</td>
<td>2011</td>
</tr>
<tr>
<td>AREMA Communications and Signals Manual</td>
<td>AREMA</td>
<td>2012</td>
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<tr>
<td>Guidance on Traffic Control Devices at Highway-Rail Grade Crossings</td>
<td>FHWA</td>
<td>2002</td>
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<tr>
<td>Highway Capacity Manual</td>
<td>TRB</td>
<td>2010</td>
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Table 2: Reference List

<table>
<thead>
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<th>Reference Title</th>
<th>Sponsoring Agency</th>
<th>Year(s) Published</th>
</tr>
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<tbody>
<tr>
<td>TCRP Report 17: Integration of Light Rail Transit into City Streets</td>
<td>TCRP</td>
<td>1996</td>
</tr>
<tr>
<td>TCRP Report 69: Light Rail Service; Pedestrian and Vehicular Safety</td>
<td>TCRP</td>
<td>2001</td>
</tr>
<tr>
<td>TCRP Research Results Digest 51: Second Train Coming Warning Sign Demonstration Projects</td>
<td>TCRP</td>
<td>2002</td>
</tr>
<tr>
<td>Rails with Trails</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCRP Report 112: Improving Pedestrian Safety at Unsignalized Crossings</td>
<td>TCRP</td>
<td>2006</td>
</tr>
<tr>
<td>TCRP Research Results Digest 84: Audible Signals for Pedestrian Safety in LRT Environments</td>
<td>TCRP</td>
<td>2007</td>
</tr>
<tr>
<td>CPUC Pedestrian-Rail Crossings In California</td>
<td>CPUC</td>
<td>2008</td>
</tr>
<tr>
<td>Caltrans Railroad Signal Design and Grade Crossing Warning Device Training Manual</td>
<td>CalTrans</td>
<td>2008</td>
</tr>
<tr>
<td>Compilation of Pedestrian Safety Devices In Use at Grade Crossings</td>
<td>FRA</td>
<td>2008</td>
</tr>
<tr>
<td>TCRP Report 137: Improving Pedestrian and Motorist Safety Along Light Rail Alignments</td>
<td>TCRP</td>
<td>2009</td>
</tr>
<tr>
<td>UTA Light Rail Design Criteria</td>
<td>UTA</td>
<td>2010</td>
</tr>
<tr>
<td>UTA Pedestrian Safety Symposium Group Worksheets</td>
<td>UTA</td>
<td>2011</td>
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<tr>
<td>UTA Commuter Rail Design Criteria</td>
<td>UTA</td>
<td>2012</td>
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<tr>
<td>UTA Street Car Design Criteria</td>
<td>UTA</td>
<td>2012</td>
</tr>
<tr>
<td>Compilation of Pedestrian Safety Devices In Use at Grade Crossings</td>
<td></td>
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</tbody>
</table>

Although many of these references were written specifically for light rail transit (LRT) many of the principles contained therein are applicable to a variety of rail modes.

1.4 MANUAL DEFINITIONS AND ACRONYMS

**AASHTO** – American Association of State Highway and Transportation Officials

**AASHTO Green Book** – A Policy on the Geometric Design of Highways and Streets

**ADA** – Americans with Disabilities Act

**APS** – Audible Pedestrian Signal

**AREMA** – American Railway Engineering and Maintenance-of-Way Association

**CPUC** – California Public Utilities Commission

**DWS** – Detectable Warning Surface

**Exclusive Alignment** – A railroad alignment that is either fully grade separated or at-grade without crossings

**FHWA** – Federal Highway Administration

**Fps** – Feet per second

**FRA** – Federal Railroad Administration

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The MUTCD defines requirements for all highway-rail and pedestrian grade crossings. These requirements include, among others, the installation of passive devices including the Grade Crossing (Crossbuck) Sign (R15-1) and, where multiple tracks and no gates are present, a Number of Tracks Plaque (R15-2P) on every approach to a highway-rail grade crossing. When a pedestrian grade crossing is located within 25 feet of the highway-rail grade crossing the pedestrian grade crossings may share the signs and other treatments with the highway-rail grade crossing. Figure 1 demonstrates how to determine the distance between a highway-rail grade crossing and a pedestrian grade crossing.
The MUTCD also identifies optional warning devices which may be applied as necessary to maintain the proper warning and control of pedestrians at grade crossings when factors such as sight distance restrictions and high pedestrian activity are present. This chapter identifies several design elements intended to address typical pedestrian risky behaviors at grade crossings. The design elements described in this chapter include MUTCD optional treatments and best practices that are used throughout the country, which are included in several national and local publications. These design elements are not intended to be an all inclusive list; rather they are representative of some of the more common practices. The final section of this chapter provides a brief discussion on the UDOT Standard Drawing GW12 series, which defines the standard application of many of the treatments presented in this chapter.

2.1 DETECTABLE WARNING SURFACE

A DWS consists of raised, truncated domes as shown in Figure 2. When placed on either side of a grade crossing, DWSs alert visually impaired individuals of the presence of the grade crossing. The intent of the DWS is to identify the beginning and/or end of the hazard area, which in turn indicates a safe location to wait. DWSs are required at all pedestrian grade crossings where a sidewalk or paved multi-use path is present. Where a LRV operates in mixed flow the standard
DWS at the base of curb ramps, which is required per ADA standards, provides sufficient warning. Standard Drawing GW 5C provides a detail of a typical DWS and Standard Drawing GW 12B1 illustrates the appropriate placement of DWSs at grade crossings.

### 2.2 LOOK SIGN (R15-8)

The MUTCD standard LOOK sign (R15-8) requires that pedestrians look both ways prior to entering the crossing. MUTCD presents this sign as an option however, this sign is applicable wherever trains operate in two directions whether on one or multiple sets of tracks. When used at a crossing with passive control or in street running alignments the LOOK sign should be placed near the detectable warning surface. When active devices are present the LOOK sign should share the post with the crossbucks as illustrated in and Standard Drawing GW12A1, but may be placed on its own post.

### 2.3 PAVEMENT MARKINGS

The “STOP” pavement marking, shown in Figure 2, is currently used in semi-exclusive alignments. These markings are often coupled with a DWS and may be located just inside the dynamic envelope. Their purpose is to remind pedestrians to stop outside the dynamic envelope of the train and wait until the train clears the grade crossing. The “STOP” marking shall be placed according to Standard Drawing GW 12B1.

### 2.4 PATHWAY DELINEATION

For the purposes of this manual, pathway delineation is defined as the pavement markings, color and/or texture that guide a pedestrian through the crossing. It is important for pedestrians to have a clear path in order to efficiently navigate a grade crossing. Pedestrians should not have to make decisions as to the appropriate direction of travel after entering the grade crossing.
Pathway delineation is especially beneficial to disabled persons. The intent of pathway delineation is to sufficiently define the path a pedestrian should take while crossing the trackway. In mixed-use alignments crosswalk striping typically serves as a pathway delineator. In semi-exclusive alignments the sidewalk itself can serve as a pathway delineator provided it has sufficient contrast from the surrounding area. However, as the sidewalk gives way to the track panel surface or trackway pavement, the pathway must then be delineated across the panels or pavement area. At wide crossings and locations where the pathway through the crossing is not clearly delineated by some other means 4 inch edge lines should be used to delineate the pathway. Figure 4 provides an example of pathway delineation where striping delineates the edges of the pathway through the crossing.

2.5 CHANNELIZATION

Warning and control treatments are only effective if pedestrians cross at the intended location; therefore, channelization should be used to direct pedestrians to the appropriate crossing location. Channelization refers to delineation (painting and/or contrasted pavement) or physical devices used to direct pedestrians toward the appropriate crossing location. The strongest form of channelization can be achieved through fencing, landscaping and other physical obstacles that inhibit pedestrians from choosing an incorrect path. Figure 5 demonstrates how channelization can be used. In the image the bedstead barriers are placed between the sidewalk and the roadway in the neutral quadrant discouraging pedestrians from bypassing (walking around) the warning devices installed for their protection. This type of channelization layout is typically not required where vehicle gates, right-of-way fencing or other obstacles prevent pedestrians from bypassing the warning devices.

When channelization is used it shall extend a minimum of 25 feet along the corridor and/or a minimum of 25 feet back from the warning devices. According to the MUTCD any fencing within the grade crossing shall have a maximum height no greater than 43
inches\textsuperscript{1} However, where fences are located outside of the pedestrian and vehicle sight triangles fence heights should be at least 4 feet, and preferably 8 feet high in order to prevent trespassing.\textsuperscript{3}

2.6 BARRIERS

Barriers may be used within a channelized area to slow pedestrian travel especially in areas where pedestrian surges could occur (e.g. sporting event centers) and/or where pedestrians tend to hurry across the tracks (e.g. stations). Barriers shall be placed to direct a pedestrian’s line of sight in the direction of oncoming trains, thus reminding individuals to look both directions as they proceed across the tracks. Figure 6 illustrates how barriers can be used to direct a pedestrian’s line of sight towards potential oncoming trains. Some layouts, such as the one illustrated in Figure 6\textsuperscript{1}, use offset crossings and wind across the entire width of the grade crossing. Other layouts, such as the layouts presented in Figure 7, direct pedestrians to look both directions before entering the crossing and provide a straight crossing over a single set or multiple sets of tracks. Both layouts force pedestrians to look before crossing.

All potential users shall be considered when designing barriers at grade crossings. In some cases it may be desirable to use barriers to force bicyclists to dismount prior to entering the crossing by reducing the spacing between barriers; however barriers should always be spaced such that wheelchairs have sufficient space to maneuver.

2.7 SWING GATES

Swing gates are movable barriers that pedestrians and other non-motorized users must open manually. MUTCD Section 8D.05 requires that swing gates be designed to open away from the tracks. A crossing user should pull the gate open to enter the crossing and push the gate open to exit the crossing. This forces crossing users to pause before entering the crossing without substantially restricting them from exiting the crossing.\textsuperscript{11} Furthermore, MUTCD requires that swing gates be designed to return to the closed position after each use. Swing gates should be designed to focus the view of the
crossing user in the direction of an approaching train on the nearest track.\textsuperscript{19} Swing gates shall also be designed in compliance with ADA requirements.\textsuperscript{5}

TCRP Report 137 suggests that pedestrian swing gates should be used where sight distance is restricted, where pedestrians tend to hurry across the tracks without looking, where channelization and barriers prevent crossing users from easily bypassing the gates, and where there is sufficient space to accommodate their use by disabled persons.

\section*{2.8 \textbf{AUDIBLE DEVICES}}

The minimum requirement per MUTCD for any grade crossing includes the installation of passive devices such as the Grade Crossing (Crossbuck) Sign (R15-1) and, where multiple tracks and no gates are present, a Number of Tracks Plaque (R15-2P) on every approach to the highway-rail or pedestrian pathway grade crossing. Treatments such as those defined earlier may be used to enhance the pedestrian crossing, but an engineering study shall determine if active devices are more appropriate.

FRA regulates the use of audible devices. Audible devices include bells, horns, and synthesized tones that are placed on the train and/or at crossing locations. The intent of these devices is to provide supplemental warning to motorists, pedestrians and bicyclists. Audible devices can be either on-vehicle, wayside (i.e. at the crossing), or both. Wayside devices include wayside horns and supplemental audible warning devices.

FRA requires the sounding of on-vehicle horns at all public grade crossings except those within a defined quiet zone. Wayside horns may be used instead of on-vehicle horns but must be installed in compliance with 49 CFR Part 222. Quiet zone regulations do not apply to supplemental audible devices.

The TCRP Research Results Digest 84 specifically addresses the use of these devices in LRT environments but many of the principles identified can be applied to other rail modes. Regarding the use of on-vehicle audible devices the report suggests that their use be determined based on the physical and operational characteristics of the crossing. These characteristics can be ranked according to 1) Emergencies, 2) Sight distance, and 3) Surrounding conditions.\textsuperscript{8} This guidance applies mainly to mass transit rail modes, which generally have more discretion regarding on-vehicle horns.

The recommendations for supplemental audible devices presented in the TCRP report are applicable to a wider variety of rail modes. Supplemental audible devices are sometimes perceived as annoying by local communities because of their tonal character and repetitive nature. However, supplemental audible devices are mandatory for all pedestrian at-grade crossings with active controls (MUTCD Section 8C.03). TCRP Research Results Digest 84 suggests that innovative and effective means should be sought to balance safety and noise impacts.\textsuperscript{8} The TCRP report provides some guidance
on how to reduce the impact of supplemental audible devices on noise sensitive communities. These recommendations are reproduced in Table 3. Each of the recommendations should be carefully considered when attempting to balance pedestrian control with community noise impacts.

### Table 3: Recommendations for Reducing Impact of Wayside Audible Devices

<table>
<thead>
<tr>
<th>Technique</th>
<th>Operational Context</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Sound Level of Device</td>
<td>All crossings except those in a high-noise environment</td>
<td>Adjust sound level of bell, replace non-adjustable bell with adjustable bell, replace electromechanical bell with electronic device</td>
</tr>
<tr>
<td>Vary Sound Level of Device</td>
<td>Crossings where background sound level fluctuates</td>
<td>Set warning level 10 dB above ambient noise level, either by measuring ambient levels or with a time clock</td>
</tr>
<tr>
<td>Improve Directionality of Device</td>
<td>Crossings where noise-sensitive receptors are not in line with pedestrian approaches</td>
<td>Install shrouds on existing bells or replace bells with wayside horns</td>
</tr>
<tr>
<td>Lower Mounting Height of Device</td>
<td>Crossings where nearby walls or structures would block sound from a lowered device</td>
<td>Move crossing bell from top of post to location within pedestrians’ field of perception</td>
</tr>
<tr>
<td>Reduce Number of Devices</td>
<td>Crossings with multiple gates and flashing light devices</td>
<td>Remove one or more crossing bells while maintaining sufficient coverage for pedestrians on all approaches</td>
</tr>
</tbody>
</table>

Grade crossings in street-running alignments are most often controlled by standard traffic signals. Some signal-controlled intersections may include audible pedestrian signals (APS) in addition to standard pedestrian signal heads. The TCRP Research Results Digest 84 reported that adding a crossing bell to a location equipped with APS may result in the violation of the pedestrian signal. Audible devices may be used in street-running alignments however supplemental audible devices should not be used at locations equipped with APS.
2.9 FLASHING-LIGHT SIGNALS

Flashing-light assemblies are an active device used to indicate the presence of an approaching train. They are commonly used to warn motorists, pedestrians, and non-motorized vehicles of an oncoming train at highway-rail grade crossings in semi-exclusive alignments. MUTCD Section 8C.03 states that roadway flashing light signals shall be installed at grade crossings where LRT speeds exceed 35 mph. When a pedestrian grade crossing is within 25 feet of a highway-rail grade crossing these same devices can provide warning to pedestrians and other non-motorized users. Additionally MUTCD Section 8C.13 states that Flashing-light signals with a Crossbuck (R15-1) sign and an audible device are required at pedestrian and bicycle crossings where an engineering study has determined that the sight distance is not sufficient for pedestrians and bicyclists to complete their crossing prior to the arrival of the train. At locations where warning devices are not easily observed visibly or audibly, additional flashing-light units may be required even if the pedestrian crossing is close enough to share control devices with the highway. Figure 8 presents a location where an additional flashing-light signal is placed in the neutral quadrant to warn pedestrians. Notice that the gate obstructs the back flashing-light units so that pedestrians’ view of them is limited.

Pedestrian grade crossings located greater than 25 feet from a highway-rail grade crossing must provide their own crossing control and can use similar flashing devices to warn pedestrians of oncoming trains. Flashing-light signals are required in locations of high pedestrian activity or areas where additional risk factors exist, such as exceptionally wide crossings and crossings shared by multiple concurrent train operations.

A potential shortcoming of standard flashing-light assemblies serving as pedestrian warnings is that the flashing lights and signage are mounted more than 7 feet high which may be outside of the area pedestrians
observe while walking. MUTCD Section 8D.06, notes that flashing-light signals at pathway grade crossings may be lowered to a height not less than 4 feet measured from the bottom edge of the pathway surface and maintaining a 2 foot clearance from the near edge of the pathway (See Standard Drawing GW 12A1).

2.10 BLANK-OUT SIGNS

Studies have found that pedestrians often ignore warning signs. One way to mitigate this is to install active pedestrian warning devices which would include flashing-light signals and audible devices, but may also include blank-out signs. Blank-out signs are train-activated warning signs that convey specific messages to crossing users. These signs are often used at crossings to indicate prohibited movements to vehicles. However, the W10-7 blank-out sign, which is shown in Figure 10, is an MUTCD approved sign which has been used to alert motorists and pedestrians to the presence of an LRV at intersections and at station locations.

Blank-out signs are advantageous because of their ability to provide specific messages to crossing users when a train is approaching. Blank-out signs are required where there are sight distance restrictions and multiple tracks to notify pedestrians of the approach of a train. Blank-out signs are also recommended in areas of high pedestrian activity. At crossings with multiple tracks blank-out signs can also be used to alert the pedestrian that the crossing is still occupied by a train, which could mean the approach of a second train. Consideration should be given to the appropriate activation warning time, for the blank-out sign prior to the train’s arrival and immediately extinguishing the sign after the train passes. If the sign is lit too long without the crossing being occupied by a train, pedestrians may ignore the sign.

2.11 AUTOMATIC GATES

For the purpose of this manual automatic gates refer to automatic pedestrian gates. The MUTCD Section 8C.13 states that if flashing-light assemblies and an audible device do not provide sufficient notice, automatic pedestrian gates should be considered. Automatic pedestrian gates are warranted only in rare circumstances where pedestrian safety concerns cannot be mitigated any other way and grade separation is not feasible (e.g. severe sight restrictions, see Section 3.2.3).
In many cases vehicle gates can be used to block pedestrians as well as motorists by placing the vehicle gate behind the sidewalk. Other instances may require a separate pedestrian gate. When a separate pedestrian gate is used for a sidewalk adjacent to a highway-rail grade crossing the pedestrian gate should operate with its own mechanism to prevent pedestrians from raising the vehicle gate by manually raising the pedestrian gate.\footnote{Channelizing fence should be used to prevent pedestrians from bypassing the automatic gate. An emergency exit swing gate must be provided unless a pedestrian storage area is provided between the gates and the train’s dynamic envelope. Where hazards may only be present for a specific approach or quadrant, automatic pedestrian gates should be located on all at-risk approaches.}

2.12 OTHER DESIGN ELEMENTS

There are several warning devices that should be considered for more specific scenarios. This section presents a few of the more common scenarios and the devices that should be used to improve pedestrian safety in specific crossing scenarios.

2.12.1 SKEWED CROSSING SIGN

Skewed crossings result in a number of concerns for grade crossing users. First of all skewed crossings tend to be longer than perpendicular crossings resulting in longer crossing times, which could potentially require longer warning and/or wait times. It is recommended that the warning time be increased to allow pedestrians to clear the crossing before a train’s arrival. Warning time should be calculated based on a 4 fps walking speed. Skewed crossings are particularly dangerous to cyclists, wheelchairs and other narrow wheeled vehicles where their wheels can get caught in the railway flanges. Skewed crossings can also result in sight distance restrictions necessitating additional safety precautions.

Figure 11: Automatic Gate

Figure 12: Realignment of Pedestrian Pathway
The AASHTO Guide to Bicycle Facilities states that the preferable skew angle between the centerline of the tracks and the bikeway is between 60 and 90 degrees. In other words, if the crossing is greater than 30 degrees from perpendicular it should be considered a skewed crossing. Skewed crossings should be avoided whenever possible. However, if realignment of the entire roadway is not possible realignment of the sidewalk or multi-use path is recommended. An example of how this can be done is shown in Figure 13. Nevertheless, if avoidance of the skew is not possible the MUTCD standard Skewed Crossing sign (W10-12), illustrated in Figure 13, is recommended to alert crossing users of the danger. Additional safety measures should also be considered including the use of barriers to force bicyclists to dismount prior to entering the crossing in order to avoid catching their wheels in the railway flanges.

2.12.2 MAINTAINING SYSTEM CREDITABILITY

Reasonable and consistent warning times at grade crossings are important for building system creditability. Unreasonable or inconsistent warning times may result in risky behavior and potential incidents. The MUTCD states that the minimum warning time at a crossing should be 20 seconds. Occasionally railroad companies add buffer time to the 20 second minimum. Multiple tracks or large clearance distances can require longer warning times. The Highway Capacity Manual (HCM) Chapter 18 states that when pedestrians experience more than a 30 second delay, they become impatient, and engage in risky behavior. Whenever possible, warning time should be kept to a minimum in order to minimize pedestrian wait times. However, this must be balanced with the amount of time pedestrians require to traverse a crossing. Crossings greater than 80 feet wide should provide additional warning time calculated based on a 4 fps walking rate.

One way to maintain reasonable and consistent warning times is through a constant warning time system. The purpose of a constant warning time system is to provide relatively uniform advance warning time between the activation of warning devices and the arrival of the train. A constant warning time system is beneficial at crossings that are shared by multiple rail uses and the maximum difference in speed between the various uses is greater than 10 mph. Constant warning time is also beneficial at grade crossings near a rail yard or where switching operations often occur.
Constant warning time equipment cannot be implemented on electrified systems. Therefore, electrified systems such as overhead catenary or third rail should use other means to maintain system creditability. Placing limits on gate downtime is one such option. Limiting gate downtime does not affect the warning time however it does limit the delay experienced by pedestrians. If pedestrians perceive that the gate downtime is excessive they may believe that the system has malfunctioned. The intent in placing limits on gate downtime is that reduced delay will reduce doubts, frustration and risky behavior.4

2.13 UDOT STANDARD DRAWINGS GW 12 SERIES

The GW 12 series of the Standard Drawings presents standard application of various pedestrian treatments to be used at grade crossings including the appropriate placement and configuration of many of the devices discussed in this chapter. The GW 12 series can be found on UDOT’s website at www.udot.utah.gov.

CHAPTER 3 RECOMMENDED SAFETY TREATMENTS

This chapter identifies standard control treatments to improve crossing safety. It also defines several risk factors which may necessitate additional safety treatments.

3.1 STANDARD SAFETY TREATMENTS

The pedestrian safety treatments identified in Table 4 are required at all grade crossings for the specified categories. Some locations may require additional safety treatments based on site specific evaluations. For the appropriate layout of these standard safety treatments see the UDOT Standard Drawings GW 12 series.

<table>
<thead>
<tr>
<th>Safety Treatment</th>
<th>Urban Crossings</th>
<th></th>
<th>Rural Crossings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban Crossings</td>
<td></td>
<td>Rural Crossings</td>
</tr>
<tr>
<td>Crossbuck Assembly</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Detectable Warning Surface</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LOOK Sign (R15-8)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>&quot;Stop&quot; Pavement Marking</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pathway Delineation</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
3.2 SAFETY TREATMENT WARRANTS

There are several variables that can affect the design of a crossing with respect to pedestrian safety. This section lists the variables that typically result in the greatest impact to the selection of pedestrian warning devices. The warrants identified in this section include recommendations for potential mitigations.

3.2.1 URBAN AND RURAL GRADE CROSSINGS

The AASHTO Green Book states that urban and rural areas have fundamentally different characteristics with regard to density and types of land use, density of street and highway networks, nature of travel patterns, and the way in which these elements are related. Urban and rural highways often differ in the number and type of warning devices required due to inherent differences in their operation.

Similar differences exist between urban and rural grade crossings, which affect the number and type of warning devices that should be applied. Grade crossings in a rural environment typically have fewer pedestrians thereby requiring fewer pedestrian safety treatments. Because of these inherent differences between urban and rural grade crossings this manual defines separate criteria for urban and rural grade crossings. However, certain factors may justify the evaluation or classification of an urban crossing as a rural crossing when determining appropriate pedestrian treatments. Similar factors may justify the evaluation or classification of a rural crossing as an urban crossing. One of these factors is the level of exposure at the crossing. Crash prediction models, used for predicting collisions at grade crossings, consistently use the exposure variables of train frequency and traffic volume. Corresponding variables for pedestrian crossings are train frequency and pedestrian volume.

According to the FRA grade crossing inventory for the state of Utah, approximately one third of all statewide public grade crossings are rural grade crossings (i.e. grade crossings on rural highways). Of all the statewide public grade crossings, urban and rural, approximately one third have 4 or fewer trains per day. Approximately one fifth of rural grade crossings have 4 or fewer trains per day. Approximately one fourth of urban grade crossings have 4 or fewer trains per day.

Higher density communities tend to have higher pedestrian activity because walking distances are shorter. Rural areas tend to have limited pedestrian activity because travel distances are longer. The AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities suggests that when pedestrian facilities in rural areas have a surrounding density greater than 1,000 persons per square mile, the same criteria for urban areas should be considered because trips may be shorter and may be closer to typical urban area pedestrian activity. Recognizing that population density alone does not require expanded pedestrian facilities this statement implies that population density may be used as a surrogate measure for pedestrian volumes.
The FHWA Railroad-Highway Grade Crossing Handbook states that traffic volume alone is not a sufficient forecaster of collisions at grade crossings. Similarly pedestrian volume alone is not a sufficient forecaster of pedestrian related incidents at grade crossings nor is train frequency. However, in some cases train frequencies and pedestrian volumes at urban and rural grade crossings may be comparable. It is recommended that train frequency and population density or pedestrian volume be considered when selecting the appropriate evaluation criteria for a crossing. Such factors may warrant the evaluation of urban crossings as rural crossings and vice versa.

3.2.2 RAIL ALIGNMENT

LRT and trolleys may operate in one of three types of alignment: exclusive, semi-exclusive, and street running. Higher speed and heavier rail modes such as freight and commuter rail are mostly restricted to semi-exclusive and exclusive alignments. However, there are areas where freight activities occur within the street right-of-way and an engineering study should carefully evaluate the appropriate control measures for both the roadway/pedestrians and rail.

When determining the appropriate pedestrian safety treatments at a grade crossing it is important to consider into which alignment type the grade crossing falls. Street running alignments are typically controlled by traffic signals and generally require minimal additional safety treatments. Where a grade crossing is in a semi-exclusive alignment it often requires various safety treatments to communicate to pedestrians and other potential crossing users the hazard present at these types of crossings. Applicable safety treatments for each alignment type should be evaluated based on the other risk factors present at the grade crossing.

3.2.3 SIGHT DISTANCE RESTRICTIONS

Sight distance is considered to be restricted when an engineering study has determined that the sight distance is not sufficient for pedestrians to see the train far enough down the tracks to complete the crossing prior to the train’s arrival. Figure 14 illustrates the definition of a “crossing”, which is from the edge of the clearance area on the near side of the trackway to the edge of the clearance area on the far side of the trackway.
Table 5 presents the FHWA minimum sight distance requirements given the layout presented in Figure 14. The FHWA Guidance on Traffic Control Devices at Highway-Rail Grade Crossings provides additional information on developing pedestrian sight triangles.

Table 5: Pedestrian Sight Distance

<table>
<thead>
<tr>
<th>Train Speed (mph)</th>
<th>FHWA Pedestrian Sight Distance (ft)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>200</td>
</tr>
<tr>
<td>20</td>
<td>265</td>
</tr>
<tr>
<td>25</td>
<td>330</td>
</tr>
<tr>
<td>30</td>
<td>395</td>
</tr>
<tr>
<td>35</td>
<td>465</td>
</tr>
<tr>
<td>40</td>
<td>530</td>
</tr>
<tr>
<td>45</td>
<td>595</td>
</tr>
<tr>
<td>50</td>
<td>660</td>
</tr>
<tr>
<td>55</td>
<td>730</td>
</tr>
<tr>
<td>60</td>
<td>795</td>
</tr>
<tr>
<td>70</td>
<td>925</td>
</tr>
<tr>
<td>80</td>
<td>1,060</td>
</tr>
<tr>
<td>90</td>
<td>1,190</td>
</tr>
</tbody>
</table>

*Values are rounded up to nearest 5 feet

Sight distance calculation assumptions:
- Walking speed = 4 fps
- Perception/Reaction time = 2 seconds
- Dynamic Envelope = 7 feet to Center of Track
- Distance between Tracks = 14 feet

Sight distance is highly dependent upon specific crossing geometry; therefore the availability of adequate sight distance shall be determined through an engineering study which includes the development of sight triangles for all pedestrian approaches. The evaluation should also consider the potential for reverse running train operations.
Where sight distance is restricted pedestrians must rely on other sources to indicate whether or not it is safe to cross. Active warning devices, including flashing-light signals and audible devices, shall be used to communicate the danger to pedestrians when sight distance restrictions prevent pedestrians from perceiving the danger. Whenever possible, sight distance should be improved to acceptable conditions. However, when sight distance cannot be improved a W10-7 blank-out sign, shown in Figure 10, shall be provided in multi-track semi-exclusive alignments in order to alert pedestrians when a train is approaching. It is also recommended at unsignalized crossings in street running alignments. Recommended placement of the W10-7 blank-out sign is illustrated in Standard Drawings GW 12A1 and GW 12E. Figure 15 demonstrates how additional active control devices may be used to mitigate sight distance restrictions. Notice the blank-out sign mounted on the pole between the tracks.

In rare circumstances sight distance may be severely restricted. At such crossings every effort shall be made to improve sight distance. However, when severe sight distance restrictions cannot be mitigated automatic gates should be used to prevent pedestrians from entering the crossing when a train is approaching or grade separation should be considered.

When determining sight distance availability at pathway grade crossings bicyclists must be considered separately. Bicyclists typically travel at faster speeds than pedestrians and, consequently, can clear the crossing more quickly than pedestrians. However, because of their higher speed, bicyclists require longer distances to stop. A bicyclist should be able to see a sufficient distance down the track to determine if they need to stop or may continue through the crossing safely. This shall be determined using the corner sight distance calculation used for vehicles in the FHWA Railroad-Highway At-grade Crossing Handbook. This calculation is used to create the sight triangles presented in Figure 16. Table 6 presents the bicycle approach sight distance for typical bicycle speeds and several train speeds. Where bicycle sight distance is restricted channelization and barriers should be used to force bicyclists to slow down or dismount prior to entering the crossing.
3.2.4 HIGH PEDESTRIAN VOLUMES

In some cases a grade crossing may be near a mall, recreational area, or station which may result in high pedestrian volumes. The TCRP Report 69 defines high pedestrian volumes as at least 60 pedestrians in each of any 2 hours of a normal day. High pedestrian volumes lead to greater exposure and potentially more incidents. Due to the increased exposure additional safety devices should be installed to reduce the potential for incidents. Crossings near high pedestrian attractors shall have active warning devices, such as flashing-light signals and audible warning devices. Appropriate placement of active warning devices is described in the MUTCD and illustrated in Standard Drawings GW 12A1 and GW 12A2.

3.2.5 SCHOOL ZONES AND SNAP PLANS

MUTCD Section 7A.03 states, “A School Zone shall be defined as a School Crosswalk Zone, a Reduced Speed School Zone, a Narrow School Route, Abutting School Zone, or a School Bus Loading Zone.” Whenever a grade crossing is within a school zone or is part of a SNAP plan as defined in the MUTCD, additional precautions should be taken.

Table 6: Bicycle Approach Sight Distance

<table>
<thead>
<tr>
<th>Bicycle Speed (mph)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>82</td>
<td>87</td>
<td>95</td>
<td>107</td>
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<td>111</td>
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<td>151</td>
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</tr>
<tr>
<td>30</td>
<td>126</td>
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<td>151</td>
<td>166</td>
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<td>166</td>
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<td>196</td>
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<tr>
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<td>313</td>
<td>332</td>
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<tr>
<td>90</td>
<td>302</td>
<td>307</td>
<td>316</td>
<td>327</td>
<td>343</td>
<td>361</td>
</tr>
</tbody>
</table>

Sight distance calculation assumptions:
Perception/Reaction time = 2 seconds
Deceleration rate = 16 fpsps
Bicycle length = 6 feet
Distance from front of bike to bicyclist = 3 feet
Detectable warning surface to edge of rail = 6.5 feet
Distance from near rail to far rail = 17 ft
to ensure the safety of the grade crossing and should include treatments similar to those applied in locations near high pedestrian attractors including active warning devices.

3.2.6 MULTIPLE TRACKS

Where multiple tracks are present at a crossing there is potential for additional trains arriving at the crossing before or shortly after the departure of the first train. Occasionally the first train may block a pedestrian’s view of the second train. In other cases a pedestrian may simply make an incorrect assumption about why warning devices have been activated or where the train is coming from. Pedestrians shall be made aware of this risk of the arrival of a second train. In most cases this can be achieved through a LOOK sign.

The risk of pedestrians making an incorrect conclusion about the safety of a grade crossing with multiple tracks is increased when there are multiple concurrent types of train operations. When pedestrian traffic is high at multi-track crossings and there are multiple concurrent train operations at the crossing the additional risk to pedestrians shall be mitigated through the installation of a blank-out sign.

3.2.7 CROSSING WIDTH

In semi-exclusive alignments the MUTCD requires a minimum warning time of 20 seconds at grade crossings prior to the arrival of the train. This warning time is intended to provide sufficient time for motorized and non-motorized crossing users to clear the crossing before the train arrives. AREMA Section 3.3.10 indicates that if the MUTCD (minimum track clearance distance for vehicles) exceeds 35 ft, additional warning time of one second for each additional 10 ft, or portion thereof, over 35 ft. should be added to the minimum warning time.

At 4 fps a pedestrian can travel 80 ft during the 20 second warning time. Occasionally a crossing may be wider than 80 ft especially where a crossing has more than 3 tracks. The crossing presented in Figure 17 is an example of an exceptionally wide crossing. Crossings greater than 80 ft wide should have additional safety treatments. MUTCD Section 8D.04 suggests that pathway delineation may be beneficial for wide crossings.1 When a wide crossing is combined with additional risk factors, such as those identified in this chapter, active warning devices should be installed.

---

1. When a wide crossing is combined with additional risk factors, such as those identified in this chapter, active warning devices should be installed.
3.2.8 UNSIGNALIZED INTERSECTIONS

In most cases where a light rail vehicle (LRV) or trolley operates in a street running alignment its grade crossings are controlled by standard traffic signals and pedestrians cross at locations designated by crosswalks. In instances where pedestrians are allowed to cross at a location that is not controlled by a standard traffic signal or a pedestrian signal, generally at mid-block crossings, additional safety treatments should be applied to improve the safety of the crossing. Passive controls may be sufficient where minimal pedestrian traffic can be expected at the crossing; however, where high pedestrian traffic can be expected active controls or potentially a pedestrian signal should be carefully considered. Recommended placement of active control devices at unsignalized intersections is presented in Standard Drawing GW 12E.

3.2.9 POTENTIAL PEDESTRIAN SURGES

Pedestrian surges occur when pedestrian volumes are extremely high during peak periods. Crossings near stations and event/entertainment centers often experience pedestrian surges. Pedestrians involved in pedestrian surges can exhibit high inattention and compromised judgment. The increased congestion may also result in increased risky behavior. In locations where pedestrian surges are likely to occur active warning devices should be provided. At signalized locations in street running alignments additional active warning devices may not be necessary, but at unsignalized locations blank-out signs and audible devices are recommended.

3.3 OTHER SAFETY CONSIDERATIONS

The items mentioned up to this point are perhaps the most easily generalized; however, additional safety indicators should also be considered.

3.3.1 CRASH HISTORY INVOLVING PEDESTRIANS

Occasionally there may be a grade crossing that meets very few or none of the warrants identified in this manual, but still experiences vehicle and pedestrian incidents even with the recommended safety treatments. Other crossings may have only a few pedestrian safety treatments and experience very few incidents. When evaluating the safety needs of a crossing its crash history should be considered.
3.3.2 RISKY PEDESTRIAN BEHAVIOR

Crash data is the traditional measurement of safety; however, vehicle and pedestrian collisions at grade crossings are relatively infrequent, therefore, the number of collisions is of limited statistical significance.\textsuperscript{12} TCRP Report 69 suggests the use of risky behavior as a potential surrogate safety indicator. The warrants identified in this manual represent scenarios that typically lead to risky behavior and can be used to evaluate proposed crossings where no data is available. The warrants can also be used for determining safety treatments at existing crossings; however, to the extent possible, crossing evaluations by an engineering study and treatment decisions should be data driven. Therefore, when determining safety treatments for an existing crossing, risky pedestrian behaviors should be observed and taken into consideration. Conclusions should be presented to the Diagnostic Team for a thorough consensus evaluation of the proposed treatments.

Examples of risky pedestrian behavior that have been observed in Utah include:

1. Standing on detectable warning surface
2. Distracted pedestrians
3. Not looking both ways
4. Disregard for safety devices

CHAPTER 4 EVALUATION/IMPLEMENTATION PROCEDURE

A standard evaluation and implementation procedure helps build a consistent use of safety treatments thus protecting the safety of pedestrians at grade crossings throughout the state. This chapter defines the evaluation and implementation procedure to be used throughout the state of Utah as new grade crossings are created and existing grade crossings are reviewed and improved.

4.1 GRADE CROSSING EVALUATION

Each grade crossing is unique and therefore shall be evaluated on a case by case basis by a diagnostic team as defined in the current UDOT Railroad Coordination Manual of
Instruction. This manual includes tools to aid diagnostic teams in the evaluation process. The checklist in Appendix B of this manual is one of these tools.

The checklist is divided into three parts: (1) General Information, (2) Potential Hazards, and (3) Proposed Mitigations. When used for the design of a proposed crossing or the redesign of an existing one the General Information and Potential Hazards sections of the checklist should be completed in the early stages of the evaluation. Additional hazards may be defined by and added to the checklist as deemed appropriate by the diagnostic team. The Proposed Mitigations section may be completed concurrently with the preliminary design. The preliminary design and checklist with proposed mitigations shall be presented to the diagnostic team during the initial review of existing or proposed crossings. The checklist with the mitigations may be updated during diagnostic team field reviews of the crossing.

The flow charts in Appendix C of this manual are another tool developed to guide designers and diagnostic teams through a consistent process of determining potential mitigations for the hazards identified in the Potential Hazards section of the checklist. There are two flow charts, the first addresses issues related to pedestrian safety at grade crossings in an urban environment, the second addresses similar issues relevant to grade crossings in a rural environment.

4.2 IMPLEMENTATION OF PROPOSED MITIGATIONS

Consistent implementation is perhaps more important than consistent evaluation. In an effort to achieve consistent implementation the diagnostic team should conduct at least two reviews of the grade crossing and proposed plans during the design and evaluation process. The initial review should be conducted during the design and environmental clearance stage of the project affecting the grade crossing. Another review should be conducted during the plan production stage. Additional reviews may be necessary during the project documents stage if conditions are altered from the concepts defined in the plan production stage. Reviews should be conducted in the field whenever possible.

The flow charts present a variety of warrants that must be addressed when designing a grade crossing. These warrants should be followed to determine the appropriate pedestrian safety treatments at the grade crossing under consideration. The devices presented in the flow chart are listed as required, recommended, and suggested depending on the warrants that are met or not met. These terms equate to the MUTCD verbiage standard, guidance, and option, respectively. Although the devices are presented in this manner, the decision to use a particular device at a particular location should ultimately be made on the basis of either an engineering study or the application of engineering judgment.
APPENDIX A REFERENCES


16. UDOT Railroad Coordination Manual of Instruction, Utah Department of Transportation, 2011.


APPENDIX B  DIAGNOSTIC TEAM CHECKLIST
<table>
<thead>
<tr>
<th>Diagnostic Team Check List</th>
<th>PEDESTRIAN GRADE CROSSING HAZARD ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade Crossing Location (City/County):</td>
<td>Diagnostic Team Member:____________________</td>
</tr>
<tr>
<td>Street Name:</td>
<td>Date:_________________</td>
</tr>
<tr>
<td>Crossing No.</td>
<td>Initial Review Date</td>
</tr>
<tr>
<td></td>
<td>Final Review Date</td>
</tr>
</tbody>
</table>

General Information:
- Train Speed: _______mph
- Crossing Width: _______ft (stop bar to 6’ past far rail)
- Max. Frequency of Trains:_____/_____ (trains per unit time)
- Number of Tracks ________

Type of Alignment:
- Semi-exclusive: □ Yes □ No
  
  A railroad alignment that is in a separate right-of-way or along a roadway where motor vehicles, pedestrians, and bicycles have limited access and cross at designated locations only. The alignment is typically separated by fencing or barriers between crossings.

  Street Running: □ Yes □ No
  
  A railroad alignment in which trains operate in mixed traffic with all types of road users. The alignment is typically separated from traffic by a curb or striping.

Type of Train Operation:
- Passenger: □ Yes □ No
- Freight: □ Yes □ No
- Commuter Rail: □ Yes □ No
- Light Rail: □ Yes □ No
- Trolley: □ Yes □ No
- Other: ___________ □ Yes □ No

Crossing Gate Timing:
- Warning Time: _______sec
- Preemption Time: _______sec
- Clearance Time: _______sec
- Total Time: _______sec

Area Information:
- Area Type: □ Rural □ Urban

  Population within 1 sq. mi.: □ ≤1000 □ >1000

Proximity of Sidewalk to Highway-Rail Grade Crossing:
- sidewalk ≤25 feet from Edge of Traveled Way (sidewalk may be treated as part of the grade crossing)
- sidewalk >25 feet from Edge of Traveled Way (sidewalk must be treated separately)

Comments/Field Observations:

Proposed Mitigations is a derivative of the pedestrian flow chart based on the Identifier responses for the potential hazards. Mitigations may be modified as determined by the initial and final Diagnostic Team Review.
<table>
<thead>
<tr>
<th>POTENTIAL HAZARD</th>
<th>HAZARD IDENTIFIER</th>
<th>COMMENTS/FIELD OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skewed crossing</td>
<td>☐ ≤30° from perpendicular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ &gt;30° from perpendicular</td>
<td></td>
</tr>
<tr>
<td>Does Crossing have a Yard track</td>
<td>☐ Yes Frequency of use <strong><strong><strong>/</strong></strong></strong>_</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ No</td>
<td></td>
</tr>
<tr>
<td>Does the Crossing have a Side track</td>
<td>☐ Yes Frequency of use <strong><strong><strong>/</strong></strong></strong>_</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ No</td>
<td></td>
</tr>
<tr>
<td>At-Grade Crossing</td>
<td>☐ Active Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Passive Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ N/A</td>
<td></td>
</tr>
<tr>
<td>Street Running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Block Crossing</td>
<td>☐ Traffic Signal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Unsignalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ N/A</td>
<td></td>
</tr>
<tr>
<td>Intersection Crossing</td>
<td>☐ Traffic Signal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Unsignalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ N/A</td>
<td></td>
</tr>
<tr>
<td>Multi-Use Path Crossing</td>
<td>☐ Traffic Signal/Active Control</td>
<td></td>
</tr>
<tr>
<td>(pedestrians and/or bicycles)</td>
<td>☐ Unsignalized/Passive Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Within 25’ of Highway-Rail Grade Crossing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ N/A</td>
<td></td>
</tr>
<tr>
<td>Intersection within 200 feet</td>
<td>☐ Traffic Signal</td>
<td></td>
</tr>
<tr>
<td>(Intersections within 200 feet should have preemption)</td>
<td>☐ Unsignalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ N/A</td>
<td></td>
</tr>
<tr>
<td>Adequate Approach Landing for Pedestrian / Bicycles (4’ X 4’ or more)</td>
<td>☐ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ No</td>
<td></td>
</tr>
<tr>
<td>Restricted Bicycle Sight Distance</td>
<td>☐ Yes</td>
<td></td>
</tr>
<tr>
<td>(for pathway crossings only)</td>
<td>☐ No</td>
<td></td>
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<tr>
<td>Restricted Pedestrian Sight Distance</td>
<td>☐ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ No</td>
<td></td>
</tr>
</tbody>
</table>
Proposed Mitigations is a derivative of the pedestrian flow chart based on the Identifier responses for the potential hazards. Mitigations may be modified as determined by the initial and final Diagnostic Team Review.

### DIAGNOSTIC TEAM CHECK LIST
#### PEDESTRIAN GRADE CROSSING HAZARD ANALYSIS

<table>
<thead>
<tr>
<th>Grade Crossing Location (City/County):</th>
<th>Street Name:</th>
<th>Diagnostic Team Member:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Name:</td>
<td></td>
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**Crossing No.:**

<table>
<thead>
<tr>
<th>POTENTIAL HAZARD</th>
<th>HAZARD IDENTIFIER</th>
<th>COMMENTS/FIELD OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Crosses Tracks with Train(s) Approaching – Safe Route to School</td>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If Yes, school district: _______________________</td>
<td></td>
</tr>
<tr>
<td>Pedestrian Crosses Tracks with Train(s) Approaching – Special Needs Groups</td>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If Yes, potential groups: _______________________</td>
<td></td>
</tr>
<tr>
<td>Potential pedestrian surges (Near event center, station, etc.)</td>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td>At 4 fps, does the Crossing width exceed the minimal 20-second warning time?</td>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>
# APPENDIX C  SAFETY TREATMENT FLOW CHART

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Decide on the appropriate safety treatment based on the proximity to the crossing and the traffic volume.</td>
</tr>
<tr>
<td>2.0</td>
<td>Evaluate the potential for pedestrian accidents and the effectiveness of the current safety measures.</td>
</tr>
<tr>
<td>3.0</td>
<td>Consider the accessibility of the crossing for people with disabilities.</td>
</tr>
<tr>
<td>4.0</td>
<td>Implement the chosen safety treatment, such as installing crossing signs, flashing lights, or pedestrian signals.</td>
</tr>
<tr>
<td>5.0</td>
<td>Monitor the performance of the safety treatment and make adjustments as necessary.</td>
</tr>
</tbody>
</table>
Urban Pedestrian Grade Crossing Flow Chart

Legend

- Decision Point
- Standard treatment
- Guidance treatment
- Option treatment

Notes:
1. If crossing skew is >30 degrees from perpendicular consider a 90 degree crossing design or add a skewed crossing sign (W10-12) to alert non-motorized crossing users, especially bicyclists, of the potential hazard.
2. Any crossing greater than 80' should provide additional warning time beyond the standard 20 seconds. The additional warning time should be calculated based on a 4 fps walking rate.
3. If the pedestrian crossing is <25' from a highway-rail grade crossing the vehicle control treatments may provide some of the required pedestrian treatments.

<4 trains/day and <1000 persons within 1 sq. mi. of the crossing?

Pedestrian access prohibited?

Street-running alignment?

Restricted sight distance?

Near a high pedestrian attractor (i.e. recreation areas, malls, stations, etc.)?

Semi-Exclusive

2 or more tracks?

Multiple concurrent types of train operations?

Crossing distance >80 ft?

Street Running

Is the crossing controlled by a traffic signal?

Treatments to Consider

- Detectable Warning Surface
- “Look” Sign (R15-8)
- “Stop” Pavement Marking
- Pathway Delineation (direct through crossing)
- Channelization (direct to crossing)
- Barriers (inhibit hurried crossing)
- Audible Device
- Flashing-Light Signals
- Blank-out Sign

This flow chart is a companion to the UDOT Pedestrian Grade Crossing Manual. It is intended as a tool to guide designers in the selection of appropriate control devices at pedestrian grade crossings. Final treatment selection should be determined through an engineering study.
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