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Trespass Prevention Research Study – West Palm Beach, FL

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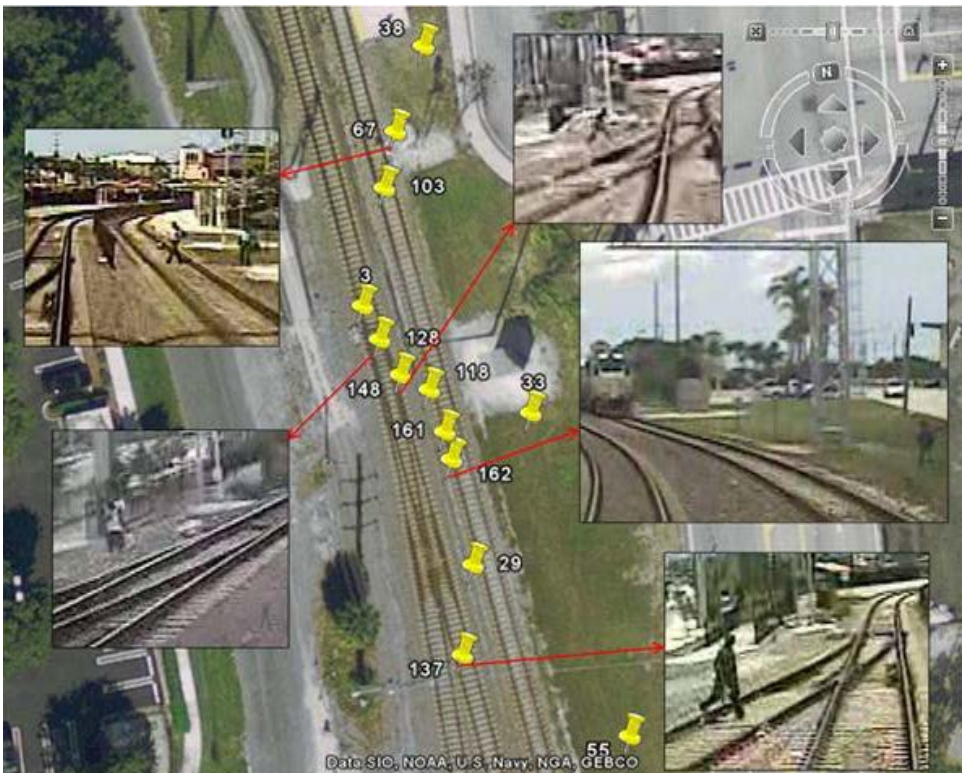

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13. ABSTRACT (Maximum 200 words)

The United States Department of Transportation's (U.S. DOT) Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center (Volpe Center), under the direction of the U.S. DOT Federal Railroad Administration's (FRA) Office of Research and Development (R&D), conducted a Trespass Prevention Research Study (TPRS) in the city of West Palm Beach, FL. The main objective of this research was to demonstrate potential benefits, including best practices and lessons learned, of implementation and evaluation of trespass prevention strategies following FRA's and Transport Canada's existing trespassing prevention guidance on the rail network in West Palm Beach, FL, and all of its rights-of-way.

This report documents the results of the implementation of the guidance discussed in this study. The results of the trespass prevention strategies will be analyzed to help determine areas of potential risk, develop solutions to prevent and minimize risk exposure, and implement successful countermeasures in the future. The ultimate objective of the research is to aid in the development of national recommendations or guidelines to reduce trespass-related incidents and fatalities.

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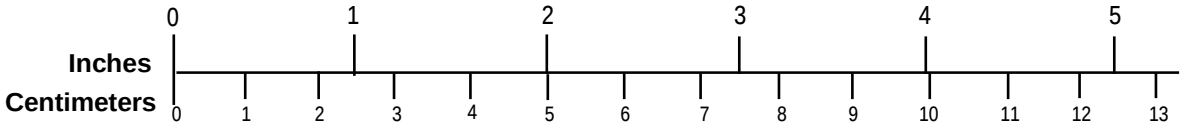

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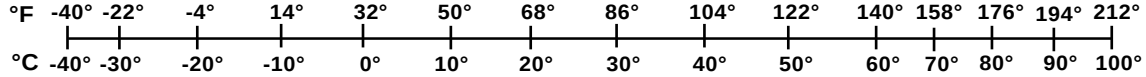

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The authors would also like to acknowledge Anya Carroll, Patrick Bien-Aime, Gabriel Lopez-Bernal, Bernard Kennedy, and Roxanne Tully, all of the Systems Safety and Engineering Division, U.S. DOT Research and Innovative Technology Administration's John A. Volpe National Transportation Systems (Volpe Center) for their support in data collection and analysis.

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Executive Summary

The U.S. DOT's Volpe Center conducted a demonstration project to implement a community-based trespass prevention approach referred to as the Community, Analysis, Response, and Evaluation (CARE) model along the South Florida Rail Corridor and Florida East Coast Railroad's rights-of-way (ROWs) in the City of West Palm Beach, FL, over a period from October 2009 to December 2013. The purpose of this demonstration was to show the potential benefits of, document the lessons learned from, and provide recommendations for implementation and evaluation of trespass prevention strategies following the CARE community-based approach developed by the Federal Railroad Administration (FRA) and Transport Canada [2][3].

The general CARE guidance provided in the model worked well to establish a framework for the stakeholders to organize, collect, and evaluate the data, develop solutions, and implement trespass mitigation strategies. It increased stakeholder collaboration, leveraged collective resources, and maximized overall effectiveness of the community-based effort to decrease trespass on railroad ROWs within the city.

The implementation and evaluation of the guidance during this demonstration project resulted in several lessons learned and recommendations for future implementations. These recommendations, listed per step in the CARE model, are summarized below.

Community

- Local champion(s) need to be identified early and given the authority to drive the community-based group from inception to execution of the trespass mitigation strategies. The leader(s) should work to ensure appropriate representation of their organizations in the stakeholder group.
- Stakeholder group should maximize use of existing local safety coalitions.
- Stakeholder group should be divided into an executive level committee consisting of decisionmakers and an operational level committee conducting the specific activities outlined in the model.
- Stakeholder engagement strategy should be developed at the beginning of the process.
- Champion(s) must develop awareness of stakeholders' sensitivities.

Analysis

- Stakeholder group should develop a data sharing plan.
- A data analysis subgroup should be created.
- Objective data collection and analysis, using the risk-based methodology validated in this study, should be performed.
- Stakeholder group should reach consensus on effectiveness measures before the Response step.

Response

- An implementation group composed of representatives from the core stakeholders should

be organized to execute the strategies. The group should be directed by executive committee members who have decisionmaking authority within their respective organizations.
- The implementation group should conduct field reviews to validate response recommendations.

Evaluation

- The local champion(s) should leverage executive-level committee members to execute the implementation plan.
- The stakeholder group should collect and analyze objective post-implementation trespass data.

The absence of a local champion and lack of decisionmaking authority by key stakeholders in the study were the biggest limiting factors to successful implementation of the CARE model in West Palm Beach, FL. Therefore, the most important recommendations center on the identification of a community-based (local) champion, or champions, who will drive the implementation of the model and encourage active involvement by senior-level participants from the key stakeholder group.

It should be noted that the FRA Office of Research and Development funded an independent evaluation of the CARE model process as implemented by the research team at the study location. This evaluation, carried out as recommended by the CARE guide, is scheduled to be completed in 2014 and will identify additional lessons learned that may be applied to future implementations of the CARE model.

For any future use of the CARE model, the research team suggests implementation and evaluation of the recommendations developed through the observations collected in this study, as well as those from the independent evaluation not reported herein.

1. Introduction

Trespassing on the rail network's right-of-way (ROW) is the leading cause of all rail-related deaths. In 2012 alone there were 841 trespass casualties of which 429, excluding known suicides, resulted in fatal injuries [1]. This data does not include trespass at highway-rail grade crossings.

Most trespassing casualties can be avoided. The U.S. Department of Transportation (U.S. DOT) Federal Railroad Administration (FRA), together with its safety partners, has been tackling this issue on several fronts, including conducting and sponsoring research in the area. FRA sponsors the Highway-Rail Grade Crossing Safety and Trespass Prevention Research Program at the U.S. DOT Research and Innovative Technology Administration John A. Volpe National Transportation Systems Center (Volpe Center). The goal of this research program is to explore new and enhanced means to improve safety (i.e., reduce incidents, injuries, and fatalities) along the railroad right-of-way. The implementation and evaluation of a community-based trespass prevention program from 2009–2013, which is summarized in this report, was one of the FRA-sponsored trespass prevention research projects conducted by the Volpe Center.

1.1 Background

The rail ROW often provides an easy, yet illegal, shortcut to many walking destinations. While notable progress has been made in the past 10 years to improve safety along rail ROWs, trespass-related fatalities have remained the biggest safety issue facing the rail network. Although trespass fatalities have declined by approximately 14.7 percent over the past decade, from 498 in 2003 to 429 in 2012 [1], much work still needs to be done.

Trespass mitigation is often classified by the three Es: Engineering, Enforcement, and Education. Rail and transit agencies, along with safety partners such as Operation Lifesaver (OLI), local communities, state rail authorities, FRA, and the Federal Transit Administration (FTA), continuously work across the 3 Es in an effort to minimize risk on the rail ROW.

FRA, in collaboration with Transport Canada, developed and published a guidance document entitled *Community Trespass Prevention Guide* [2], which details a collaborative step-by-step rail ROW trespass problem-solving approach for local communities. Transport Canada has also published its own document entitled *Trespassing on Railway Lines – A Community Problem-Solving Guide* [3], which provides a very similar community-based problem-solving approach to deal with trespassing issues. Both guides detail the Community, Analysis, Response, and Evaluation (CARE) problem-solving model.

1.1.1 FRA Office of Railroad Safety Trespass Initiatives

The FRA Office of R&D conducts research on all aspects of highway-rail grade crossing safety and trespass prevention. Notable progress has been made in the past 10 years to improve safety at highway-rail grade crossings. Collisions at grade crossings have declined by approximately 34 percent, and fatalities at grade crossings have also declined by approximately 30 percent over the past decade, between 2003 and 2012 [1]. However, although trespass-related fatalities have also seen a general decrease over this time, the rate has not been as good as the success

experienced at grade crossings. Trespass fatalities surpassed the number of fatalities at grade crossings in 1997 and have since become the biggest rail safety concern.

It should be noted that the term "trespasser" is defined in the FRA Guide for Preparing Accident/Incident Reports [4] as:

> ***Trespassers (Class E).*** *Persons who are on that part of railroad property used in railroad operation and whose presence is prohibited, forbidden, or unlawful. Employees who are trespassing on railroad property are to be reported as "Trespassers" (Class E).*
>
> *Note: A person on a highway-rail crossing should not be classified as a trespasser unless the crossing is protected by gates or other similar barriers that were closed when the person went on the crossing, or unless the person attempted to pass over, under, or between cars or locomotives of a consist occupying the crossing.* [4, Chapter 2, Page 6]

Taking this definition into account, pedestrian and cyclist casualties that result from violating grade crossing gates while they are closed are reported as grade crossing incidents although they are also deemed to be trespassing. The breakdown of trespass fatalities based on location (grade crossing and ROW) is important for this study since analysis of the West Palm Beach, FL, data indicates a significant grade crossing trespass problem. Specifically, trespass events involving pedestrians and cyclists violating pedestrian gates at crossings both before and after a train traverses the crossing have been noted as a significant problem in the study area and therefore included as part of this trespass study.

It should be noted that the trespass fatality data presented above excludes known suicides, as determined by a coroner or other public authority, because FRA currently excludes events that are known to be suicides from its trespass casualty data set.

FRA has been working on trespass mitigation strategies since its establishment in 1966. Spurred by the Secretary of Transportation's 1994 Rail-Highway Crossing Safety Action Plan [5], FRA has worked hard to reach out to law enforcement and judicial communities to highlight the grade crossing and trespass issues. FRA worked with Transport Canada to develop the CARE model; the collaboration resulted in the release of a guide entitled *Community Trespass Prevention Guide* in 2011 [2]. Additionally, FRA has worked closely with OLI through the years on education and outreach efforts related to grade crossing safety and trespass prevention. FRA has also funded research projects focused on technology, such as the video-based trespass deterrent system installed and evaluated in Pittsford, NY, from 2001 to 2004 [6]. More recently, FRA released a report that compiled a list of State laws and regulations affecting grade crossings and trespassing [7], a report on the development of demographic profiles of rail trespasser fatalities [8], and another on guidance on pedestrian crossing safety at or near passenger stations [9].

One of the latest initiatives was a collaborative effort in 2012 between FRA and FTA to run a workshop dealing with rail ROW trespass issues in St Louis, MO [10]. The workshop was designed to bring together major stakeholders affected by this issue and whose goal was to share best practices in dealing with it. The effort was deemed extremely successful by the participants as evidenced by their exceptionally positive feedback upon the conclusion of the workshop. It followed a similar workshop held in San Carlos, CA, in 2008 [11].

The Rail Safety Improvement Act (RSIA) of 2008 (PL 110-432) [12] was also enacted around this time period. Section 208 of the RSIA specifically addresses trespasser prevention and highway-rail grade crossing safety:

> *"In consultation with affected parties, the Secretary of Transportation shall evaluate and review current local, State, and Federal laws regarding trespassing on railroad property, vandalism affecting railroad safety, and violations of highway-rail grade crossing signs, signals, markings, or other warning devices and develop model prevention strategies and enforcement laws to be used for the consideration of State and local legislatures and governmental entities."* [8,H.R. 2095-28]

The Fiscal Year 2011 U.S. DOT's Top Management Challenges report highlights the RSIA requirement for FRA to develop a long-term strategy to "prevent railroad trespasser accidents, incidents, injuries, and fatalities" [13, p.24].

As a result of the 2008 workshop, the RSIA, and direction from the FRA Office of Railroad Safety, the FRA Office of R&D funded a study on trespass prevention strategies with the ultimate goal of developing and demonstrating trespass prevention and mitigation best practices that could form the basis for national guidelines on the topic. Specifically, the Volpe Center was tasked by the FRA Office of R&D to conduct a trespass prevention research study on a roughly 7-mile stretch of South Florida Regional Transportation Authority (SFRTA) ROW and 5-mile stretch of Florida East Coast Railway Company (FEC) ROW in the city of West Palm Beach, FL.

1.1.2 Transport Canada Trespass Initiatives

FRA has also worked closely with Transport Canada on the development of trespass prevention strategies. Under the Canadian Government's "Direction 2006" public-private partnership initiated in 1996, a community trespass prevention initiative was implemented with the goal of reducing trespassing and grade crossing incidents. This initiative created a community-based problem-solving guide to address the trespassing issue. This Canada national guidance document, entitled *Trespassing on Railway Lines – A Community Problem-Solving Guide*, details a collaborative step-by-step problem-solving approach for local communities [3]. The guide details the CARE problem-solving model, much like the FRA guidance document previously referenced. As noted in the guide, the goal of the CARE model is to create safer communities by fostering the development of long-term trespass prevention strategies through collaborative community problem-solving partnerships.

1.1.3 Industry and Community Initiatives

In addition to Federal initiatives, the railroad industry and its State and local partners have also developed and implemented many trespass prevention strategies throughout the years. Some examples are:

- Operation Lifesaver (http://oli.org/)
- Norfolk Southern's "Train Your Brain" safety campaign (http://www.brainysworld.com/)

- Union Pacific's CARES (Crossing Accident Reduction Education and Safety) program (http://www.uprr.com/she/safety/upcares/index.shtml)
- Long Island Railroad's TRACKS (Together Railroads and Communities Keeping Safe) program (http://web.mta.info/lirr/safety/)
- DuPage Railroad Safety Council (http://www.drsc.org/)

Most of these are public safety initiatives that address trespassing dangers in order to promote grade crossing and pedestrian safety. They generally aim to raise public awareness through outreach efforts that involve their local, county, and State law enforcement partners.

1.2 Objectives

The main objective of this research was to demonstrate the potential benefits, as well as best practices and lessons learned, of implementation and evaluation of trespass prevention strategies following a community-based approach developed by FRA and Transport Canada on the rail network in West Palm Beach, FL, and all of its ROWs.

Ultimately, this research aims to aid in the development and dissemination of national recommendations or guidelines for reducing trespass-related incidents and fatalities. Although used in Canada to deal with ROW trespass issues at the local level, the CARE procedures and benefits of this guide have yet to be fully evaluated in the United States. Through the validation of the process and implementation of the CARE model in West Palm Beach, a set of national recommendations or guidelines were developed as part of this project. These recommendations may be used in the future to develop model prevention strategies as called for in the RSIA of 2008 [12].

1.3 Overall Approach

The approach to this research project involves implementing and evaluating the community-based problem solving model in a local community where there is a large trespass problem. The Volpe Center research team used the CARE model developed by FRA and Transport Canada as a baseline strategy to initiate its 4-year research project, which started in July 2009. The methodology is centered on working with the SFRTA stakeholder partnership to demonstrate potential benefits, as well as best practices and lessons learned, of implementation and evaluation of trespass prevention strategies on the rail network in West Palm Beach, FL, and all of its ROWs.

The first step in this work was to conduct a literature review of studies and implemented programs on trespass prevention, including outreach to the developers of the CARE model. The intent of the literature review was to provide information about the use and effectiveness of these programs.

The next step in this research study was to identify a local community with a significant trespass problem and implement the CARE approach. Finally, recommendations for next steps and additional studies on the subject area were developed.

1.4 Organization of the Report

This report is organized as follows:

- Chapter 2 provides a summary of the CARE model and describes the selected test area of West Palm Beach, FL.
- Chapters 3 through 6 present the implementation of each step of the CARE model in the study area.
- Chapter 7 presents the conclusions of the study and recommendations for next steps.

2. CARE Model and Test Site Selection

2.1 CARE Model

This study used an existing initiative developed by FRA and Transport Canada to address the trespassing issue as a starting point. The resulting guidance document by both organizations details a collaborative step-by-step problem-solving approach—the CARE model—for local communities. The TPRS research team used the CARE guide as a baseline for developing a plan to mitigate the trespass issue in the city of West Palm Beach.

The CARE guidance is a collaborative problem-solving approach to addressing trespass on railroad lines in communities. This process, shown in Figure 1 [14], consists of four steps:

1. COMMUNITY: Identification of the trespassing problem within the community and the associated stakeholders
2. ANALYSIS: Data analysis of the trespassing problem and identification of the underpinning causes
3. RESPONSE: Identification and implementation of the most effective response(s)
4. EVALUATION: Evaluation of the effectiveness of the implemented treatment [2]

The model is detailed and guidance on its implementation is given in both the FRA and Transport Canada published documents [2] and [3] and is therefore not duplicated herein. Section 4 of this report presents details on the treatment implementation and lessons learned from its demonstration in the test area.

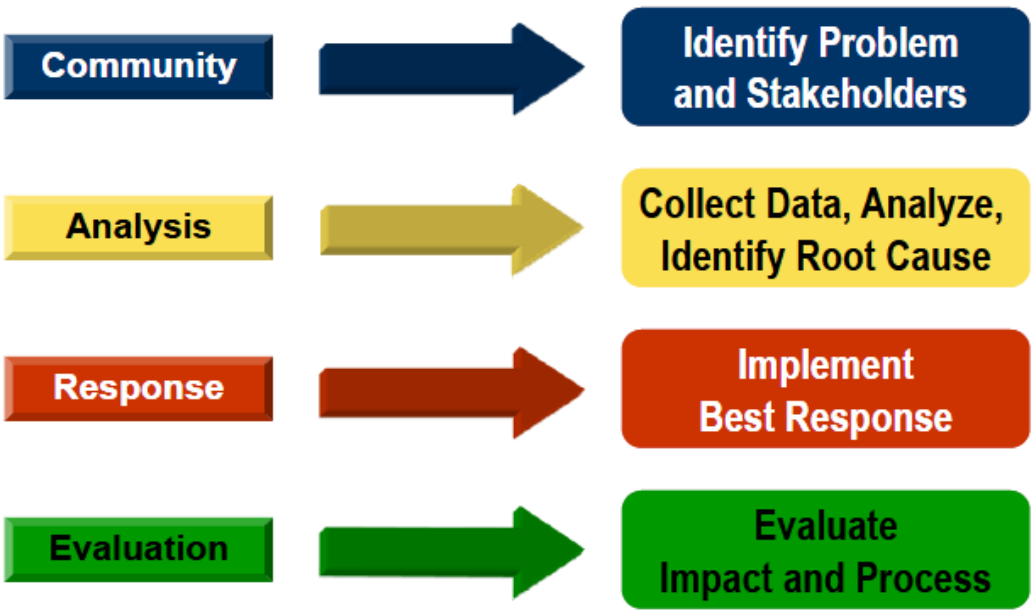

Figure 1. CARE Model

2.2 Test Area

The Volpe Center research team was tasked by the FRA Office of R&D in 2009 to conduct a study on trespass prevention strategies with the ultimate goal of developing and demonstrating trespass prevention and mitigation best practices that could form the basis for national guidelines.

2.2.1 Site Selection

Under direction from the FRA Office of Railroad Safety, the Volpe Center was tasked by the FRA Office of R&D to conduct the study on a roughly 7-mile stretch of the South Florida Rail Corridor (SFRC) ROW on which SFRTA operates and a 5-mile stretch of FEC ROW in the city of West Palm Beach, FL. SFRTA experienced a record number of casualties in 2008 with regard to trespass events in Palm Beach County, which envelops the City of West Palm Beach as well as 37 other municipalities and unincorporated areas. That year, SFRTA reported a total of five trespass casualties in West Palm Beach County.

A 1 ½ to 1 ¾ mile stretch of track near 45th Street and Okeechobee Boulevard within the city was the site of four fatalities in 2008. Following these events, SFRTA reached out to the community in West Palm Beach including the Mayor's Office and local residents and homeowners. A formalized group of West Palm Beach communities, Palm Beach County, Florida DOT (FDOT), and SFRTA was then assembled to raise local awareness. Adjustments, including added signage, education outreach, and increased enforcement patrols, were made along this stretch of corridor at that time (2008–2009).

FRA selected this study area based on the then recent (2008) fatal incidents on the SFRTA line, the fact that SFRTA had already created a stakeholder group by 2009 to address the issue (which is the first step in the CARE process), and its willingness to be part of the effort. FRA determined this location, the City of West Palm Beach, FL, to be the most appropriate for a research study on precursors, mitigation strategies, and support for the development of national guidance related to trespass prevention.

2.2.2 Site Characteristics

The SFRTA's Tri-Rail service, which is a commuter rail operation between Miami and West Palm Beach, was originally selected for this research study that began in July 2009. The SFRTA line is all double-tracked and equipped with four-quadrant and pedestrian gates at all crossings in the study area. The SFRTA Tri-Rail service currently operates 50 daily commuter rail trips through the study area, which is a Quiet Zone. Additionally, the ROW is owned by FDOT and operated by CSXT, which runs freight trains on the line. Amtrak also runs passenger service consisting of four daily trains over the same line.

The original scope of the TPRS was only in relation to trespass concerns along the SFRTA operations within the city of West Palm Beach. Upon review of incident data and site visits, the scope was later expanded to encompass all rail lines in the city and to include the FEC, which owns and operates a separate line on ROW to the East of the SFRTA line within West Palm Beach. FEC uses its line, composed of both single-track and double-track segments throughout the study area, for freight operations. As later discussed, the Volpe Center research team

discovered that FEC also had a major problem with trespassing on its ROW within the study area.

Figure 2 shows a map of the two rail lines within the study area. The boundaries of the study area are defined by milepost locations on both lines, with the SFRC study area bounded by mileposts 966-973 and FEC by mileposts 296-301. The SFRC study area is specifically bounded by 45th Street on the north end and Summit Boulevard on the south end.

Figure 2. Trespass Prevention Research Study Area in West Palm Beach, FL

2.3 Model Implementation

The research team reached out to SFRTA in September 2009 to initiate this demonstration project. A formal kickoff meeting was held in October 2009 at the West Palm Beach City Hall with the existing stakeholders formed before the initiation of this research study. That meeting was used to introduce the study team to the group, provide an overview of the CARE model, and formally kick off the demonstration project. This group was then assembled on a quarterly basis to report on activities, discuss progress, and develop and assign action items pertinent to its trespass mitigation mission. All activities detailed below per step in the CARE model, as shown in Table 1, were coordinated and executed by the stakeholder group and facilitated by the Volpe Center and FRA research staff.

It should be noted that stakeholders within this group, such as the SFRTA and FL Operation Lifesaver, were already carrying out their own internal safety initiatives and continued their safety programs throughout the duration of the study period. The efforts made by this study through implementation of the CARE model added an additional layer of safety improvement through increasing stakeholder collaboration, leveraging collective resources, and thereby aiming to maximize overall effectiveness.

Table 1. CARE Model Steps

Community	Analysis	Response	Evaluation
Identify and describe the trespass problem. Identify community resources and begin to involve them in the safety project. Organize a problem-solving committee with community stakeholders and develop an action plan.	Develop data collection and analysis plan. Collect trespass data. Analyze the data collected to determine the underlying causes of the trespass problem. Establish baseline and identify measures to be used to determine program's effectiveness.	Identify and implement feasible countermeasures. - Develop counter measures (CM) for implementation plan. - Implement CM, such as education, enforcement, engineering, and other strategies developed by the committee.	Assess impact of the response and determine whether the trespass problem was displaced, reduced, unchanged, or eliminated. Evaluate the process used and assess whether the key stakeholders were identified and included, the underlying causes correctly identified, the response implemented as planned, and reason(s) why part of the plan may not have been implemented. Develop and implement a long-term program monitoring plan if deemed necessary.

3. Community

The first step in the CARE process, as previously shown in Table 1, is to identify the trespass problem and reach out to all potential stakeholders. Stakeholder organizations range from State and local public safety departments, rail operators, schools, local businesses, community groups, media organizations, and others who may be locally impacted by this safety issue.

3.1 Trespass Problem

The first action item under the COMMUNITY step is to identify and describe the trespass problem. As previously noted, the local operating railroads and FRA had already identified the general trespass problem in the city of West Palm Beach before the initiation of the research study.

3.2 Stakeholder Identification

The second action item is to identify the community resources and begin trying to get those potential stakeholders involved in the safety project. Prior to the TPRS, SFRTA reached out to the State and local community in the city of West Palm Beach. These included the FDOT, Florida Operation Lifesaver, Palm Beach County and West Palm Beach authorities, and local organizations. This formalized group focused on raising local awareness and started the dialogue necessary for development of a community strategy to mitigate the trespass problem in the area. The group also started implementing some countermeasures such as creating and distributing flyers at targeted grade crossings, performing education outreach at local schools, and adding additional signage before the start of the TPRS.

One of the initial goals of the TPRS research activity was to re-energize and build upon this already established group. The first objective of the Volpe Center research team was to convene the original stakeholder group originally organized by SFRTA, discuss the research project, and build up momentum for the effort. This occurred during the first formal meeting in October 2009 held at the West Palm Beach City Hall. Following the initial "kickoff" meeting, the research team worked with FRA to develop a formal press release (Appendix A) announcing the study. The research team also identified and invited additional stakeholders such as the City of West Palm Beach Planning Department to be part of the group. The group formed for this study, formerly known as the Stakeholder Users Group (SUG), was comprised of representatives from the following entities:

- U.S. DOT
    - FRA
        - Office of Railroad Safety
        - Office of Research and Development
    - Volpe Center
- SFRTA
    - Safety and Security
    - Veolia (contract operator)
    - Wackenhut (contract security)
- FEC
- Amtrak

- CSXT
- FDOT
- City of West Palm Beach
    - Mayor's Office
    - Police Department
    - Engineering Services Department
    - Planning and Zoning Department
    - Neighborhood Associations
- Palm Beach County
    - Sheriff's Office
    - School District
- FL Operation Lifesaver
- Transport Canada

Where possible, multiple representatives from each stakeholder entity formed the SUG, with one person being the primary representative and any additional people being their alternates. Additionally, the research team included a representative from Transport Canada to serve as an advisor to the study based on his expertise and involvement with the development of the CARE model.

Figure 3 shows a picture from a SUG meeting held on November 5, 2012. Table 2 shows the full list of stakeholder representatives as of the last SUG meeting held on March 21, 2013.

Figure 3. Stakeholder User Group Meeting

Table 2. Stakeholder User Group Members

No.	Organization	Name	Comments
1	AMTRAK	Paul Manger	Primary
2	AMTRAK Police Department	Hugh Krasin	Primary
3	CSXT	Michael Hren	Primary
4	CSXT	Peggy Smith	Primary
5	CSXT	Gary West	Alternate
6	CSXT Police Department	Kevin Brown	Primary
7	CSXT Police Department	Ryan Gustin	Alternate
8	FDOT	Brian Reeves	Primary
9	FDOT	Tom Keane	Alternate
10	FDOT/Florida Operation Lifesaver	Annette Lapkowski	Primary
11	FEC	R.B. (Bob) Stevens	Primary
12	FEC	Robert Ledoux	Primary
13	FEC	Charles Stone	Alternate
14	FEC	Glenn Kistler	Alternate
15	FEC	Francis (Fran) Chinnici	Alternate
16	FRA - R&D	Tarek Omar	Primary
17	FRA - RR Safety	Michail Grizkewitsch	Primary
18	FRA - RR Safety	Ron Ries	Primary
19	FRA - RR Safety	Dan Knote	Alternate
20	FRA - RR Safety	Frank Frey	Alternate
21	Palm Beach County Sheriff's Office	CPL. James Moss	Primary
22	SFRTA	Allen Yoder	Primary
23	SFRTA	Michael Jones	Alternate
24	SFRTA	Bonnie Arnold	Alternate
25	Transport Canada	Daniel Lafontaine	Advisor
26	Veolia	Ronnie Russell	Primary
27	Veolia	Ralph Rappa	Alternate
28	Volpe Center	Tashi Ngamdung	Support
29	Volpe Center	Len Allen	Primary
30	Volpe Center	Marco daSilva	Primary
31	Wackenhut	Tim Cates	Alternate
32	Wackenhut	Richard D. Cannon Jr.	Primary
33	WPB Engineering Services Department	Brian Collins	Primary
34	WPB Mayor’s Office	Jeri Muoio (Mayor)	Primary
35	WPB Neighborhood Association	Rick Rose	Primary
36	WPB Planning and Zoning Department	Alex Hansen, AICP	Primary
37	WPB Police Department	Joe Myers	Primary
38	WPB Police Department	Vincent L. Demasi (Chief)	Primary
39	WPB School District Police Department	Bob Leh (retired)	Primary

3.3 Committees and Subcommittees

The CARE process provides a framework of committees and subcommittees to tackle different aspects of the work. The overall committee, composed of all the stakeholders listed above, held its first meeting in October 2009. That meeting focused on introduction of the Volpe Center research team, as well as the FRA team, and overview of the purpose and objectives of the research study. This kickoff meeting also served as a venue for introductions of the stakeholders and discussion of activities the original stakeholder group had undertaken up to that time. This team subsequently met quarterly either in person in the City of West Palm Beach, or through Web-based means. Additionally, the SUG participated in several field reviews that included visits to trespass areas and Tri-Rail ride-alongs.

The research team also established the three following subcommittees, following the CARE model, to facilitate data collection activities as well as conduct more focused discussions.

- Railroad Safety and Operations subcommittee
    - SFRTA
    - CSXT
    - FEC
    - Amtrak
    - FDOT
- Railroad and Local Police subcommittee
    - CSXT Police
    - Amtrak Police
    - West Palm Beach Police
    - Palm Beach County Sheriff's Office
    - Palm Beach County School District Police
- Local Organizations subcommittee
    - Mayor's Office
    - City Departments
    - Neighborhood Associations
    - Florida Operation Lifesaver

The research team facilitated discussions with each subcommittee on various topics related to their focus of expertise. The team also aided in the development of recommendations particular to each topic that later fed into the overall recommended mitigation strategies.

The SUG formally met on 11 occasions throughout the study period, starting with the kickoff meeting in October 2009 and ending with the final meeting in March 2013. The research team also held various meetings with specific stakeholders outside of the SUG throughout the study period.

3.4 Lessons Learned

This first step in the CARE process, involving assembling and collaborating with a stakeholder group, is of great importance to the effective execution of any trespass mitigation strategy since most of the solutions will depend on the active involvement of many of the stakeholders. The activities involved with this step are not only conducted at the beginning of the overall effort but continued throughout the model's execution. A benefit realized from this activity, aside from the

ones discussed below, was establishing communication lines between stakeholders. One such example is the now well-established connection between the city's Planning Department and railroads' safety departments. These collaborations have led to safety-related benefits to the community outside the scope of this study.

There were several key things that worked well with the execution of this first step in the CARE model and some things that did not work so well, some attributable to the model itself and others to the way in which it was implemented in this specific study area.

Things that worked well

The formal adoption of a SUG, scheduling of frequent meetings and site visits, and the model's collaborative nature led to several benefits including:

- Stakeholder buy-in: Getting early buy-in and ownership of the problem by the stakeholders, including getting the local community (not just the railroad stakeholders) to recognize problem. This is perhaps the main key to successful implementation of the overall model. The development and dissemination of an FRA press release lent credibility to the approach and increased stakeholder buy-in early in the process.
- Consensus building: Building consensus among the stakeholders by actively engaging all players throughout the process.
- Perspectives: Obtaining a view of the trespass problem and potential mitigation strategies from different perspectives.
- Stakeholder Representation: Identification and inclusion of additional stakeholders, especially the city's Planning Department, who were not originally involved. Not only did they contribute to the problem identification and mitigation processes by representing resident' mobility concerns to engineers primarily concerned with safety, but also became more aware of rail safety implications of planning activities both long-range (traffic mitigation and zoning) and short-term (school remodels and other planning activities).
- Raising local awareness: Reaching out to local officials, city departments, and community organizations helped to raise awareness of the trespass problem. Lines of communication were opened in the community, so the operating railroads did not feel alone in addressing the trespass problem.

Things that didn't work so well

One of the disadvantages the research team, as well as the FRA representatives, had from the beginning was that they were not local to the study area. Although the overall effort had positive benefits, a local champion for the group did not emerge. The study team had hoped to be the catalytic agent to kick-start the safety program and be the facilitator throughout the process. However, because of the absence of a local champion, the study team ultimately became the driving force for the entire project; this was not ideal. Another disadvantage that became clear to the research team during the project was that a group had already been formed prior to the study. Although this seemed to be a great benefit at first, the research team did not have an opportunity to structure the group and select the appropriate representatives since much of that had already

been done. The major barriers that emerged during the execution of the COMMUNITY step in the CARE model were:

- Stakeholder engagement: Difficulty engaging some stakeholders. Several types of representatives were present in the SUG – ranging from those that "make," "help," "let," and "watch." The representative composition ranged across those categories. Additionally, non-rail stakeholder interest waned after the start of the study primarily due to the decrease in fatalities in 2010.
- Stakeholder group size: Large stakeholder group led to sometimes difficult consensus building, even on problem definition.
- Stakeholder representation: Stakeholder group participants were selected by their organizations, which led to a wide range of participation level (i.e., executive as representative from one railroad in the same group as a signal maintainer a representative from another).
- Representative continuity: Because of the long-term nature of this effort, there was a significant representative turnover. Several participants retired or otherwise moved on to other endeavors during the course of the implementation of the CARE model in the study area. This turnover often led to a downward delegation, if any at all, from the affected stakeholder organization.

Recommendations

The implementation of this step in the West Palm Beach study area revealed some issues that were discussed above. Recommendations to address these, which all revolve around stakeholder group representation matters, are:

- Local champion(s) need to be identified early and given the authority to drive the community-based group from inception to execution of the trespass mitigation strategies. The selected leader should work to ensure appropriate representation is present in the stakeholder group.
- Stakeholder group should maximize use of existing local coalitions already addressing community safety issues.
- Implementation of a two-level stakeholder group scheme composed of an executive level group of decisionmakers to function as a steering committee and an operational level group to conduct the specific activities outlined in the model. The operations-level stakeholders would participate in the day-to-day activities involving problem identification, data collection, and development of strategies, and the executive-level stakeholders would be engaged at a higher level and drive the implementation of recommended strategies.
- Stakeholder engagement strategy should be developed at the beginning of the process. The champion needs to find effective ways to educate decisionmakers within each participating stakeholder entity in order to foster better participation and more informed decisions. The champion also needs to focus on rallying support from all stakeholders by

clearly explaining how he and his organization fit into the problem-solving project and how its success will be beneficial.

- The champion must develop awareness of stakeholder sensitivities that may influence their level of transparency and active participation with the group. Discussion of certain issues, such as overall problem definition and availability of resources, should be kept to the executive committee, and discussion of specific mitigations strategies (such as what type of enforcement strategies should be considered) should be kept to the appropriate subgroups.

4. Analysis

The second step in the research process is to collect and analyze the data and try to determine the underpinning causes of the trespass problem. Since trespass casualties are relatively rare (SFRTA experienced four fatal casualties in 2008 along the study area), surrogate measures of safety for incidents other than trespass casualties need to be considered for analysis. Examples of surrogate measures include violation data reported by local law enforcement, locomotive crew observations, and video recording of specific locations. Analysis of all of these types of data will contribute to the development of a baseline risk assessment of the corridor as well as each individual trespass trouble spot within the study area. Specific to the TPRS, the research team worked with the stakeholder group to identify the following sources of trespass data:

- FRA incident data
- Local law enforcement violation data
- Operating railroad trespass data
    - Incidents
    - Train crew observations
    - Locomotive video
- Field observations by research team
- Targeted data collection

This section describes the data that was received and analyzed, as well as the data analysis process used to identify and prioritize trespass locations. It should be noted that the research team was not able to obtain all the pertinent data identified through discussions with the project stakeholders. Although the research staff requested and received some law enforcement and locomotive crew observation data, the bulk of the analysis to date has focused on locomotive video data supplied by SFRTA.

4.1 FRA Incident Data

The Volpe Center research team queried the 1997–2009 FRA Railroad Causality database for trespass incidents within the study area [1]. However, the FRA incident data related to trespass, although very important, did not provide enough information on trespass incidents to yield any accurate determination about trespass locations. As of 2009, this data was only reported at the county level. Over the 13-year period from 1997–2009, a total of 136 trespass incidents were reported in the county. Those incidents resulted in a total of 74 trespass fatalities and 63 injuries.

Figure 4 shows the yearly breakdown of the FRA-reported trespass incidents per operating railroad within the county over the 5-year period preceding the start of the study, from 2004 to 2008 [1]. As shown, SFRTA experienced a record number of casualties in 2008 with regard to trespass events in Palm Beach County. It should be noted that it was operated as the Tri-County Commuter Rail Authority (TCCX) before 2008. A 1 ½ to 1 ¾ mile stretch of ROW from 45th Street and Okeechobee Boulevard in the city of West Palm Beach, FL, was the focus of four of the five fatalities in the county in 2008.

As shown in Figure 4, FEC also has a major problem with trespassing on its ROW within the study area. In fact, there were more trespass casualties reported by FEC than by all other operations combined, except in 2008 when SFRTA experienced the most. Upon review of this

incident data and site visits by the research team, the original scope was expanded by FRA in early 2010 to encompass all rail lines in the city of West Palm Beach area, including the FEC.

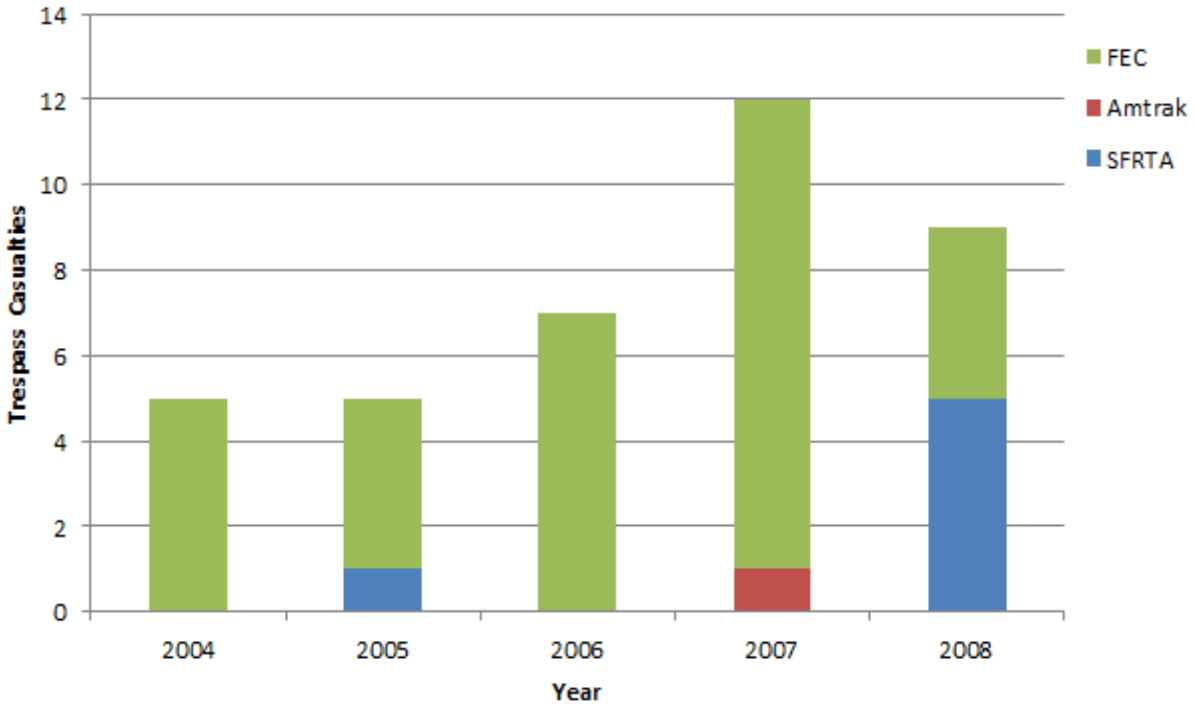

Figure 4. Trespass Casualties in Palm Beach County, 2004–2008

4.2 Law Enforcement Incident Data

Trespass incident data was requested from the law enforcement stakeholders who formed the Railroad and Local Police Subcommittee. Upon discussion with the subcommittee in February 2009, the Volpe/FRA team drafted a formal letter of request that was mailed to each entity (Appendix B). The letter, originally sent on June 18, 2010, formally requested all pertinent information such as detailed incident reports, trespass databases, suicide incidents, current laws, regulations and agreements, etc. regarding trespass prevention within the local area of the City of West Palm Beach.

Amtrak police provided data on trespass events. The research team was unable to obtain data from the West Palm Beach Police, CSXT Police, FEC Police, and the Palm Beach County School District Police. No formal request for data was submitted to the Palm Beach County Sheriff's Office.

Amtrak Police Data

Amtrak provided trespass event data as reported in its Computer Aided Dispatch (CAD) system. The information reported by Amtrak contains a total of four entries from 2007 and on. Of those, two entries refer to trespassers on the ROW, one entry is for the fatality that occurred in 2007 and is shown in Figure 4, and one entry is for delay to the Amtrak train due to a trespass fatality by a SFRTA Tri-Rail commuter train.

4.3 Operating Railroad Trespass Data

The research team also requested all pertinent trespass incident data from the operating railroads. As of December 2013, only SFRTA has provided the research team with several types of data, as detailed below. The research team did not receive any data from CSXT, FEC, or any additional Amtrak data aside from the set detailed above.

SFRTA Incident Data

SFRTA provided the research team with two different sets of data. The first set contains a log of trespass events from February 2004 to February 2010. The data set contained a total of 23 entries detailing trespass events within the study area. A total of six events involved a trespass fatality, two of which were categorized as suicides. The other 17 entries contain reports of trespass activity reported by the Tri-Rail locomotive engineers. Two of those involved apparent unsuccessful suicide attempts. The West Palm Beach Police responded and detained both trespassers in those events.

SFRTA Train Crew Observations

The second data set is from Veolia Transportation, which is the contract operator for SFRTA's Tri-Rail service. Upon initial discussions with SFRTA, the research team was able to obtain Veolia's cooperation in documenting trespassing on or along the railroad tracks along the study area between 45th Street and Summit Boulevard. Veolia Transportation's temporary order to train crews directing the train crews to document trespassers that were observed along the railroad ROW, or crossing over the tracks at a location other than a designated crosswalk, was in effect for approximately 2 weeks in April 2010 (April 7, 2010, to April 19, 2010). This effort resulted in the reporting of 73 trespassers over a total of 514 trips through the study area. Although most trespass events consisted of reports of a single trespasser, multiple trespassers were noted in 15 of the reported events.

SFRTA Locomotive Video Data

SFRTA provided the Volpe Center research team with locomotive video data from a sample of their trips through the study area in the city of West Palm Beach. The study area consists of approximately 7 route miles along the ROW, which the trains take an average of 15 minutes to traverse. Unlike fixed data collection systems that monitor a specific location regardless of train presence, the locomotive-based approach provides a risk-based picture of the trespass problem based on exposure to train presence on the ROW. The data set contained video data from 613 trips dating from March 5, 2010, to July 5, 2010. This 4-month data set represents roughly 10 percent of all SFRTA trips through the city of West Palm Beach during that period. The main objective of this video analysis was to determine which locations along the study area were more prone to trespassing and then provide trespass rate data for existing conditions. This data could then be used to evaluate the effectiveness of implemented treatments. It should be noted that there were several limitations with the video analyzed in this study, some of which may have a significant impact on the use of this data. The most significant issue was that the video data was grainy at times and potential trespassers may not have been detected by visual analysis of the video. Nevertheless, the data from the video analysis offered a very detailed and comprehensive picture of the trespass issue.

A trespass event was defined as an event involving a person or cyclist on the railroad ROW identified through analysis of the video data. Trespass events were further classified into two subtypes: at grade crossings and on the ROW. Trespassing at a grade crossing was defined as occupying the crossing while the grade crossing gates were in the down position, which follows the same definition of a trespasser at a gated crossing as defined by FRA [5]. As already mentioned, the SFRTA line in the study area is double-tracked and all crossings are equipped with four-quadrant and pedestrian gates. Figure 5 shows an example of this type of trespassing event involving, in this case, a pedestrian and a cyclist violating the down gates at the Banyan Boulevard crossing after the train has passed (this view is from the rear cab-car). The other trespass type, trespassing on the ROW, was used to capture all non-grade crossing trespassing. Figure 6 shows an example of this type of event involving two trespassers on the ROW.

A total of 176 trespass events involving 230 trespassers were identified through the review of the set of 613 trips. This averaged out to 0.3 trespass events per trip, or one trespass event every 3.5 trips. The overall probability of a trespass event during any given trip was almost 29 percent. A total of 60 of the 176 events involved trespassing at a crossing either before or after a train while the gates were in the down position. The remaining 116 events involved trespassers along the ROW at non-crossing locations. Figure 7 shows the distribution of each type of trespass event.

Figure 5. Grade Crossing Trespass Event

Figure 6. ROW Trespass Event

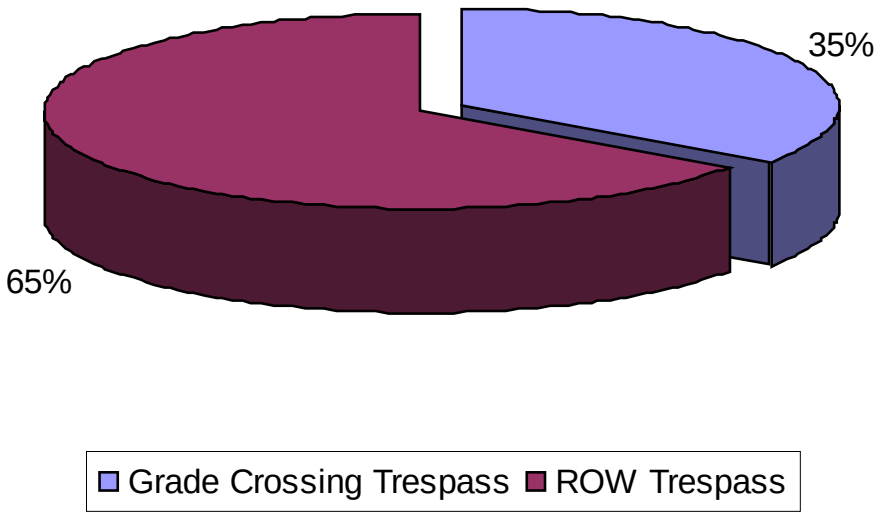

Figure 7. Trespass Event Location, SFRTA Locomotive Video Data

As shown in Table 3, most of the grade crossing trespass events involved pedestrians or cyclists violating the gates after the train. As already mentioned, the SFRTA line is double-track throughout the study area. A significant risk of a second train approaching from the opposite

direction while the gates are still down exists. In fact, 7 percent of the grade crossing incidents were classified as second train events, where the trespasser violated the crossing gates after one train had passed and while a second train was approaching. About 12 percent of the 60 grade crossing trespass events identified in the locomotive video data occurred before the train (during its approach to the crossing). The last type of event, identified as "Neither," involved trespassers not crossing the tracks but rather waiting past the downed gates for the train to clear the crossing.

Table 3. Grade Crossing Trespass Event Types

Type	Count	Frequency
After Train	46	77%
Before Train	7	12%
Second Train	4	7%
Neither	3	5%
Total	60	100%

Figure 8 shows the breakdown of trespass events by time of day. Overall, approximately 70 percent of the trespass events occurred after 12 p.m. The data also reveals that the highest number of trespass events on the SFRTA line within the study area occurred during the 3 p.m. to 6 p.m. time period, regardless of event type. It should also be noted that of the 50 daily weekday trips by the SFRTA line, a total of 22 trips pass through the study area in the morning hours and 28 in the afternoon and evening hours.

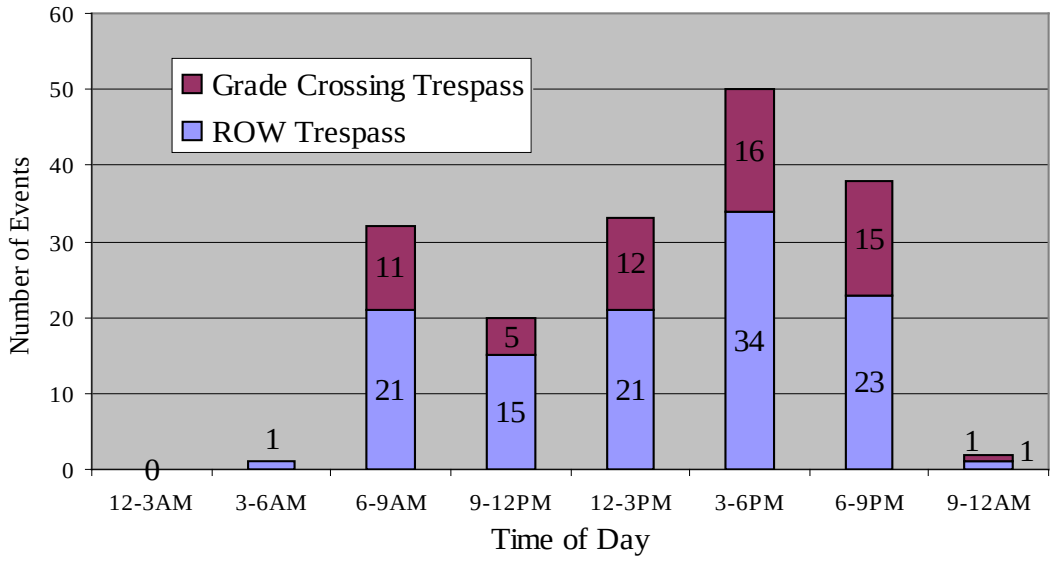

Figure 8. Trespass Events by Time of Day

The SFRTA locomotive video data analysis was primarily performed to help identify and quantify the trespass problem. The trespass data was plotted onto the Google Earth geobrowser

to visually depict trespass events along the SFRTA study area. The visualization of this data allowed for better interpretation and analysis of trespass patterns.

Figure 9 shows the locations of all 176 trespass events. The numbers on the graphic identify each event as listed in the database created by the Volpe Center research team. Although it is clear that the trespass problem is present almost everywhere along the line, it is difficult to determine specific trouble spots at this level of detail. Figure 10 displays the zoomed-in area identified by the red circle in Figure 9, which covers the south approach to the West Palm Beach station. A total of 13 of the 116 ROW trespass events were recorded at that location alone. Additionally, 12 of the 13 events at this location involved a trespasser crossing over the track, which amounts to almost 40 percent of the 31 ROW events involving trespassers crossing the tracks at non-grade crossing locations in the study area.

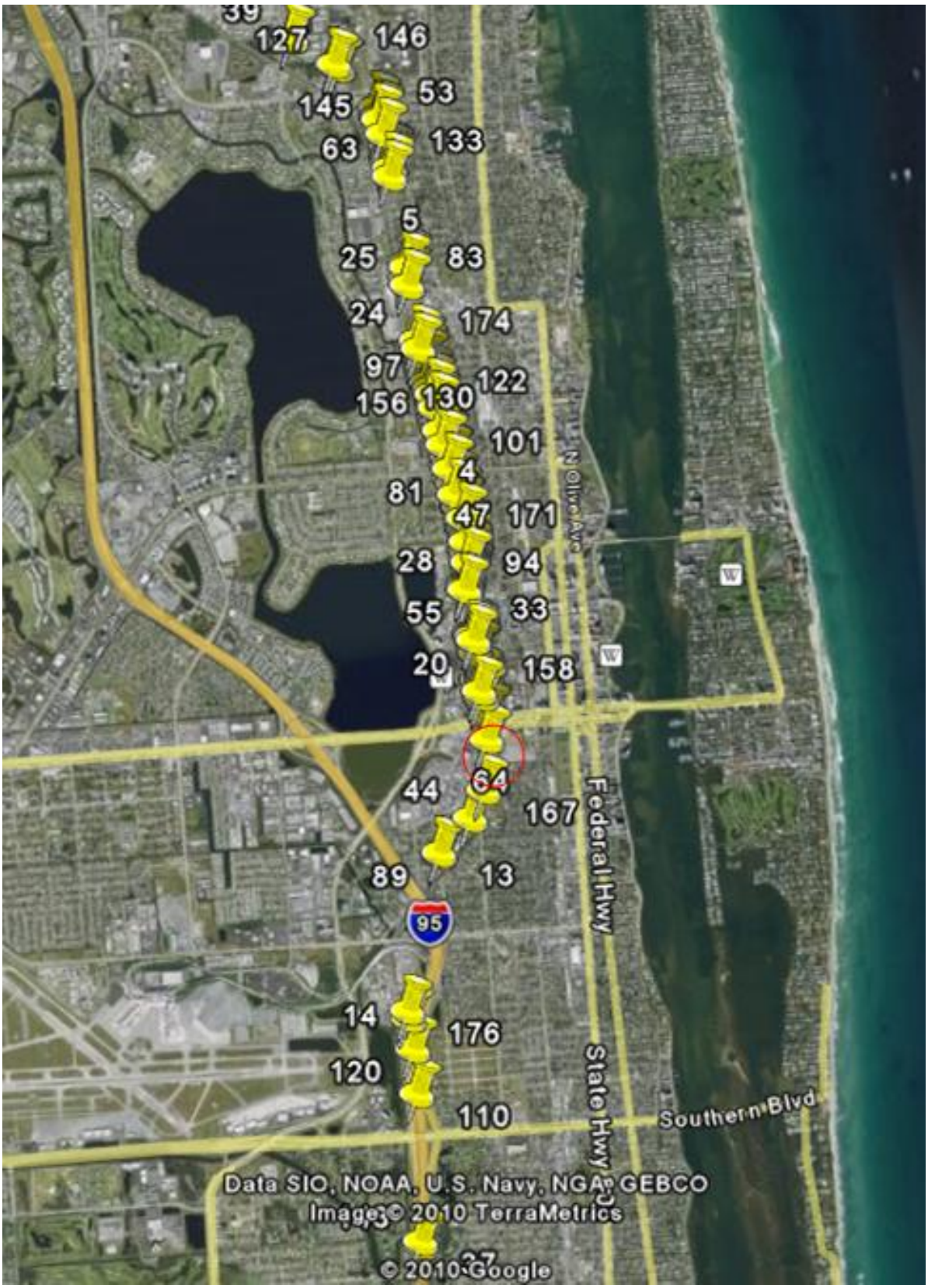

Figure 9. Location of Locomotive Video Trespass Events on SFRTA Line

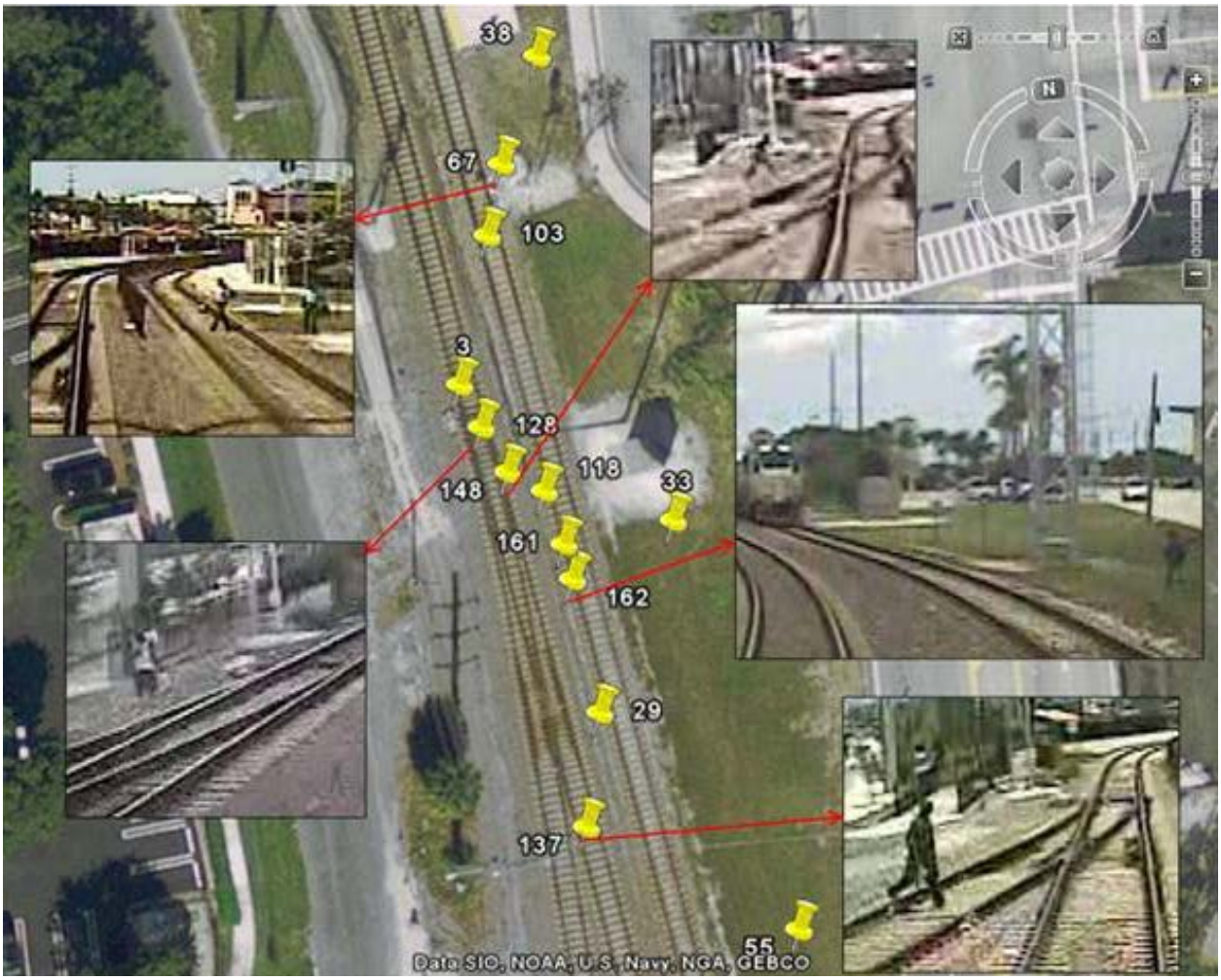

Figure 10. Trespass Event Locations and Snapshots on South Approach to West Palm Beach Station

4.4 Field Observations

The research team performed several site visits along both the SFRTA and FEC ROWs throughout the study's duration to identify and collect data on trespass activities. Members of the SUG often accompanied the study team to observe the trespass conditions. These field observations served as a starting point for discussion among the SUG of the overall problem and underlying causes. Subsequent trespass observations collected throughout the study period were validated by the results of the locomotive video data previously discussed.

SFRTA

During the first visit to the study area in October 2009, the research team was provided with an opportunity to ride in the locomotive during an SFRTA Tri-Rail trip through the study area. The research team noted two separate trespass events during that single trip. Figure 11 shows a trespass event involving a female trespasser crossing the tracks ahead of the oncoming train on the ROW between Palm Beach Lakes Boulevard and 7th Street.

Figure 11. Trespasser Crossing Tracks on North Approach to 7th Street Crossing (SFRTA)

During the same visit, the research team was also invited to observe a rail safety blitz focusing on education by SFRTA, FL Operation Lifesaver, and CSX and enforcement by the West Palm Beach and CSX Police Departments in the study area near the West Palm Beach station. The study team observed multiple trespass events during the blitz and intervention by the education partners to provide information to the violators. Figure 12 shows an example of one of these interactions between the CSX Police and a trespasser.

Figure 12. Safety Blitz Trespass Intervention (October 15, 2010)

FEC

The research team performed multiple site visits to known trouble spots all along the ROW within the study area and catalogued a total of 32 locations where there was evidence of trespass (observed trespassing, worn paths, and breaks in fencing). The research team observed many instances towards the northern part of the study area involving children with backpacks trespassing across the FEC tracks. Figure 13 shows an example of such an event observed by the research team during a site visit in April 2010. During that same visit at that same location, the research team observed 15 trespassers in less than 30 minutes. Most of the trespassers were children or teenagers crossing the tracks. Following these field observations, the research team engaged in discussions with the Palm Beach County School District to ascertain the underlying cause of this issue. The team concluded that this particular location and the predominance of children and teenage trespassers may have had to do with the catchment area of the local schools (the geographic area from which students are eligible to attend a local school) and substantial distance between grade crossings in that area.

Figure 13. FEC ROW Trespass Event Example

The research team performed a more comprehensive review of the FEC ROW in September 2010 to collect site-specific data on each known trespass area. A data collection form was developed for the site survey. The form, an example of which is shown in Figure 14, was used to capture site-specific data such as location, crossing type information, if at a crossing location, nearby signage, characteristics of the surrounding environment, and any other pertinent information the research team identified during the site visit. Pictures of each location were also taken and attached to the form. Figure 15 shows the location from the 43rd Street dead end. Note the worn path leading up to the ROW to the right of the picture. A close-up of the NO TRESPASSING sign is shown in Figure 16. The research team also captured a trespass event involving an adult male crossing the ROW at that location, which is noted at the bottom of the

site form in Figure 14 and shown in Figure 17. As already noted, the research team catalogued a total of 32 trespass locations in this manner along the FEC ROW in the study area.

SITE VISIT

Volpe Center Representative: Tashi Ngamdung

Site Visit Information

1) Site Visit date and time	9/8/2010
2) Is the trespass location at crossing or at right of way?	Crossing ☐ Right of Way ☒
3) Location	43rd Street on FEC
4) Mile Post (if available)	Between 296 and 297
13) GPS coordinates (if available)	26°45'5.83"N 80°3'37.27"W
5) Crossing ID	
6) Warning Devices	Choose One
7) Is it a closed Crossing?	YES ☐ NO ☒
8) Is the closed crossing barricaded?	YES ☐ NO ☒
9) Describe the Barriers	
10) Type of Development	Residential ☒ Commercial ☒ Industrial ☐ Rural ☐
11)Surrounding Environment	Institution ☒ Essential Service ☐ Local Business ☐ Public Facilities ☐ Post Office and/or City Hall ☐ Attractions ☐ Other ☒ Church
12) Number of Track	2
14) Is there Station nearby?	YES ☐ NO ☒
15) Is there no trespassing sign?	YES ☒ NO ☐
16) Picture ID	244 - 252
17) Comments	The worn out trespassing route connect the 43rd street that is separated by the tracks. One side of the track looks like dead end street and the other side is open area. The dead end side is barricaded with guard rails however the rails are torn down. During our site visit, we saw a man in his late 40 with his fishing rod cross the track.

Figure 14. FEC ROW Site Visit Data Collection Form

Figure 15. 43rd Street Dead End Abutting FEC ROW

Figure 16. Signage on FEC ROW at 43rd Street Location

Figure 17. Trespass Event Captured on FEC ROW at 43rd Street Location

4.5 Data Analysis

Once the data was collected, the SUG had to determine how to analyze the information in order to identify the areas of greatest trespass risk along the corridor. This analysis was only performed for the SFRTA corridor, not the FEC ROW, which did not have enough available data on the corridor.

The research team used a hazard analysis process based on the U.S. Department of Defense document, "System Safety Program Plan Requirements" (MIL-STD-882) [15], and the hazard identification/resolution processes described in the American Public Transportation Association's publication, "Manual for the Development of System Safety Program Plans for Commuter Railroads" [16]. As shown in the FRA document, "Collision Hazard Analysis Guide: Commuter and Intercity Passenger Rail Service" [17], FRA requests that passenger rail operators conduct this type of analysis to identify and address hazards in their systems. The process outlined in these documents facilitates the systematic identification, analysis, and resolution/mitigation of hazards. Additionally, it recognizes and includes any existing strategies, such as safety blitzes, currently in place.

The research team adapted and applied this methodology to the trespass problem for this study. The research team also developed a risk-based prioritization algorithm with which to analyze the trespass issue on the corridor using severity definitions already in use by the SFRTA. The hazard analysis and risk-based prioritization algorithm were used to identify several trespass

high-risk areas along the Tri-Rail corridor. The results of the analysis, which are contained in Appendix C and further discussed in a technical paper published in 2013 by the American Society of Mechanical Engineers (ASME) [18], were used by the study's stakeholder group to develop a set of mitigation strategies for identified higher-risk locations.

The system analyzed with this hazard analysis methodology consists of the SFRC corridor specifically bounded by Australian Avenue and Summit Boulevard. The analysis and risk classification yielded a set of 3 high-risk, 4 medium-risk, 6 low-risk, and 21 negligible trespass risk segments on the corridor. The results of the trespass severity analysis, which yield a risk-based priority score for each segment of the corridor based on trespass data, are shown in the SFRC corridor map in West Palm Beach in Figure 18.

The data analysis was completed and reported to the stakeholder group at the March 7, 2011, SUG meeting. At that point, the SUG initiated deliberations on mitigation strategies, which are part of the RESPONSE step in the CARE model, for the top seven locations. The top seven locations were:

- 7th Street Grade Crossing (pedestrian trespass)
- Banyan Boulevard Grade Crossing (pedestrian trespass)
- ROW between 45th and 36th Streets
- ROW between Banyan Boulevard and West Palm Beach Station
- Mockingbird CP
- ROW between 7th Street and Banyan Boulevard
- ROW between Caroline and Boyd Streets

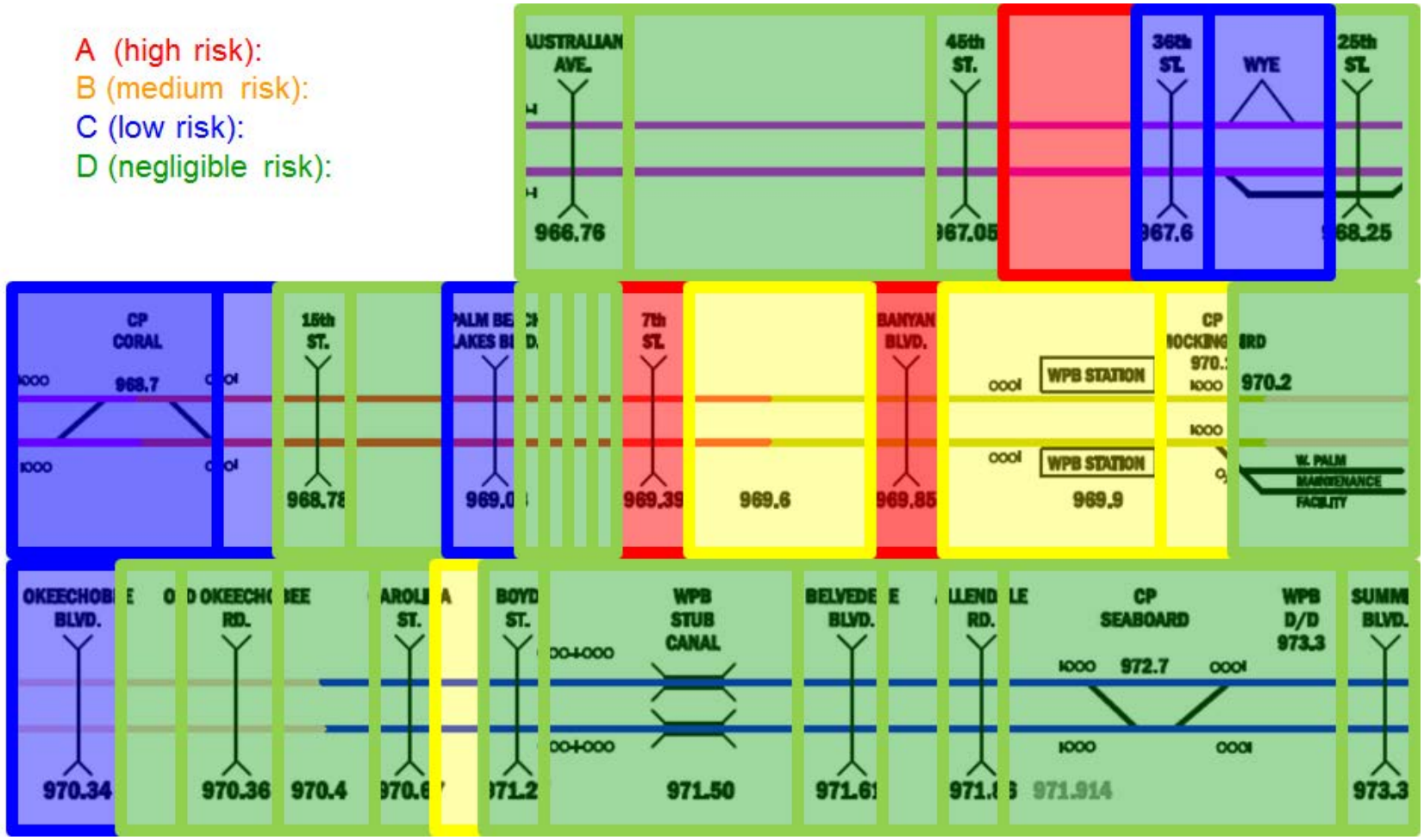

Figure 18. SFRC Corridor Map Trespass Risk Areas in West Palm Beach

4.6 Lessons Learned

The way in which the analysis step in the CARE process is executed is heavily dependent on the site and stakeholder characteristics. Specific to the study area, the analysis step involved multiple methods of data collection including analysis of the FRA and railroad incident data, review of locomotive crew and field observations, locomotive video data, and targeted data collection. Additionally, a consensus on the analysis method and validity of the results had to be reached among the stakeholders. Although a seemingly straightforward step as outlined in the CARE model, much work was needed to collect the necessary information about the trespassing problem in order to analyze it and be able to proceed to the next step in the process. More than 30 trespass locations were identified in both the SFRC and FEC ROWs. Because of the large-scale nature of the study area and limited resources that could be applied to tackle the issue, a ranking methodology was needed.

Things that worked well

Several tasks within this step worked extremely well. These include:

- Transit agency collaboration: The bulk of the data used to analyze the trespass problem on the SFRC originated from the SFRTA. The transit agency was very accommodating of the study team's data requests, particularly in granting access to its locomotive video data. That data set provided the information needed for a comprehensive analysis of the city's entire corridor.
- Consensus on data analysis method: The study team's active engagement with the stakeholders through the data collection and analysis process led to ultimate buy-in of the results by the SUG.
- Data analysis and results: The efforts by the study research team, which was composed of research analysts and engineers, resulted in the development of a trespass-specific severity risk method and yielded a comprehensive analysis of the trespass data.
- Targeted data analysis: Additional data collection at specific sites that were initially identified as high-risk trespass areas proved very beneficial because it validated the results of the analysis. These additional data points quantified the trespass problem for the SUG, driving home the scale of the problem at the most severe locations.

Things that didn't work so well

Activities that did not work so well or at all were:

- Trespasser surveys: Surveys of trespassers, which are listed in the CARE model under the analysis step, were not performed during this study because of the unavailability of local law enforcement to conduct them.
- Data sharing: Although some stakeholders were very proactive with sharing data, others did not collaborate much in this respect even after identifying relevant data. Ultimately, this minor issue did not affect the results for the SFRC since SFRTA provided adequate information. However, it did impact the study team's efforts to perform a substantial

analysis of the FEC corridor for which no data aside from the FRA incident data and field observations was made available.

- Data Analysis: Although the overall data analysis was well executed and provided meaningful results, the SUG was not actively engaged with the research team during this process, aside from discussions of progress and ultimate results. This lack of involvement may have been due to the absence of data analysts in the SUG.

Recommendations

The implementation of this step proved to be very complicated because of the overall size of the study area, as well as data sharing and quality issues. Recommendations to address these are:

- Stakeholder group should develop a data sharing plan. The stakeholder group should reach a consensus on the data needs for the program and protocols for sharing the information within the group. This should be done at the executive level, which should then nominate a working group-level representative from their organization to collect and contribute to the analysis to be performed by the data collection subgroup.
- A data analysis subgroup should be created. A data analysis subgroup, which may be the same as the data collection subgroup listed in the CARE model, should be assembled to analyze the data and report out to the overall SUG. This approach is not currently listed in the CARE model. It should be noted that members of this group should have a data analysis or system safety background, which will be beneficial for successful accomplishment of their mission.
- Objective data collection and analysis, using the validated risk-based methodology from this study, should be performed. The research team also recommends performing an objective targeted data collection activity that is not dependent on in-person observations by railroad employees. Although the research team collected and reviewed observation data from locomotive engineers, it realized that this data was subjective and not always accurate. The collection of trespass data from objective data sources such as locomotive video data or fixed video cameras is recommended for a comprehensive assessment of trespass conditions.
- The stakeholder group should reach a consensus on effectiveness measures before the Response step. The SUG should achieve consensus regarding what measure(s) will be used to gauge effectiveness of the responses developed and implemented in the next step of the CARE model. These measures could be any of the following: change in trespass casualty numbers, change in trespass observations, increase in inter-organization collaboration, or other measures identified by the group.

5. Response

The third step in the CARE process is to identify and implement strategies to solve the underlying causes of trespassing. These strategies generally revolve around the 3 Es: Engineering, Education, and Enforcement.

5.1 General Trespass Mitigation Strategies

Once the hazards are classified and ranked based on their risk, a mitigation strategy should be developed for each hazard. Safety treatments include engineering (passive and active devices), education, and enforcement. These may be applied locally to address a specific trespass trouble spot or system-wide. The ultimate goal is to manage the risk. The list below, although not exhaustive, catalogues possible trespass prevention treatments that the SUG considered. It excludes potential treatments or strategies, such as grade separations, that would be very unlikely to be implemented because of funding or other site-specific limitations.

Engineering

- Passive
    - Signs
    - Fencing/landscaping/channelization
    - Second train warning signs (for crossing trespass)
    - Pedestrian gate skirts (for crossing trespass)
    - Pedestrian crossing
    - Pedestrian over/underpass
- Active
    - Second train approaching signals (for crossing trespass)
    - Pedestrian crossing
    - Train operations change (switch platforms depending on pedestrian traffic flow)

Education

- Education outreach programs
    - Media events
    - Safety message (signage and/or PSAs) on platforms and in trains (system-wide)
        - Also at PalmTran bus station adjacent to West Palm Beach station
    - OLI presentations to local community (targeted)
        - Local schools
        - Local businesses
        - Specific "attractive nuisances," such as the Boys & Girls Club on Pinewood Ave (near 40th Street) abutting FEC ROW and King Foods on 36th Street abutting CSX ROW

- Safety blitzes (targeted)
- Bulletin material for local employers, coordinated through their Safety or HR offices (signs, safety notices…)

Enforcement

- Enforcement of State and local trespass laws
  - May involve educating the police department on the statutes and their authority
  - May need to work on energizing enforcement through outreach to law enforcement agencies and the judicial branch to recognize grade crossings and trespass violations as serious problems.

5.2 Recommended Mitigation Strategies

At the March 7, 2011, SUG meeting, the stakeholder group initiated deliberations on possible mitigation strategies for the SFRC study area. The group agreed to target the top seven locations identified through the data analysis for immediate action.

For the study area in West Palm Beach, some treatments were deemed unfeasible from the start. In particular, the installation of grade crossings, even pedestrian-only crossings which would have addressed some of the pedestrian connectivity issues in the area that were forcing a trespassing condition, was not possible because of the existence of a FL DOT policy banning the creation of any new crossings along the SFRC [19]. Although initially discussed as a potential treatment for some locations, this approach was quickly eliminated from the list of possible strategies.

The research team facilitated discussions and compiled the final list of recommended strategies as approved by the SUG on February 28, 2012. These strategies outline the current trespass conditions and probable causes, list the potential mitigation strategies discussed by the group, and contain a final statement outlining the recommendations specifically tailored to each of the seven target trespass locations. As an example, the final statement for the location identified by "ROW between Caroline and Boyd Streets" reads:

> *In lieu of reinstating a dedicated pedestrian crossing at Boyd Street, the SUG noted that an adequate channelization system, buttressed by wayfinding and No Trespassing signage, could be implemented to guide pedestrians to safe crossing points both north and south. A multi-use trail parallel to the ROW is one example of channelization that could dissuade trespass activity. The SUG supported the implementation of a system-wide education campaign to address education concerns and targeted enforcement at the closed Boyd Street crossing after adequate wayfinding and channelization measures had been made.*

The strategies also include a graphic of the existing site characteristics and changes proposed by the SUG. The list of recommended strategies, including graphic representations of existing conditions and proposed treatments, is found in Appendix D.

5.3 Implementation of Recommended Strategies

The final list of recommended strategies was approved by the stakeholder group in February 2011. However, the group was successful in implementing only a part of the recommendations as of the date of this report (December 2013). Some stakeholders did take the information back to their respective organizations and use it for their internal safety programs. One example is the added outreach by FL Operation Lifesaver to local schools identified through this study. Other strategies proved to be resource intensive and work had to be done to secure the needed funding for such improvements. One such example is the effort by the Palm Beach Metropolitan Planning Organization and FDOT to secure a transportation enhancement grant for a pedestrian accessibility project along Tamarind Ave. That project, which is slated for completion in 2016, will provide a direct safety benefit between 7th Street and Banyan Boulevard by including a sidewalk along Tamarind, as recommended by the SUG.

Two tactics were undertaken by the study team to kick-start the implementation phase of this project. The first involved organizing a field review with the SUG to assess the high-risk areas in person and discuss how to accomplish the recommended action items based on the strategies they had developed. The field review took place on July 20, 2012, and was attended by 14 representatives from various stakeholders, as shown in Figure 19.

Figure 19. Field Review on July 20, 2012

The other tactic involved returning to the data analysis step in the CARE model. In addition to collecting and analyzing a wealth of data during that step, the research team also performed a targeted data collection and analysis at the trespass spots identified by the analysis as being the most risky (the three high risk and four medium risk locations in Figure 18). This data was collected between November 2012 and February 2013 through video-based recording systems,

an example of which is shown in Figure 20, and reported to the SUG at the March 2013 meeting. The targeted data collection was used to validate the results of the risk analysis and quantify the trespass problem, in terms of daily occurrences, to the stakeholders in order to kick start the response step in the CARE model.

Figure 21 shows an example of the trespass frequency during one 24-hour period at the *Mockingbird CP* location, which is the area just south of the West Palm Beach station near a track signal bungalow. An example of a trespass event at that location is shown in Figure 22 (note the *NO TRESPASSING* sign).

Figure 20. Data Collection System Installation for Targeted Data Collection (November 2012)

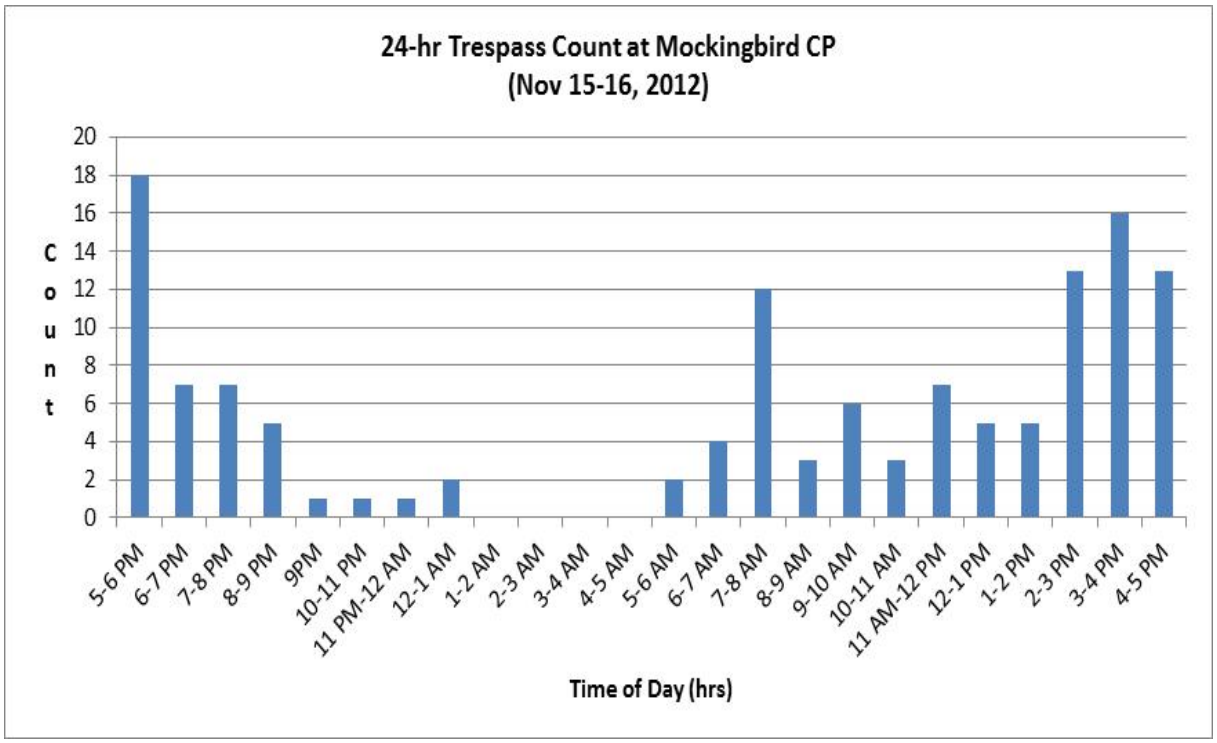

Figure 21. 24-Hour Trespass Count at CP Mockingbird (5 p.m. November 15–5 p.m. November 16, 2012)

Figure 22. Trespass Example at CP Mockingbird Location

As of December 2013, several strategies had been implemented or were in the process of being implemented at each of the top seven locations along the SFRC. The installation of a fence at the location bounded by 45th and 36th Streets is one example of an implemented recommendation at one of the high-risk locations. Figure 23 shows an event captured by the locomotive video at that location involving three trespassers and two trains, one of which is seen near the top left of the picture as it approaches. One of the recommended strategies for that location was the installation of a fence to the east of the ROW. The fence was installed by FDOT in September 2012, as shown in Figure 24.

Figure 23. Trespass event on SFRC ROW between 45th and 36th Streets

Figure 24. Fence on SFRC ROW between 45th and 36th Streets (September 2012)

A summary of the recommendations and current status for each of the seven locations is shown in Table 4. As reflected in that summary, many improvements were made as a direct result of the CARE model implementation.

Table 4. Summary of Recommended Strategies and Status as of December 2013

Location	Recommended Strategies	Status as of December 2013
7th Street Grade Crossing (pedestrian trespass)	• Enhanced channelization using fencing or landscaping • Pedestrian Gate Skirts • Wayfinding Signage • Education outreach to Tamarind Avenue businesses and customers	• No recommended strategies yet implemented
Banyan Boulevard Grade Crossing (pedestrian trespass)	• Enhanced channelization using fencing or landscaping • Pedestrian Gate Skirts • Sidewalk and fencing • Targeted pedestrian blitz at station • Enforcement campaign	• Education of passengers and pedestrians by SFRTA and FL Operation Lifesaver • Enforcement by West Palm Beach Police and CSX Police
ROW between 45th and 36th Streets	• Fencing • Wayfinding signage • Education campaign for neighborhood and Northmore school	• Increased education outreach to school by SFRTA and FL Operation Lifesaver • Fencing installed by FDOT • Fencing installed by city • Security patrols increased in the area by SFRTA security contractor
ROW between Banyan Boulevard and West Palm Beach Station	• Sidewalk redesign • Platform fence end extenders • Inter-track fence extension • Landscaping existing trail • Enhance static wayfinding signage • Targeted pedestrian blitz at station • Enforcement campaign	• Education of passengers by SFRTA and FL Operation Lifesaver • Enforcement by SFRTA security contractor and CSX Police • Contract for landscape channelization currently being procured by FDOT
Mockingbird CP	• West side fence extension • Targeted pedestrian blitz at station • Increased outreach to Dreyfoos school • Enforcement campaign	• Education of passengers by SFRTA and FL Operation Lifesaver • Enforcement by SFRTA security contractor and CSX Police • Additional signage installed by FDOT • Operational change by SFRTA, consisting of switching two

		southbound trains in the afternoon to the east side platform, continued. This change, in existence before the study due to the large trespass activity from students after school crossing the tracks at this location to get to the southbound platform, was kept in place during the study period.
ROW between 7th Street and Banyan Boulevard	• Construct sidewalk on west side of ROW along Tamarind Ave • Install wayfinding and NO TRESPASSING signage • Enforcement campaign after installation of signage	• Additional signage installed by FDOT • City identified funding for and scheduled sidewalk construction for 2016
ROW between Caroline and Boyd Streets	• Install additional wayfinding and NO TRESPASSING signage • Pedestrian channelization • System-wide education campaign • Targeted enforcement at the closed Boyd Street crossing location	• Fencing extended over channel and gaps repaired by the city • Additional signage installed by FDOT • Increased outreach by FL Operation Lifesaver to nearby school

Additionally, FEC and the City of West Palm Beach have implemented improvements along the FEC corridor that have either been a direct result of or influenced by this study. Some examples are:

- Boys & Girls Club fencing installed by club
- Fencing at park bordering Boys & Girls Club repaired by city
- Beautification project by city of Quadrille Boulevard area bordering ROW (landscaping and fencing), as shown in Figure 25

Figure 25. Landscaping bordering FEC ROW along Quadrille Boulevard (January 2013)

5.4 Lessons Learned

The RESPONSE step in the CARE model is the most crucial since it involves actual implementation of strategies designed to solve the trespassing problem. It also proved to be the most difficult for reasons discussed below.

Things that worked well

Generally, the first part of this step involving the development of the location-specific recommended mitigation strategies went very well. Specifically:

- Stakeholder Participation: Stakeholders were generally very engaged in discussing potential mitigation strategies and drawing on their background and organization's perspectives to influence their input. This maximized the list of potential strategies that were used in consideration of the final product.
- Field Review: An in-person review by stakeholders of trespass issues at specific locations helped to generate action directed at implementing recommended strategies. The field review also generated additional discussion about resources that individual stakeholders could employ.
- Targeted Data Collection: As with the field review, the targeted data collection provided additional information crucial to getting stakeholders to execute the recommendations.

Things that didn't work so well

Several barriers to implementation surfaced during the execution of this step in the CARE model.

Specifically, the challenges were:

- Resource identification/application: In general, stakeholders were active in making recommendations but not as much in identifying what their organizations could bring to bear. This could have been a product of the selected representatives, many of whom were not in a position within their respective organizations to do so. Additionally, all stakeholders had limited resources (including funding) and differing priorities. For example, preventing trespassing is at the top of the priority list for the rail safety partners, but not necessarily for the local police department, which undoubtedly has many other pressing societal issues with which to deal. Another example is that FDOT, as owner of the SFRC, is liable for trespass incidents but lacks the capacity to address them. Early identification of funding sources should be a priority for the stakeholder group.
- Consensus building: Stakeholders had different perspectives on the problem and on ways to solve them. For example, the railroad stakeholders' preferred approach was to seal off the corridor as much as possible (emphasis on fencing and enforcement), while the city preferred to make neighborhoods more accessible (emphasis on more crossings at grade or grade-separated, and education).
- Development of Implementation Plan: Although a set of recommended strategies was developed and approved by the SUG, an implementation plan was not developed. The research team attempted to facilitate the development of a plan but it proved too difficult for several reasons. First, the study area and range of recommended strategies were both very large. Second, there were many stakeholder organizations involved in the process, which made it difficult to coordinate responses that depended on multiple stakeholders. And third, and most significant, the absence of executive-level group members in the group became a key barrier to execution of any recommendations.
- Jurisdictional fragmentation: The fragmented nature of the study area was a major block to implementing workable solutions. There were several different jurisdictions and rail stakeholders involved and no one actor controlled enough to proceed unilaterally. Additionally, jurisdictional barriers especially related to enforcement made parts of the implementation strategy very difficult to execute. An example was the reluctance of the local police to step on the ROW, which is State property, to enforce trespassing laws.

Recommendations

The RESPONSE activities would have benefitted from the existence of the following two bodies within the SUG:

- An executive committee: As recommended in the previous steps. Specifically, an executive committee would have been the most appropriate body to identify and commit organization resources to implement the recommendations.
- An implementation group: The creation of an implementation group composed of the core stakeholders to execute the strategies. As evident in the recommendations, much of

the implementation on the SFRC would be done by the owner of the ROW (FDOT) and the City Planning, Engineering, and Police Departments, with some additional support from SFRTA. With this in mind, an implementation group with just those stakeholders would streamline lines of communication and decrease unneeded interactions with the overall SUG during this very crucial step. The SUG would still be involved, but not directly at this stage, unless specifically called for in the recommended strategies.

Additionally, the research team recommends the use of implementation group field reviews. The execution of field reviews by the implementation group would serve to validate the recommendations. It would also provide an opportunity for the key stakeholders to review site conditions in person and generate any ideas not previously discussed. A targeted data collection task could also be considered at the field review if there were uncertainties remaining related to the type and degree of trespass. Also, as relayed by several stakeholders throughout the process, it would have been useful to have information on estimated costs and proven benefits of possible countermeasures. The research team gathered some of this information from other transit agencies and railroads, but not much information was publicly available.

6. Evaluation

The last step in the CARE model is to evaluate the effectiveness of the responses based on the measures identified in the data analysis step. One measure used by the SUG involved the trespass casualty data, which is shown in Figure 26 for the study period between January 2009 and August 31, 2013 [1], the latest available data point. Comparing the study data (4 years 8 months) with the pre-study data (5 years) shown in Figure 4 reveals that little has changed overall in the study area on the SFRC (seven total casualties on the line in each period). However, the SFRTA casualty numbers dramatically improved from their high of five in 2008, even with much higher train frequency throughout the study period (SFRTA doubled train frequency in 2008). As for the FEC ROW, the average dropped from approximately six to four trespass casualties per year between those two periods.

Even though casualty data seems to point to an increased safety level in the area during the study period, this improvement cannot be directly attributed to the implementation of the CARE model. Although efforts by the SUG most probably contributed to the safety improvement, the casualty data set is very limited and external factors such as population shifts and opening or closing of pedestrian traffic generators such as stores were not accounted for during the study period.

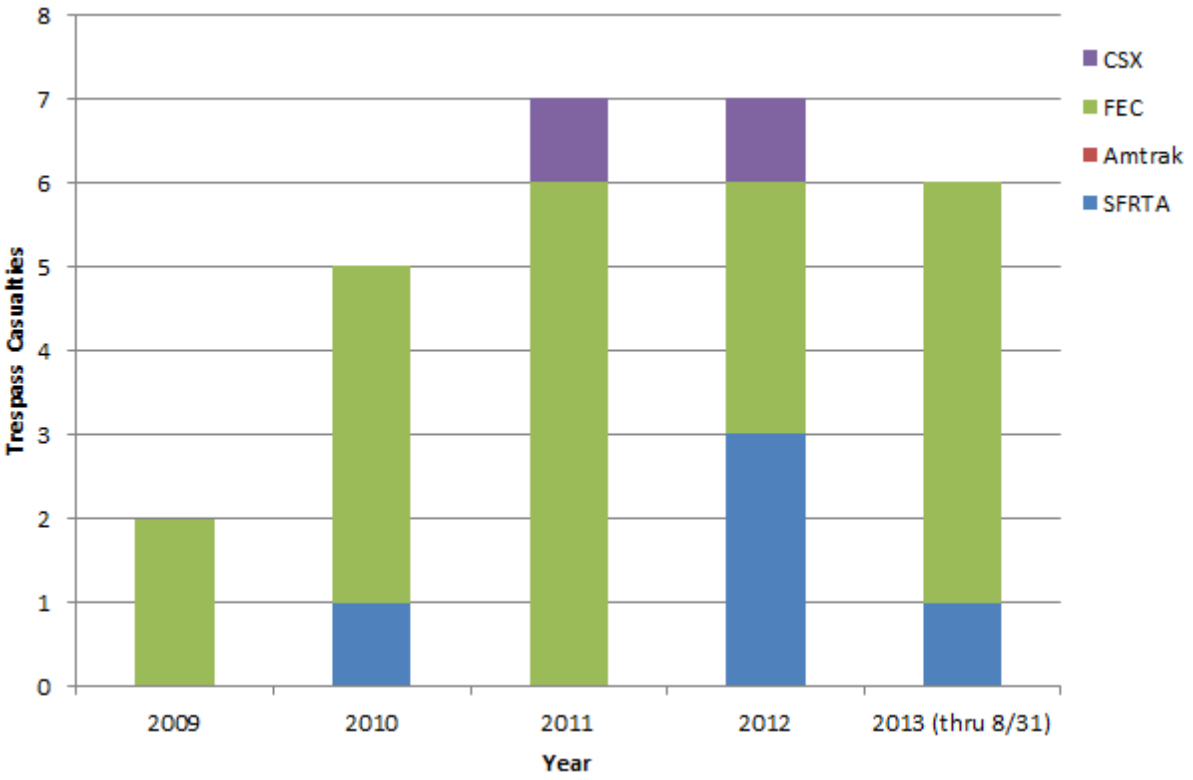

Figure 26. Trespass Casualties in Palm Beach County, January 2009 to August 2013

Another effectiveness measure discussed by the SUG was the level of trespass activity. The best gauge of this, and what the study team used for the baseline, was trespass data gathered through analysis of the SFRTA locomotive video data. Collection and analysis of post-implementation data has not been performed as of the date of this report since many of the recommended strategies have only recently been, or are still yet to be, implemented. Ideally, this analysis should be performed after most of the recommendations have been implemented, which is estimated to be within the next 2 years.

Yet another measure is a before and after analysis of trespass data at the specific locations in which the research team conducted targeted data collections. Baseline data, such as the one previously shown in Figure 21, has been collected and could be compared with post-implementation data once the recommended mitigation measures have been implemented at those specific locations. Post-implementation data has yet to be collected as of the date of this report. However, the research team has installed data collection equipment at strategic locations within the study area to collect such data after the implementation of the recommendations.

Other benefits were realized by the implementation of the CARE model. Due to its community-based framework, the implementation of the model helped to increase communication and collaboration among stakeholders, which in turn led to collaboration among organizations on other projects that had a direct impact on the mitigation of the trespass problem. The model also served as a tool to educate non-rail stakeholders on the nature and severity of the problem with respect to their community, which is often not well understood outside of the operating railroads. An added benefit of this study is that the city now has a tailored grant application template and has regular coordination with FDOT and SFRTA on planning and engineering activities around the ROW.

It should be noted that the FRA Office of Research and Development funded an independent evaluation of the CARE model process as implemented by the research team in the study area. This evaluation, as recommended by the CARE guide, is scheduled to be completed in 2014 and will identify additional lessons learned that may be applied to further implementations of the CARE model.

6.1 Lessons Learned

Things that worked well

The Evaluation step of the model has not been fully executed as of the date of this report since many of the strategies are in the process of being or are yet to be implemented in the study area. Even though a thorough evaluation cannot be completed at this time, the following two success factors should be highlighted:

- Comprehensive data collection: The detailed data collected and analyzed by the study team has provided an excellent baseline with which to compare the post-implementation data once collected.
- CARE model framework: The model worked well in providing the necessary guidance to identify and include the needed stakeholders and to guide the overall trespass mitigation program.

Things that didn't work so well

The implementation of the recommended strategies was the hardest step in the overall CARE process. Some responses were implemented throughout the study period, some are scheduled to be implemented in the near future, and others remain uncertain. Since the evaluation step of the model depends on the implementation of trespass mitigation strategies, not much has been accomplished in this last step of the model. Specific barriers included:

- Resource availability: The availability of needed resources, often related to funding, was the biggest barrier to implementing many of the recommendations.
- Decisionmaking authority: The absence of executive-level representation by some key stakeholders delayed, and in some cases prevented, the implementation of recommended strategies.

Recommendations

As previously stated, the creation of a separate committee composed of executive-level representatives from key stakeholder organizations would address the barriers mentioned above. This committee would be able to perform a reality-check of the recommendations based on its assessment of the respective organizations' resources and capabilities; it could then execute the implementation plan.

Specific to this study, the research team recommends that the SUG continue to assess and evaluate risk throughout the network because the mitigation strategies developed by the stakeholder group may have influenced the risk on the network and perhaps shifted it to other locations. The research team also recommends a follow-up task within the next 3 years to evaluate the impact of the strategies implemented during or immediately after the conclusion of the study. This activity would also provide an opportunity for the research team to evaluate the long-term viability of the CARE process by documenting activities by the SUG from the time the research team ceased involvement.

7. Conclusion

The DOT's Volpe Center, under the direction of the FRA Office of R&D, conducted this research to demonstrate potential benefits, as well as best practices and lessons learned, of implementation and evaluation of trespass prevention strategies following a community-based approach developed by FRA and Transport Canada on the rail network in the city of West Palm Beach, FL, and all of its ROWs.

The guidance used for study, the CARE model, was implemented by the research team and local stakeholders along the SFRC and FEC ROWs in the study area over a period from 2009 to 2013. This study area was selected by FRA based on the then recent (2008) fatal incident history on the SFRTA line, the fact that SFRTA had already created a stakeholder group by 2009 to address the issue (which is the first step in the CARE process), and its willingness to be part of this effort.

7.1 Potential Impact

The CARE guidance provided a structure under which stakeholders and their resources could be effectively organized, as well as a process by which to analyze the trespass problem and its underlying causes, develop a set of responses, and evaluate their impacts. Although a safety initiative had already been started by some local stakeholders before the study, the efforts carried out by this study through implementation of the CARE model added an additional layer of safety improvement through increasing stakeholder collaboration and leveraging collective resources, thereby aiming to maximize overall effectiveness.

Even though casualty data seems to point to increased safety in the area during the study period, this improvement cannot be directly attributed to the implementation of the CARE model. Although efforts by the SUG most probably contributed to the safety improvement, the casualty data set is very limited and external factors such as population shifts and opening or closing of pedestrian traffic generators such as stores were not accounted for during the study period.

A more comprehensive safety benefit analysis consisting of a before and after assessment of trespass data at the specific locations may yield a better estimate of the model's impact. Baseline data has been collected as part of the study and could be compared with post-implementation data once the recommended mitigation measures have been implemented at those specific locations.

Other benefits were realized by the implementation of the CARE model. Because of its community-based framework, the implementation of the model helped to increase communication and collaboration among stakeholders, which in turn led to collaboration among organizations on other projects that had a direct impact on the mitigation of the trespass problem. Specific impacts included the development of a tailored grant application process now used by the city, as well as the implementation of other rail safety projects by FDOT and SFRTA along the SFRC.

The implementation of the CARE model also served as a way to educate non-rail stakeholders about the nature and severity of the trespassing problem with respect to their community, an issue that is often not well understood outside of the operating railroads.

It should be noted that stakeholders within this group, such as the SFRTA and FL Operation Lifesaver, were already carrying out their own internal safety initiatives and continued their safety programs throughout the duration of the study period.

7.2 Lessons Learned

The general CARE guidance provided in the model worked well to establish a framework for the stakeholders to organize, collect and evaluate the data, develop solutions, and implement trespass mitigation strategies. It also worked well in creating and fostering stakeholder buy-in, building consensus, and facilitating the discussion from multiple perspectives. Its implementation and evaluation during this demonstration project resulted in several lessons learned and recommendations for future implementations. These recommendations, listed step by step in the CARE model, are summarized below.

Community

- Local champion(s) need to be identified early and given the authority to drive the trespass mitigation strategies formulated by the community-based group from inception to execution.
- Stakeholder group should maximize use of existing local safety coalitions.
- Stakeholder group should be divided into an executive level committee consisting of decisionmakers and an operational level committee conducting the specific activities outlined in the model.
- Stakeholder engagement strategy should be developed at the beginning of the process.
- Champion(s) must develop awareness of stakeholders' sensitivities.

Analysis

- Stakeholder group should develop a data sharing plan.
- A data analysis subgroup should be created.
- Objective data collection and analysis, using the risk-based methodology validated from this study, should be performed.
- Stakeholder group should reach consensus on effectiveness measures before the Response step.

Response

- An implementation group composed of representatives from the core stakeholders should be organized to execute the strategies. The group would be directed by executive committee members, who have decisionmaking authority within their respective organizations.
- The implementation group should conduct field reviews to validate response recommendations.

Evaluation

- The local champion(s) should leverage executive-level committee to execute the implementation plan.

- The stakeholder group should collect and analyze objective post-implementation trespass data.

Perhaps the most important overall recommendation by the research team centers on the creation of a two-level stakeholder group composed of an executive level group consisting of decisionmakers and functioning as a steering committee and an operational level group conducting the specific activities outlined in the model. The operations level stakeholders would participate in day-to-day activities involving problem identification, data collection, and development of strategies. The executive level stakeholders would be engaged at a higher level and drive the implementation of recommended strategies. Evidence for supporting this recommendation existed throughout the implementation of all four steps of the CARE model in the city of West Palm Beach.

7.3 Next Steps

The implementation and validation of the CARE model by the research team resulted in the application of a risk-based hazard analysis process to analyze the trespass data. Next steps should include additional research building on the adaptation initiated in this study of risk-based strategies to trespass data analyses. The research team also recommends a follow-up task within the next 3 years to evaluate the impact of the strategies implemented during or immediately after the conclusion of the study. This activity would also provide an opportunity for the research team to evaluate the long-term community engagement sustainability fostered by the CARE process.

It should be noted that the FRA Office of Research and Development funded an independent evaluation of the CARE model process as implemented by the research team in the study area. This evaluation, as recommended by the CARE guide, is scheduled to be completed in 2014 and will identify additional lessons learned that may be applied to further implementations of the CARE model.

Ultimately, the research team suggests implementation and evaluation of the recommendations developed through the observations collected in this study, as well as those from the independent evaluation that are not reported herein, in any future use of the CARE model.

8. References

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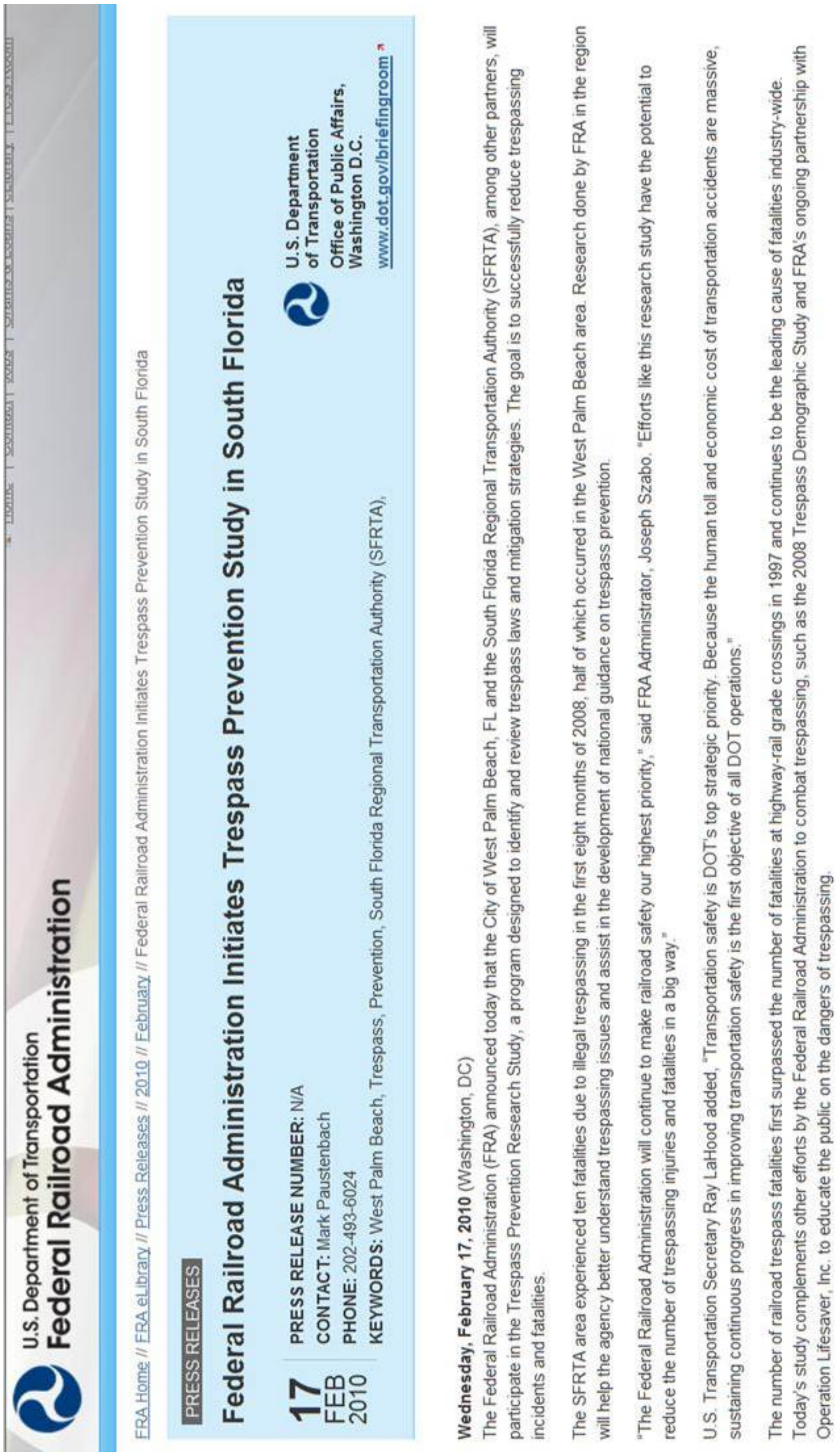
Appendix A. Press Release

http://www.fra.dot.gov/eLib/details/L01026



U.S. Department of Transportation
Federal Railroad Administration

FRA Home // FRA eLibrary // Press Releases // 2010 // February // Federal Railroad Administration Initiates Trespass Prevention Study in South Florida

PRESS RELEASES

Federal Railroad Administration Initiates Trespass Prevention Study in South Florida

17 FEB 2010

PRESS RELEASE NUMBER: N/A
CONTACT: Mark Paustenbach
PHONE: 202-493-6024
KEYWORDS: West Palm Beach, Trespass, Prevention, South Florida Regional Transportation Authority (SFRTA),

U.S. Department of Transportation
Office of Public Affairs, Washington D.C.
www.dot.gov/briefingroom

Wednesday, February 17, 2010 (Washington, DC)
The Federal Railroad Administration (FRA) announced today that the City of West Palm Beach, FL and the South Florida Regional Transportation Authority (SFRTA), among other partners, will participate in the Trespass Prevention Research Study, a program designed to identify and review trespass laws and mitigation strategies. The goal is to successfully reduce trespassing incidents and fatalities.

The SFRTA area experienced ten fatalities due to illegal trespassing in the first eight months of 2008, half of which occurred in the West Palm Beach area. Research done by FRA in the region will help the agency better understand trespassing issues and assist in the development of national guidance on trespass prevention.

"The Federal Railroad Administration will continue to make railroad safety our highest priority," said FRA Administrator, Joseph Szabo. "Efforts like this research study have the potential to reduce the number of trespassing injuries and fatalities in a big way."

U.S. Transportation Secretary Ray LaHood added, "Transportation safety is DOT's top strategic priority. Because the human toll and economic cost of transportation accidents are massive, sustaining continuous progress in improving transportation safety is the first objective of all DOT operations."

The number of railroad trespass fatalities first surpassed the number of fatalities at highway-rail grade crossings in 1997 and continues to be the leading cause of fatalities industry-wide. Today's study complements other efforts by the Federal Railroad Administration to combat trespassing, such as the 2008 Trespass Demographic Study and FRA's ongoing partnership with Operation Lifesaver, Inc. to educate the public on the dangers of trespassing.

For more information, call 202-493-6024

Appendix B. Letter of Request for Incident Data

U.S. Department
of Transportation

**Research and
Innovative Technology
Administration**

55 Broadway
Cambridge, MA 02142

Volpe National Transportation Systems Center

June 18, 2010

Dear Trespass Prevention Research Study Participant Officials,

The U.S. Department of Transportation (DOT) announced on February 17, 2010 that the City of West Palm Beach, Florida and the South Florida Regional Transportation Authority (SFRTA) among other railroad, State and local partners is participating in the Trespass Prevention Research Study, a safety demonstration program designed to identify and review mitigation laws/strategies, and analyze successful processes for the reduction in trespass incidents and fatalities to aid in the development of national guidance.

FRA has determined this location, the City of West Palm Beach, Florida, to be the most appropriate for a research study on precursors, mitigation strategies and support to the development of national guidance related to trespass prevention. A Trespass Prevention Research Study (TPRS) Stakeholder User Group (SUG) was established in October 2009 with participation from multiple railroad industry, local, State and Federal organizations.

The cumulative results of the trespass prevention strategies will be analyzed to better inform the determination of areas of potential risk, develop solutions to prevent and minimize risk exposure and implement successful countermeasures in the future. Preliminary analysis from the WPB corridors trespass prevention activities including legislative, physical infrastructure, and educational and outreach strategies indicate a positive reduction in trespass-related incidents and fatalities.

PUBLIC LAW 110–432—OCT. 16, 2008, FEDERAL RAIL SAFETY IMPROVEMENTS, DIVISION A—RAIL SAFETY; TITLE II—HIGHWAY-RAIL GRADE CROSSING AND PEDESTRIAN SAFETY AND TRESPASSER PREVENTION; Sec. 208. Trespasser prevention and highway-rail grade crossing safety illustrates the FRA safety goals, “In consultation with affected parties, the Secretary of Transportation shall evaluate and review current local, State, and Federal laws regarding trespassing on railroad property, vandalism affecting railroad safety,

and violations of highway-rail grade crossing signs, signals, markings, or other warning devices and develop model prevention strategies and enforcement laws to be used for the consideration of State and local legislatures and governmental entities."

Trespass incidents are required to be routinely reported and result in very serious consequences. This research study will provide a better understanding of these events and aid in the development of countermeasure strategies.

This request for trespass data information supports the above requirements and outlines the need to obtain more detailed trespass incident information from all parties associated with the TPRS SUG membership. All information shall be kept confidential and only generic results shall be used to document the study results.

Please provide to the USDOT/Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center representatives, government representatives conducting this three year study, with all pertinent information to include detailed incident reports, trespass databases, suicide incidents, current laws, regulations and agreements, etc. regarding trespass prevention within the local area of the City of West Palm Beach.

We appreciate your current and future involvement in this very important research study to mitigate trespass events nationwide and reduce the highest incident rates within the railroad industry.

Sincerely,

Ms. Anya A. Carroll, TPRS Team Lead, USDOT/RITA/Volpe Center

On behalf of Leonard Allen, Program Manager, USDOT/FRA/R&D

Appendix C. Hazard Analysis Methodology and Results

The first step in the hazard analysis process is to establish a model that will be used to analyze the hazards. There are various hazard analysis techniques currently in use. A few examples are: fault tree analysis, event tree analysis, failure mode and effects analysis, and system hazard analysis.

The research team used a hazard analysis process based on the U.S. Department of Defense document "System Safety Program Plan Requirements" (MIL-STD-882) [15] and the hazard identification/resolution processes described in APTA publication "Manual for the Development of System Safety Program Plans for Commuter Railroads" [16]. As documented in the Federal Railroad Administration's document "Collision Hazard Analysis Guide: Commuter and Intercity Passenger Rail Service" [17], FRA requests that passenger rail operators conduct this type of analysis to identify and address hazards in their systems. The process outlined in these documents facilitates the systematic identification, analysis, and resolution/mitigation of hazards. Additionally, it recognizes and includes any existing strategies currently in place, such as safety blitzes, the operational change at West Palm Beach train station relating to the Dreyfoos School, and the newly installed fencing at the Boys & Girls Club. The research team adapted and applied this methodology to the trespass problem for this study.

The hazard analysis and resolution process, as graphically represented in the FRA document entitled "FRA Approach to Managing Gap Safety" [20] is shown in Figure C-1. The process is composed of five steps. An alternative way to depict this general process, specifically developed for the trespass problem, is shown by the flow diagram in Figure C-2, which has been adapted from a 2004 University of Waterloo proposal to Transport Canada [21]. The diagram represents a decision support model for prioritizing safety improvement programs at high risk trespass locations. The various elements of this model will be detailed later in this section.

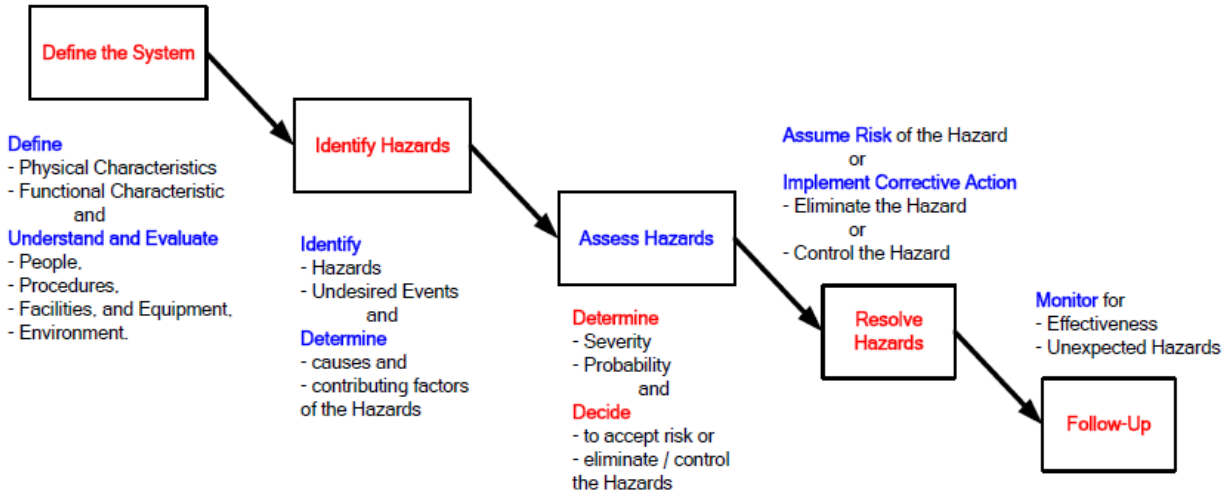


Figure C-1. Schematic Diagram of the Hazard Analysis and Resolution Process

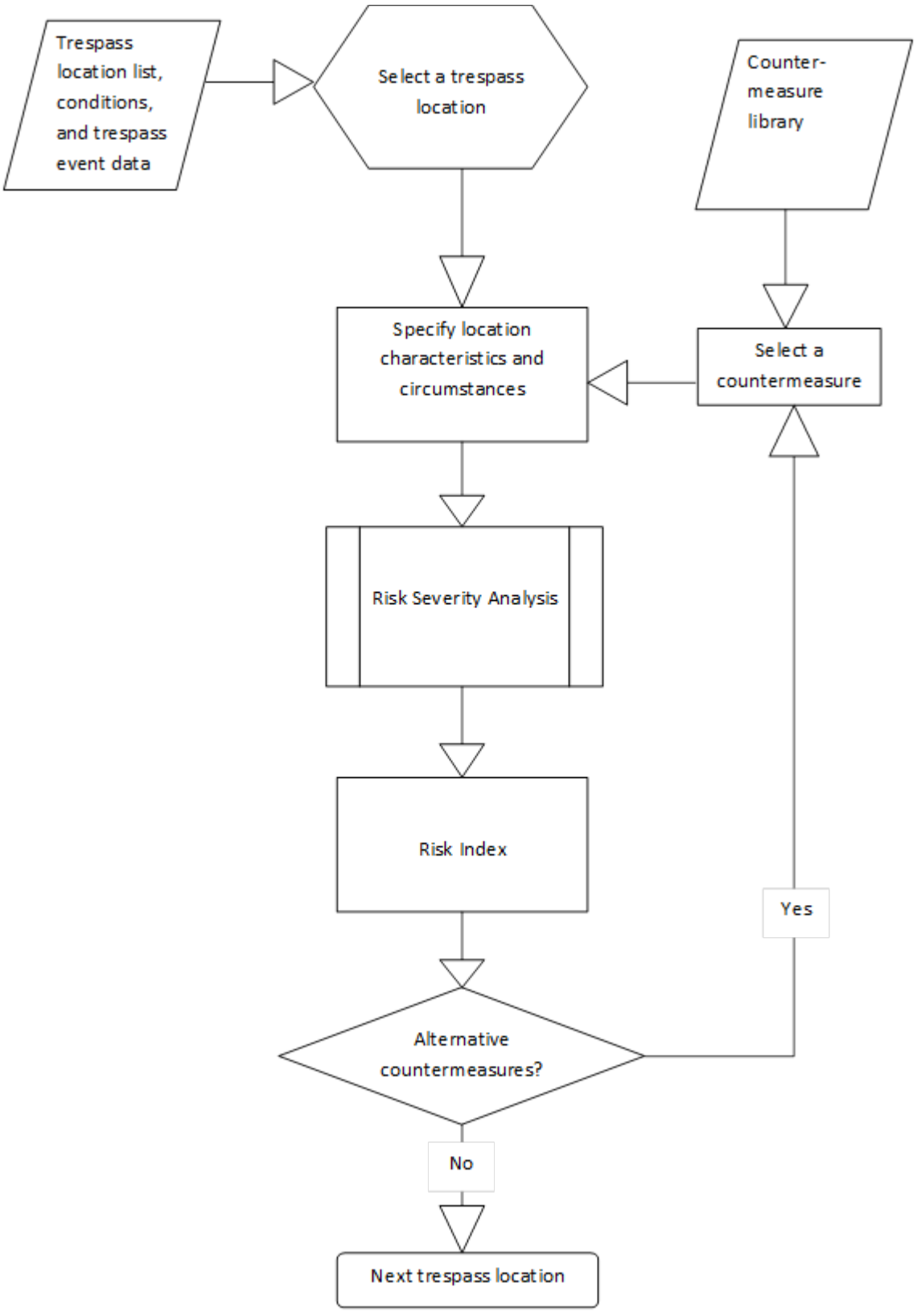


Figure C-2. Countermeasure Identification and Analysis

Define the System

As shown in Figure C-1, the first step in the hazard analysis and resolution process is to define the system. System definition is generally comprised of a description of train operations, rolling stock, track configuration, signal system, infrastructure, and the environment. It can vary depending on the focus of the hazard analysis, which in this case is trespassing.

The original scope of the TPRS only addressed trespass concerns along the SFRTA operations within West Palm Beach, FL. Upon initial review of incident data and subsequent site visits, the scope was later expanded to include all rail lines in the West Palm Beach area to include the FEC, which owns and operates a separate line on ROW to the East of the SFRTA line. Figure C-3 shows a map of the two rail lines within the study area. The boundaries of the study area are defined by milepost locations on both lines, with the SFRTA study area bounded by mileposts 966-973. The SFRTA study area is specifically bounded by Australian Avenue on the north end and Summit Boulevard on the south end. The FEC study area is specifically bounded by 54th Street on the north end and Forest Hill Boulevard on the south end.

SFRTA/Tri-Rail

The ROW on which SFRTA runs its Tri-Rail Commuter Rail service is owned by FDOT and operated by CSX. CSX runs freight operations on this double-tracked line through the study area. All 15 grade crossings in the study area from Australian Avenue to Summit Boulevard are protected by 4-quadrant and pedestrian gates. The average number of daily CSX freight moves through the area is currently unknown. There is one rail station in the city, West Palm Beach Station, along Tamarind Ave. SFRTA currently operates 50 daily train trips through the study area (25 southbound and 25 northbound) on weekdays and 16 daily trips on weekends. The Tri-Rail trains run in locomotive forward operation on southbound trips and cab-forward operation on northbound trips. Amtrak also runs its Silver Meteor and Silver Star service on this line, two trips each way per day.

Florida East Coast Railway

FEC uses its line, composed of both single-track and double-track segments throughout the study area, for freight operations. The average number of daily FEC freight moves through the area is currently unknown, although FEC has mentioned 15–20 at stakeholder meetings. There are 34 grade crossings in the study area from 54th Street to Forest Hill Boulevard and most are active two-quadrant gated crossings. The crossing at 54th is the only passive crossing in the study area. The FEC corridor also contains a rail yard within the study area.

West Palm Beach

The City of West Palm Beach, located in Palm Beach County, is the oldest incorporated municipality in South Florida. It has a population of approximately 100,000 residents. The city was founded by Henry Flagler, who also owned the Florida East Coast Railroad. The FEC line to West Palm Beach was completed in 1894. The town was incorporated later that same year [22].

Figure C-3. Trespass Prevention Research Study Area – West Palm Beach, FL

The system analyzed with this hazard analysis methodology consists of the SFRC corridor specifically bounded by Australian Avenue and Summit Boulevard. The corridor was divided into 32 segments, each designated with its own identification (ID) tag for the purposes of this study. In general, each grade crossing location and each section of ROW between grade crossings were designated as single segments. The major exception to this is the section of ROW between Palm Beach Lakes Boulevard and 7th Street which was divided into four segments because there was separate trespass evidence along four different areas of that section. These segments are shown on the corridor map in Figure C-4 and listed in Table C-1, where Australian Avenue (segment A1) is the northernmost segment and Summit Boulevard (segment A34) is the southernmost segment on the SFRC corridor. As previously noted, because of lack of data the FEC corridor was not included in the hazard analysis.

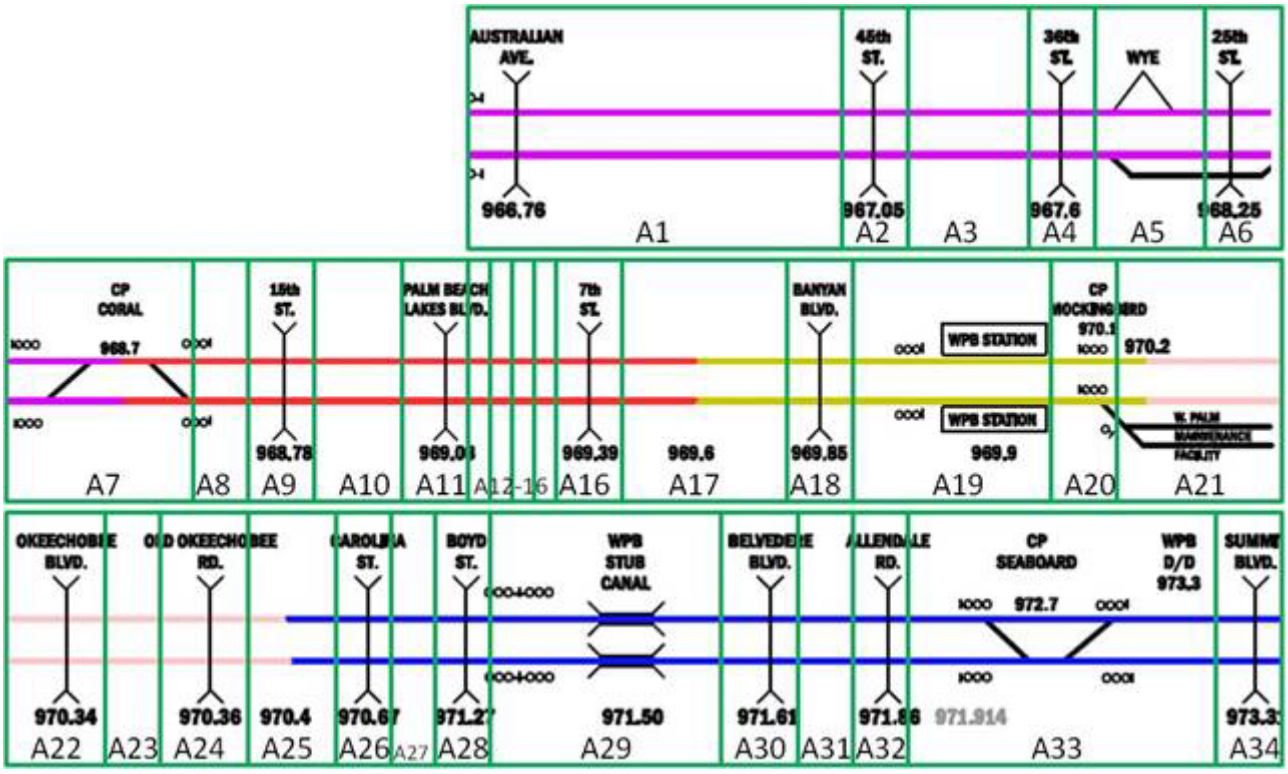


Figure C-4. SFRC Corridor Map within West Palm Beach divided into ROW Segments

Table C-1. SFRC Corridor Segments

ID	Location Description	ID	Location Description
A1	Australian Ave	A18	Banyan Blvd
A2	45th St	A19	ROW between Banyan Blvd and WPB Station
A3	ROW between 45th and 36th	A20	CP Mockingbird
A4	36th St	A21	ROW between CP Mockingbird and Okeechobee Blvd
A5	ROW between 36th and 25th	A22	Okeechobee Blvd
A6	25th St	A23	ROW between Okeechobee Blvd and Old Okeechobee Rd
A7	ROW near Coleman Park	A24	Old Okeechobee Rd
A8	ROW on north approach to 15th St	A25	ROW between Old Okeechobee Rd and Carolina St
A9	15th St	A26	Carolina St
A10	ROW between 15th and Palm Beach Lakes Blvd	A27	ROW between Carolina St and Boyd St (closed)
A11	Palm Beach lakes Blvd	A28	Boyd St (closed)
A12	ROW at 11th St	A29	ROW between Boyd St (closed) and Belvedere Rd
A13	ROW at 10th St	A30	Belvedere Rd
A14	ROW at 9th St	A31	ROW between Belvedere Rd and Allendale Rd
A15	ROW at 8th St	A32	Allendale Rd
A16	7th St	A33	ROW between Allendale Rd and Summit Blvd
A17	ROW between 7th St and Banyan Blvd	A34	Summit Blvd

Identify Hazards

The second step in the hazard analysis and resolution process is hazard identification. This step involves identifying and cataloging potential or existing hazards within the study area. Historical incident data generally reveals some hazards. However, the historical incident and trespass event data for this corridor was very limited. Additional strategies, such as the use of "close-call" data and observations during site visits, were considered for hazard identification. The main body of the report provides a review of the data collection efforts and analysis.

The most critical hazard with respect to trespass on the ROW is the possibility of a collision between a train or hi-rail vehicle and a trespasser on the ROW or at a gate-protected grade crossing. It should be noted that FRA classifies a person on a highway-rail crossing as a trespasser if the crossing is protected by gates and those gates were closed when the person went on the crossing [4]. An additional hazard is the potential for a derailment as a result of impact with a pedestrian (many trespassers in the study were either riding or walking with a bicycle) or as a result of an emergency brake application due to presence of a trespasser. The main hazard categories, with respect to trespass are:

- Collision with a trespasser
- Derailment due to impact with trespasser (possibly due to bicycle)
- Derailment due to emergency brake application (to avoid impact with trespasser)

For the case of trespass hazard identification and subsequent severity assessment (which is the next step), it is useful to categorize the different types of trespass. An initial category list is provided below:

- Trespassing along the ROW (walking parallel to tracks)
- Trespassing across tracks at non-grade crossing location
- Trespassing across tracks at grade crossing location (violating gates)
- Suicide

Classifying trespassing events in this manner will aid in the development of mitigation strategies as part of the hazard resolution step. The research team reviewed several data sources for the purpose of hazard identification and classification. These were:

- FRA incident data
- Local law enforcement violation data
- Operating Railroad trespass data
    - Incidents
    - Train crew observations
    - Locomotive video
- Field observations by research team

It should be noted that the research team did not receive all of the pertinent data identified through discussions with the project stakeholders. Although the research staff requested and received some law enforcement and locomotive crew observation data, the bulk of the analysis focused on locomotive video data supplied by SFRTA, as well as incident data provided by

SFRTA and Amtrak. A technical paper written by the research team and published in 2013 by the ASME [18] contains an analysis of this data.

Figure C-5 shows an example of the results of the data analysis for the segment of ROW approaching the West Palm Beach station from the south, referred to as CP Mockingbird (segment ID A20). The inlaid trespass snapshots were extracted from the locomotive video data supplied by Tri-Rail for this study.

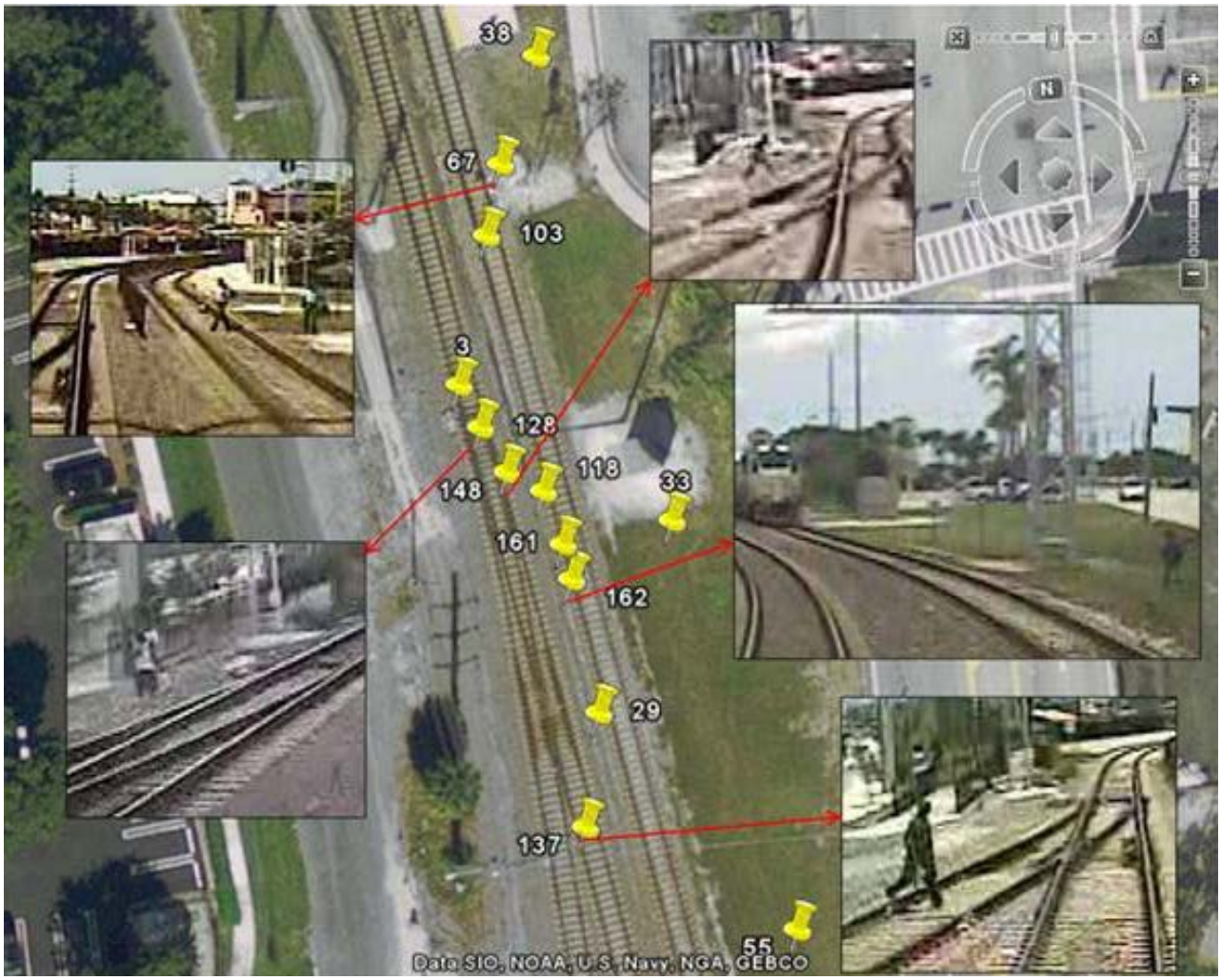


Figure C-5. Trespass Event Locations and Snapshots on South Approach to West Palm Beach Station (Segment ID A20 – CP Mockingbird)

Additional consideration should also be given to nearby pedestrian traffic generators, such as public transportation stops, schools, parks, businesses, and residential areas. These generators, sometimes referred to as attractive nuisances, should be noted if it is determined that they are a factor in the trespass issue at a specific location.

A general concept used by engineers to determine how much pedestrian protection to build into grade crossings is commonly referred to as the 10-minute walk rule [23]. This rule was drafted from studies that showed pedestrians tend to walk up to 10 minutes in order to reach their

destination. This makes the walk-to radius of a traffic generator such as a commercial center up to a half mile. Although usually applied in the context of grade crossings, specifically if there will be substantial pedestrian traffic over them, the general principal of the 10-minute walk rule can be used to determine potential trespass issues resulting from a pedestrian traffic generator.

One such example of a pedestrian traffic generator with rail ROW trespass implications on the SFRC ROW is the Northmore Elementary School. This school is in close proximity to the SFRC ROW near 45th Street. Its student catchment area, as outlined by the green boundary shown in Figure C-6, includes residential neighborhoods from the other side of the ROW [24]. Additionally, even if using a conservative ⅓ mile estimate of distance traveled with the 10-minute walk rule, a substantial portion of the residential area to the opposite side of the ROW is within walking distance of the school, the area contained within the blue circle in Figure C-6. As shown by the data analysis, this school is a causal factor for the trespass problem noted at or near the northeast corner of the housing development on the west side of the ROW just north of 36th Street. As shown later in this report, most trespass events on the SFRC ROW (the blue line in Figure C-6) near the school involve young trespassers crossing the tracks. Interestingly, the school boundary follows the FEC ROW outlined by the red line to the right of the school in Figure C-6, and therefore theoretically decreasing the exposure to students walking to and from school since their school is on the same side of the ROW.

Figure C-6. Northmore Elementary School Attendance and Walk Rule Boundaries

The Boys & Girls Club at 4105 Pinewood Avenue is an example of a trespass generator on the FEC line. That facility, which abuts the FEC ROW as shown in Figure C-7, generates trespass The Boys & Girls Club at 4105 Pinewood Avenue is an example of a trespass generator on the FEC line. That facility, which abuts the FEC ROW as shown in Figure C-7, generates trespass traffic over the ROW from neighborhoods on the west side of the tracks. The nearest grade crossing is more than 750 feet away.

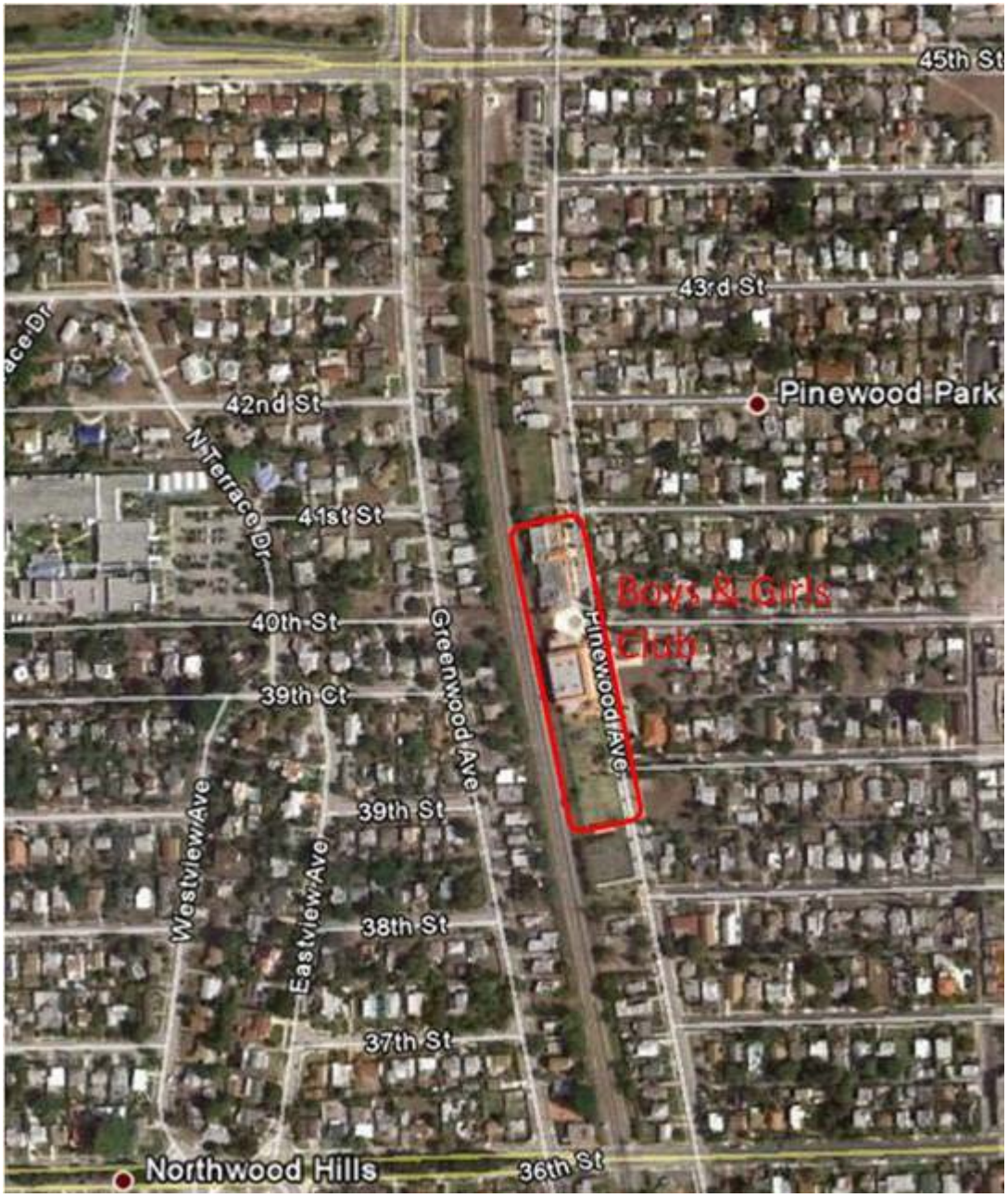


Figure C-7. Boys & Girls Club

Assess Hazards

This section describes the general hazard assessment methodology used by SFRTA, the location-based trespass hazard assessment developed for this study, as well as the outcome of the assessment. The end result is a risk-based prioritized list of all of the segments shown in Figure C-4.

Hazard Assessment Methodology

The hazard assessment component of the analysis process is dependent on definitions of hazard severity and frequency and a risk matrix with associated recommended levels of action. The analysis presented herein is based on the set of severity and frequency definitions, as well as the risk matrix and disposition categories already established by SFRTA within its System Safety Program Plan (SSPP) [17].

First, the hazard severity has to be classified. SFRTA has already developed severity definitions that it uses in its SSPP. SFRTA uses nine severity definitions referred to as "consequences" in its hazard management process. The rate of occurrence of each identified hazard also needs to be estimated within the hazard analysis. The SFRTA frequency definitions have also been specified in its SSPP.

A cross-tabulation of the two definitions above results in what is called a risk matrix. The TPRS Hazard Management team then has the additional task of grouping cells within the matrix according to the perceived hazard risk. Each group of cells will then form a risk category for which a corresponding disposition, or mitigation strategy, is defined. Table C-2 shows the complete SFRTA hazard risk matrix [17]. Table C-3 lists the risk matrix disposition categories as defined by SFTRA [17]. The disposition categories describe the recommended actions that need to be taken for each level of risk.

Table C-2. SFRTA Risk Matrix

Frequency	Consequence								
	R	C1	C2	C3	C4	C5	C6	C7	C8
	Service Related	Negligible	Minor	Minor with Medical Care	Serious Admitted to Hospital	Serious	Serious with Multiple Injuries	Critical	Disastrous
Certain	R	B	B	B	A	A	A	A	A
Likely	R	C	B	B	B	B	A	A	A
Probable	R	C	C	B	B	B	B	A	A
Unlikely	R	C	C	C	C	C	B	B	A
Rare	R	D	C	C	C	C	C	B	B
Improbable	R	D	D	D	D	C	C	B	B
Incredible	R	D	D	D	D	D	D	C	C

Table C-3. SFRTA Risk Matrix Disposition Categories

Risk Class	Description
A	**High Risk** - Short term mitigation actions must be taken immediately. Appropriate risk control measures will be implemented to reduce or eliminate the risk. Medium / Long term mitigation plans must be developed. Close observation and frequent review of mitigation plans must be evaluated for effectiveness.
B	**Medium Risk** - Short term mitigation actions must be taken as soon as practicable. Appropriate risk control measures will be implemented, if necessary, to reduce the risk. Medium / Long term mitigation plans must be developed and evaluated periodically for effectiveness.
C	**Low Risk** - Appropriate risk control measures may be implemented to reduce the risk. Medium / Long term mitigation plans may be developed to reduce or eliminate the risk and be periodically evaluated for effectiveness.
D	**Negligible Risk** – Risk may be considered acceptable; no additional risk control action may be required. Appropriate risk control measures may be implemented to further reduce or eliminate the risk. Risk should be tracked in the hazard consequence log.
E	**Hazard Eliminated** - Hazard has been eliminated and/or condition(s) no longer exists.
R	**Service-Related** - No direct safety risk; no safety action is necessary. Not to be registered in the Hazard Log.

Location-Based Trespass Hazard Assessment Methodology

The SFRTA definitions provided above were developed for a hazard analysis of its entire system. A railroad system is made up of people, procedures, equipment and facilities, and the operating environment. The research team needed to revise these definitions given the focus of the study. Since trespass fatalities are a relatively rare event, the use of surrogate measures of safety other than trespass casualties needed to be considered for analysis. Examples of surrogate measures include violation data reported by local law enforcement, locomotive crew observations, and video recording of specific locations. Analysis of all these types of data contributed to the development of a baseline risk assessment of the corridor and of each individual trespass trouble spot within the study area.

The research team developed a risk-based prioritization algorithm to analyze the trespass issue on the corridor. This algorithm is based on existing strategies used by both New Jersey Transit (NJT) and Long Island Rail Road (LIRR) [12]. The algorithm is composed of a formula containing numerical values attributed to several assessment criteria. Assessment criteria examples are prior incidents, near miss history, track curvature, sight obstructions, number of tracks, train speed, prevalent trespass type (across vs. along tracks), nearby traffic generators (schools, parks, tec.), and number of daily trains. The values are obtained by location-specific data analysis, such as the number of fatalities and trespass events during a given period, and each criterion is assigned a weight, or point rating. Although a very complex algorithm can be developed with several criteria, there are data limitations as well as relative severity point rating

issues to combining the criteria. The research team recognized this, and the need for more research to be done in the area, and therefore tailored the prioritization algorithm to the data available in the study. It should be noted that the algorithm does not differ too much from the LIRR formula. The major difference is the way in which the research team calculated that "trespasser report" component of the formula. The formula for determining the risk severity for each segment in this study was given by:

$$PS = FA(10) + FS(5) + DS(2) + TR$$

Where,

PS = Priority Score

FA = Fatal Incidents

FS = Fatal Suicides (and attempts)

DS = Debris Strikes

TR = Trespass Reports

The majority of trespass report (TR) data in this study was obtained from analysis of the SFRTA locomotive video data, which is contained in the first report [1] of this study. The research team assigned different Trespass Severity Factor (TSF) values depending on the type of trespass event. For example, a lower weighting value was given for a trespass event involving someone walking along the ROW as opposed to an event involving someone crossing the tracks. Although both of these are trespass events, the latter one involving someone crossing the tracks, and therefore the path of the train, is considered a higher risk event. This distinction became very useful for this study. For example, there were many trespass events at segment A17 of the corridor, but these events were not necessarily high-risk. Most of them involved people walking along the ROW next to Tamarind Avenue where no sidewalk exists. The algorithm, and the overall Trespass Location Severity Analysis (TLSA) developed and used for this study, is summarized in the ASME technical paper [18].

Trespass Location Severity Analysis Results

The results of the TLSA yield a risk-based priority score for each segment of the corridor based on trespass data, as shown in Table C-4.

Table C-4. Trespass Location Severity Analysis Results

Segment		Fatal Accidental		Fatal Suicide		AttemptedSuicide		Debris Strike		Trespasser Report		Priority
ID	Description\Hazardous scale per incident (X)		10		5		5		2		1	Score
A1	Australian Ave	0	0	0	0	0	0	0	0	3	3	3
A2	45th St	0	0	0	0	0	0	0	0	3	3	3
A3	ROW between 45th and 36th	2	20	0	0	0	0	0	0	4	4	24
A4	36th St	0	0	0	0	0	0	0	0	6	6	6
A5	ROW between 36th and 25th	0	0	0	0	0	0	0	0	5	5	5
A6	25th St	0	0	0	0	0	0	0	0	2	2	2
A7	ROW near Coleman Park	0	0	1	5	0	0	0	0	3	3	8
A8	ROW on north approach to 15th St	0	0	0	0	0	0	0	0	6.5	6.5	6.5
A9	15th St	0	0	0	0	0	0	0	0	1	1	1
A10	ROW between 15th and Palm Beach Lakes Blvd	0	0	0	0	0	0	0	0	1	1	1
A11	Palm Beach lakes Blvd	0	0	0	0	0	0	0	0	6	6	6
A12	ROW at 11th St	0	0	0	0	0	0	0	0	1.5	1.5	1.5
A13	ROW at 10th St	0	0	0	0	0	0	0	0	1.5	1.5	1.5
A14	ROW at 9th St	0	0	0	0	0	0	0	0	1	1	1
A15	ROW at 8th St	0	0	0	0	0	0	0	0	2.5	2.5	2.5
A16	7th St	1	10	1	5	1	5	0	0	14	14	34
A17	ROW between 7th St and Banyan Blvd	0	0	0	0	0	0	0	0	10.5	10.5	10.5
A18	Banyan Blvd	1	10	0	0	0	0	0	0	16	16	26
A19	ROW between Banyan Blvd and WPB Station	0	0	0	0	1	5	0	0	12.5	12.5	17.5
A20	CP Mockingbird	0	0	0	0	0	0	0	0	12.5	12.5	12.5
A21	ROW between CP Mockingbird and Okeechobee Blvd	0	0	0	0	0	0	0	0	3	3	3
A22	Okeechobee Blvd	0	0	0	0	0	0	0	0	5	5	5
A23	ROW between Okeechobee Blvd and Old Okeechobee Rd	0	0	0	0	0	0	0	0	0.5	0.5	0.5
A24	Old Okeechobee Rd	0	0	0	0	0	0	0	0	2	2	2
A25	ROW between Old Okeechobee Rd and Carolina St	0	0	0	0	0	0	0	0	0.5	0.5	0.5
A26	Carolina St	0	0	0	0	0	0	0	0	1	1	1
A27	ROW between Carolina St and Boyd St (closed)	1	10	0	0	0	0	0	0	0.5	0.5	10.5
A28	Boyd St (closed)	0	0	0	0	0	0	0	0	2.5	2.5	2.5
A29	ROW between Boyd St (closed) and Belvedere Rd	0	0	0	0	0	0	0	0	0	0	0
A30	Belvedere Rd	0	0	0	0	0	0	0	0	0	0	0
A31	ROW between Belvedere Rd and Allendale Rd	0	0	0	0	0	0	0	0	0	0	0
A32	Allendale Rd	0	0	0	0	0	0	0	0	0	0	0
A33	ROW between Allendale Rd and Summit Blvd	0	0	0	0	0	0	0	0	3.5	3.5	3.5
A34	Summit Blvd	0	0	0	0	0	0	0	0	1	1	1

The proposed Priority Score (PS) mapping to the risk classes shown in Table C-2 was defined by the research team, and agreed to by the SUG, as:

A (high risk):	$PS \geq 20$
B (medium risk):	$10 \leq PS < 20$
C (low risk):	$5 \leq PS < 10$
D (negligible risk):	$PS < 5$

The analysis and risk classification per the PS criteria above yielded a set of 3 high-risk, 4 medium-risk, 6 low-risk, and 21 negligible trespass risk segments on the corridor. Table C-5 shows the prioritized list of the segments in the corridor.

Table C-5. Risk-Based Prioritized Segments

Location		Priority			
ID	Description	Score			
A16	7th St	34	A21	ROW between CP Mockingbird and Oke. Blvd	3
A18	Banyan Blvd	26	A15	ROW at 8th St	2.5
A3	ROW between 45th and 36th	24	A28	Boyd St (closed)	2.5
A19	ROW between Banyan Blvd and WPB Station	17.5	A24	Old Okeechobee Rd	2
A20	CP Mockingbird	12.5	A6	25th St	2
A17	ROW between 7th St and Banyan Blvd	10.5	A12	ROW at 11th St	1.5
A27	ROW between Carolina St and Boyd St (closed)	10.5	A13	ROW at 10th St	1.5
A7	ROW near Coleman Park	8	A10	ROW between 15th and Palm Beach Lakes Blvd	1
A8	ROW on north approach to 15th St	6.5	A14	ROW at 9th St	1
A11	Palm Beach lakes Blvd	6	A26	Carolina St	1
A4	36th St	6	A34	Summit Blvd	1
A22	Okeechobee Blvd	5	A9	15th St	1
A5	ROW between 36th and 25th	5	A23	ROW between Oke. Blvd and Old Oke. Rd	0.5
A33	ROW between Allendale Rd and Summit Blvd	3.5	A25	ROW between Old Oke. Rd and Carolina St	0.5
A1	Australian Ave	3	A29	ROW between Boyd St (closed) and Belvedere Rd	0
A2	45th St	3	A30	Belvedere Rd	0
			A31	ROW between Belvedere Rd and Allendale Rd	0
			A32	Allendale Rd	0

The trespass risk severity classification for each of these segments is highlighted in Figure C-8. It is clear that the majority of the trespass severity risk is located along approximately 1 mile of the study area from the 7th Street grade crossing to the CP Mockingbird location. The risk analysis resulted in medium or high-risk designations for the five segments within that 1-mile section. The risk was shown to be medium or high in only two other segments outside of that area. The segment running between 45th and 36th Streets (A3) was deemed high-risk and the segment bounded by Carolina and Boyd Streets (A27) was classified as medium-risk by the analysis. The analysis classified all other segments as either low risk or negligible risk.

The research team developed a set of location-specific mitigation strategies for each of the higher-risk segments identified through the TLSA, as shown in Appendix D. A set of corridor-wide strategies was also developed.

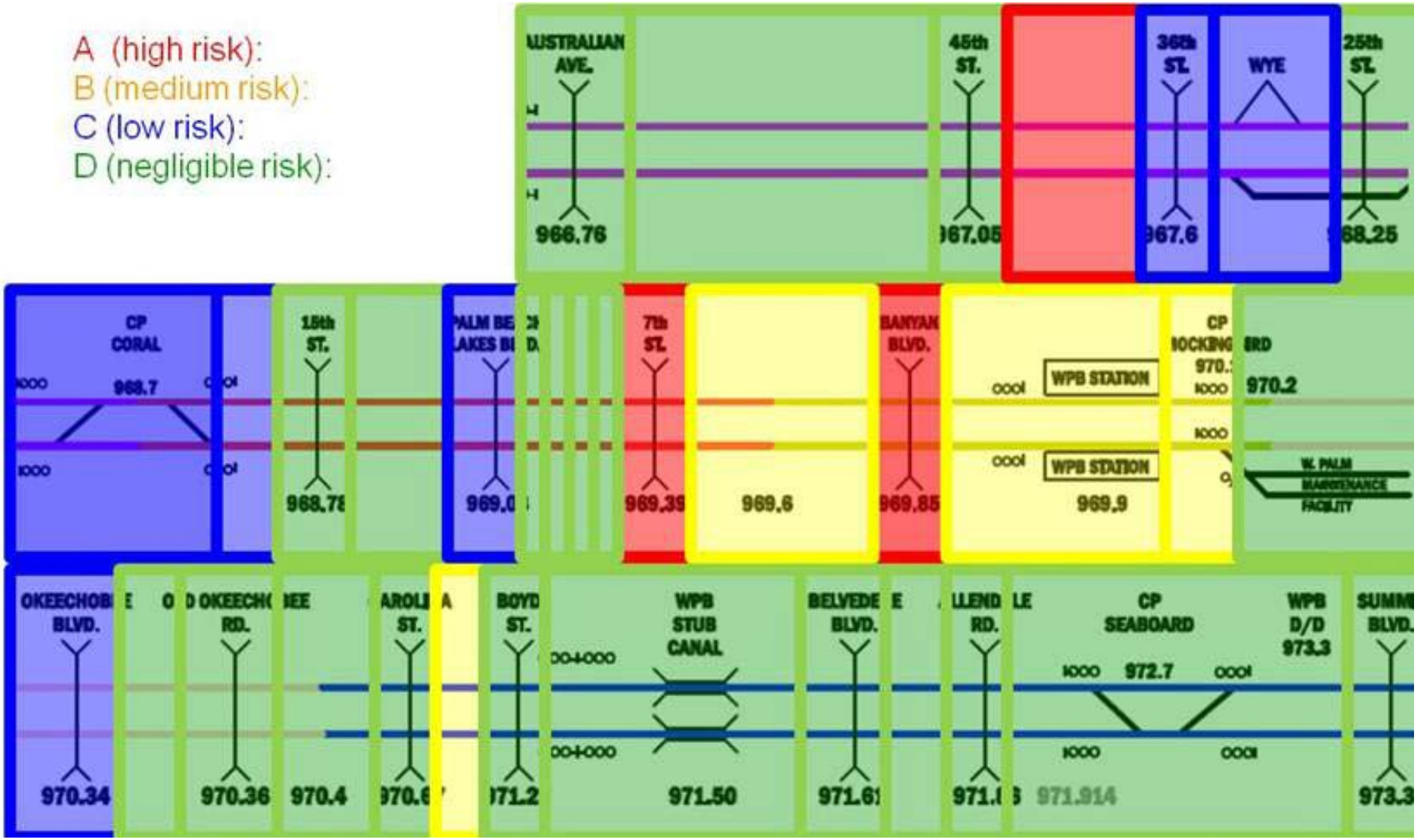


Figure C-8. Corridor Map Risk Areas

Appendix D. Recommended Trespass Mitigation Strategies Approved by the SUG on February 28, 2012

This Appendix presents the final recommended risk control measures discussed and approved by the Trespass Prevention Research Study (TPRS) stakeholders at the Stakeholder User Group (SUG) meeting held on February 28, 2011.

A page is dedicated to each of the seven most dangerous sections identified through the Trespass Severity Location Analysis (TSLA). The seven top dangerous sections identified include two active highway-rail grade crossings, four sections of ROW, and one isolated section of ROW that is a popular, illegal crossing point for the pedestrians. Each page provides a brief outline of the existing conditions of section, trespass history, and a short discussion of the applicable mitigation techniques. Each location features a unique set of characteristics and attributes which facilitate unsafe trespass behavior. As such, the solutions and proposed treatments vary widely for the seven locations. A graphic showing the existing conditions and proposed treatments is also included for each location.

Location ID: A16
Description: 7th Street Grade Crossing

Priority Score: 34
Risk Class: A (High Risk)

Trespass History:
- 1 fatality (12/04/07)
- 1 suicide (09/22/05)
- 1 attempted suicide (03/24/06)
- Tri-Rail locomotive video - 14 trespass events (03/05/10-07/05/10)
- 3 trespass events noted via Veolia reports (04/07/10-04/19/10)

Trespass Characteristics

Most events involve pedestrians violating the pedestrian gates at the crossing.

Potential Mitigation Strategies

Engineering

- A Pedestrian Channelization System could restrict pedestrian movement to designated areas within the crossing while closing gaps in the existing fencing along the ROW.
  - Fencing / Landscaping / Jersey Barriers
  - Z-Gates / Swing Gates
  - Pedestrian gate skirts
- Static Wayfinding Signage along the corridor could be installed to direct pedestrians to appropriate crossing points.

Education

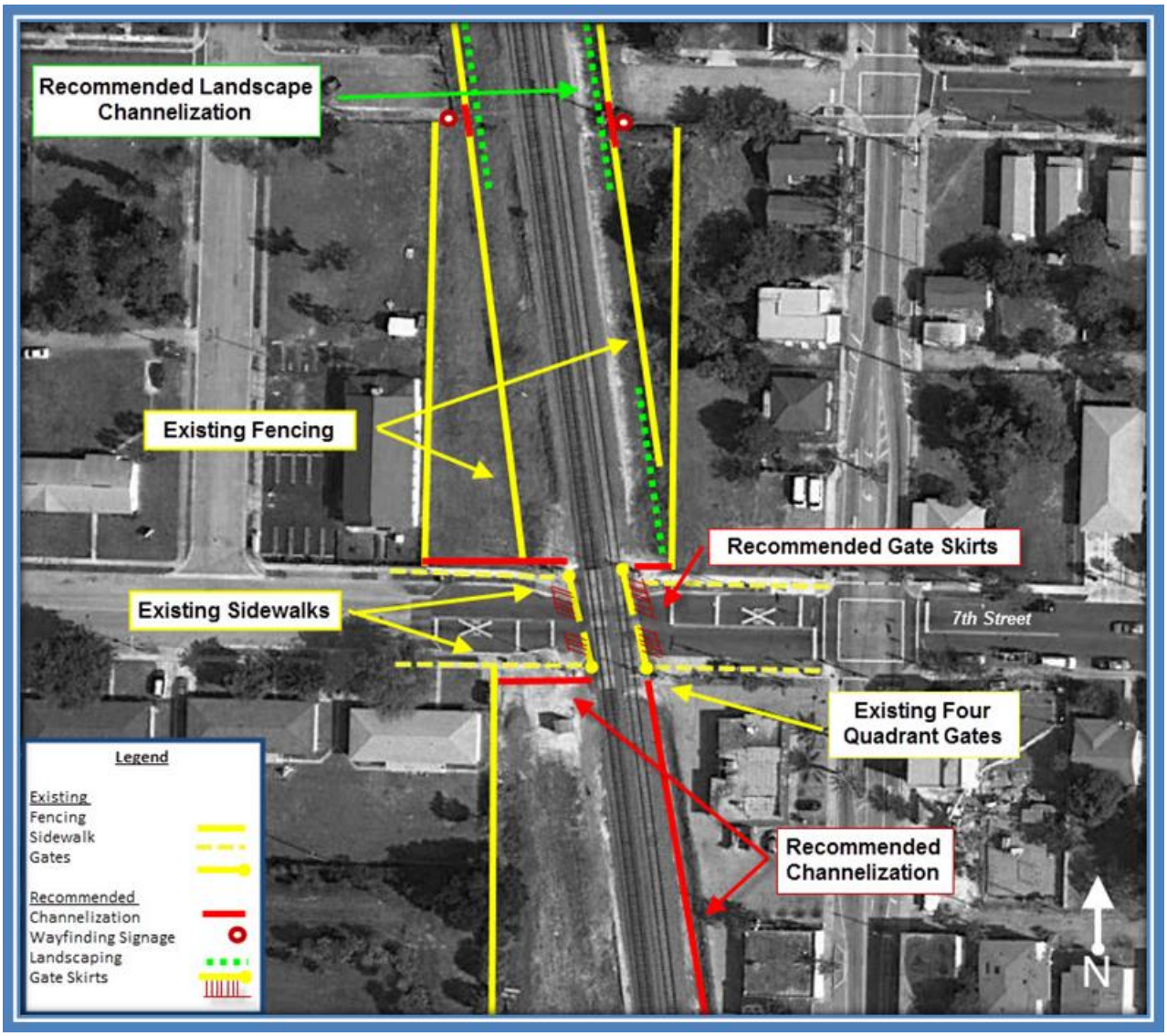
- A Targeted Pedestrian Blitz could be designed to enhance pedestrian awareness of the potential hazards of disregarding railroad warning devices.
- A System-Wide Education Program could also enhance pedestrian awareness of and compliance with posted signs and regulations.

Enforcement

- A Targeted Enforcement Campaign at the crossing could support an education campaign while gaining further publicity for safe crossing practices.
- Better Display of Penalties, including posted signs with signal-violation penalties, could also serve as an effective deterrent.

SUG Recommended Risk Control Measures

The SUG noted that the existing channelization system allows pedestrians and vehicles to consistently violate the grade crossing warning devices. The proposed engineering treatments at 7th Street included enhanced channelization using fencing or landscaping to contain crossing activity. The SUG also supported the use of gate skirts in conjunction with the channelization. The SUG endorsed wayfinding signage throughout the corridor to direct pedestrians to the nearest safe crossing point. As an education strategy, the group proposed a coordinated effort that would engage the customers of the businesses located along Tamarind Avenue. The group also noted that the West Palm Beach athletic league adjacent to the crossing could offer the potential to leverage a combined education and enforcement campaign focused on 7th street.



Notes:

- Wayfinding signage and channelization at closed crossings should be positioned in a manner that directs pedestrian activity to preferred crossing points while informing pedestrians of the penalties associated with illegally crossing the ROW.

Location ID: A18
Description: Banyan Boulevard Grade Crossing

Priority Score: 26
Risk Class: A (High Risk)

Trespass History:
1 fatality (07/17/05)
16 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)

Trespass Characteristics

Most events involve pedestrians violating the pedestrian gates at the crossing.

Potential Mitigation Strategies

Engineering

- A Pedestrian Channelization System could restrict pedestrian movement to designated areas within the crossing while closing gaps along the crossing.
  - Fencing / Landscaping / Barriers
  - Z-Gates / Swing Gates
  - Pedestrian gate skirts
- A 2nd Train Warning System (passive/active) could provide further guidance to pedestrians by indicating when 2nd train events are occurring.
- Static Wayfinding Signage along the corridor could be installed to direct pedestrians to appropriate crossing points.

Education

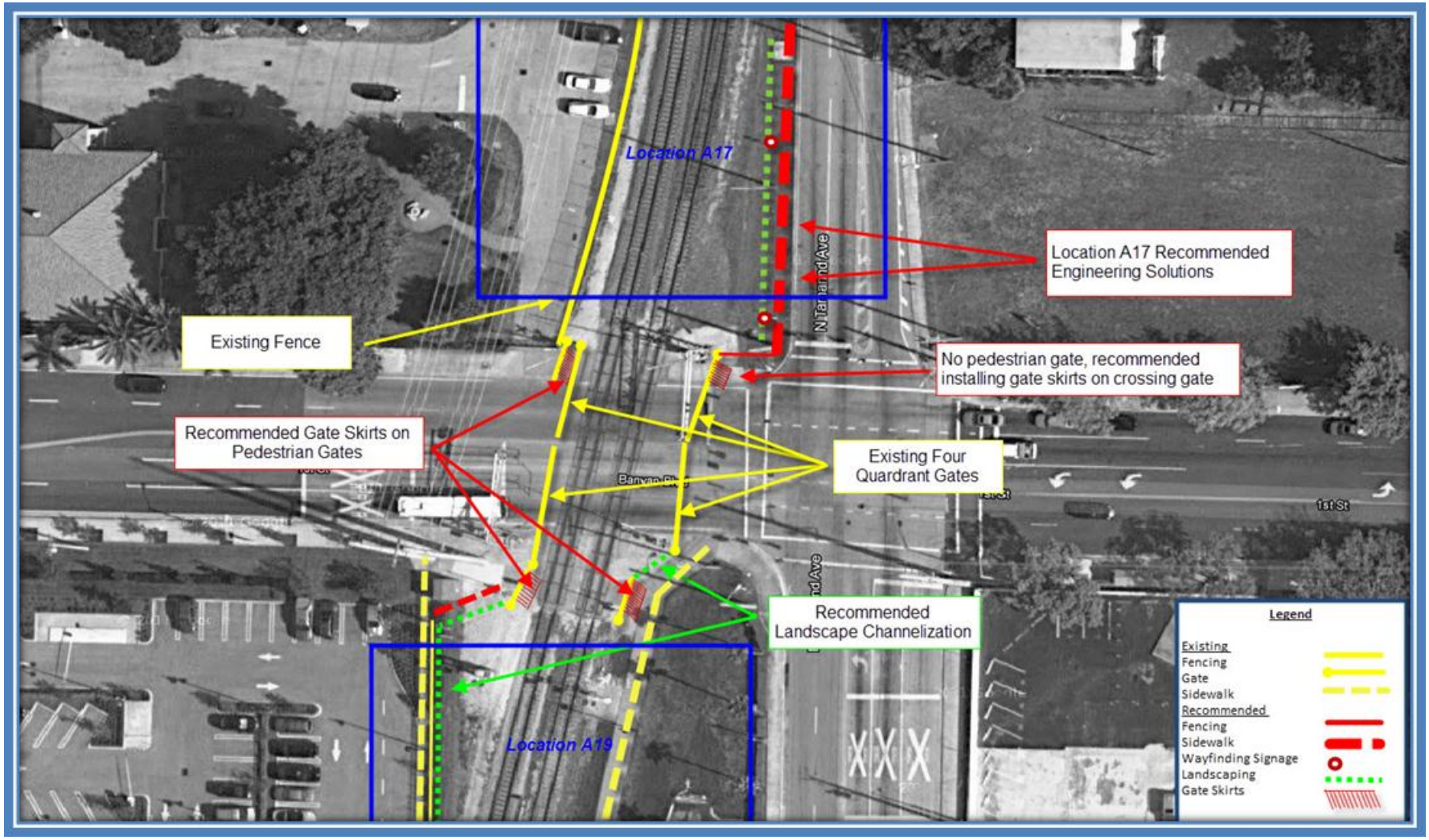
- A Targeted Pedestrian Blitz aimed at Tri-Rail, Amtrak, and Palm Tran riders could be designed to enhance pedestrian awareness of the potential hazards of disregarding railroad warning devices.
- A System-Wide Education Program could enhance pedestrian awareness of and compliance with posted signs and regulations.

Enforcement

- A Targeted Enforcement Campaign at the crossing could support an education campaign while gaining further publicity for safe crossing practices.
- Better Display of Penalties, including posted signs with signal-violation penalties, could also serve as an effective deterrent.

SUG Recommended Risk Control Measures

The SUG observed high levels of trespass incidents involving pedestrians ducking under the gates to consistently violate the grade crossing warning devices. Recommended engineering treatments at this location include installation of gate skirts in conjunction with channelization. Construction of sidewalk and fencing is recommended adjacent to location A17. The SUG recommended a targeted pedestrian blitz along with an enforcement campaign aimed at Tri-rail, Amtrak, and Palm Tran riders.



Notes

- Ensure landscape channelization (southeast and southwest quadrant) does not interfere with grade crossing warning device maintenance. Potentially add a wall or barrier, in addition to the landscape, at these locations.

Location ID: A3
Description: ROW between 45th and 36th Streets

Priority Score: 24
Risk Class: A (High Risk)

Trespass History:
- 2 fatalities (02/07/08, 04/21/08)
- 14 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)
- 8 trespass events noted via Veolia reports (04/07/10-04/19/10)

Trespass Characteristics

Most events involve young trespassers crossing the ROW near the northeast corner of the Sunset Place Apartments on the west side of the ROW.

Potential Mitigation Strategies

Engineering

- Reinforcing the existing Channelization by eliminating the gaps between the concrete wall and the canal, or introducing landscaping, could help to alleviate trespass concerns along the ROW.
- Consistent Fencing along the east side of the track could also serve as an effective barrier to trespass activity.
- The introduction of a new Pedestrian Crossing such as an at-grade crossing or an overpass could provide pedestrians with a new, safer crossing point.

Education

- Given the high incidence of young trespassers along the corridor, an Education and Outreach Campaign focusing on Northmore Elementary School could serve as a low-cost, effective trespass mitigation strategy.
- An Officer on the Train (OOT) program could help identify trespass activity while providing law enforcement with a better understanding of the risks.

Enforcement

- A Targeted Enforcement Campaign along the corridor could support an education campaign while gaining further publicity for safe crossing practices.
- Better Display of Penalties, including posted signs with signal-violation penalties, could also serve as an effective deterrent.

SUG Recommended Risk Control Measures

The SUG observed that the high incidence of trespass events at the center of the corridor between the Sunset Place Apartments and Northmore Elementary School was a direct result of the long distance required to access safe crossing points. The SUG came to the consensus that the trespass issues along the ROW between 36th and 45th Streets were attributable to the absence of a suitable pedestrian grade crossing. Cognizant of the costs associated with the installation of an overpass, the SUG group recommended minor engineering treatments to modify existing control measures and restrict access to the ROW. The SUG advocated for an intensive Education campaign focused on the surrounding community and the students of Northmore Elementary School. Given the young age of many of the trespassers, an enforcement campaign was ill-advised.

Notes:

- Initial considerations include the installation of a pedestrian at-grade crossing near 39th Street. However, this proposal of a pedestrian at-grade crossing conflicts with Florida Department of Transportation Policy 000-725-002 which states that any added pedestrian crossing will need to be grade-separated.
- Wayfinding signage and channelization at closed crossings should be positioned in a manner that directs pedestrian activity to preferred crossing points while informing pedestrians of the penalties associated with illegally crossing the ROW.

Location ID: A19
Description: ROW between Banyan Boulevard and West Palm Beach Station

Priority Score: 17.5
Risk Class: B (Medium Risk)

Trespass History:

1 attempted suicide (11/24/09) – reported by Tri-Rail at the WPB station but exact location within property unknown

22 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)

4 trespass events noted via Veolia reports (04/07/10-04/19/10)

Trespass Characteristics

Most events involve rail system users walking to and from west side station platform from Banyan Boulevard. A small number (3 out of 22) locomotive video trespass events involved trespassers crossing the tracks in the section between the end of the inter-track fence and Banyan Boulevard.

Potential Mitigation Strategies

Engineering

- Enhancing the existing pedestrian channelization treatments on west side of ROW could limit access to the ROW.
  - "Y" Sidewalk Access Around CSX Control Box
  - Additional Landscaping / Fencing
  - Plastic Feelers along existing station fence
- An Enhanced Static Wayfinding Signage system or pavement markings could help guide pedestrians along the safest, designated route.
- Eliminating the Fencing and Landscaping altogether could also improve the visibility of the existing sidewalk, providing a clear line of sight of the safest route.

Education

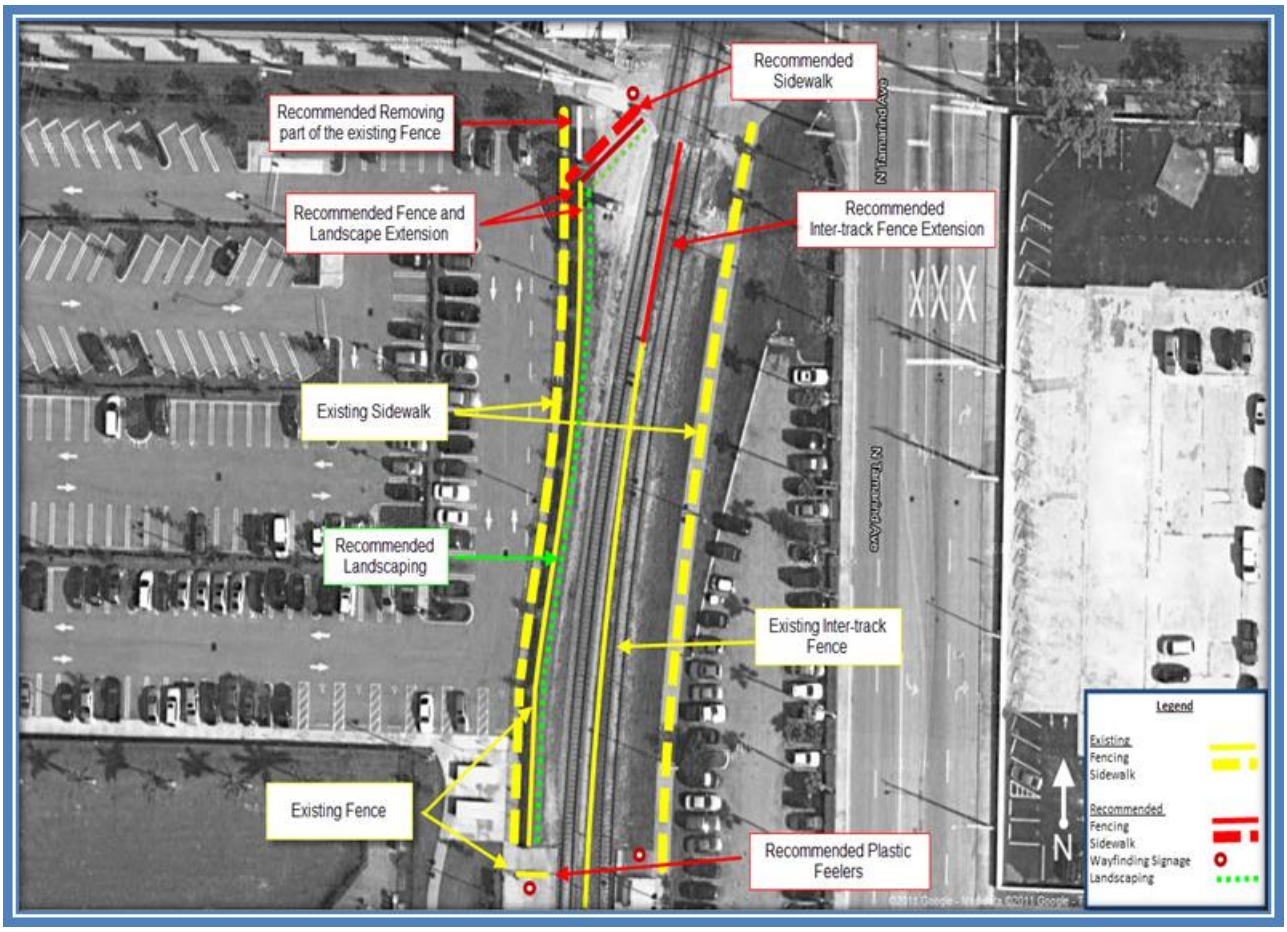
- A Targeted Pedestrian Blitz aimed at Tri-Rail, Amtrak, and Palm Tran riders could be designed to enhance pedestrian awareness of the potential hazards of disregarding railroad warning devices.

Enforcement

- A Targeted Enforcement Campaign at the station could support an education campaign while gaining further publicity for safe crossing practices. Stiff penalties such as delayed or denied boarding after a trespass violation could help deter future unsafe behavior.

SUG Recommended Risk Control Measures

The SUG observed high levels of rail system users walking to and from west side station platform from Banyan Boulevard. The SUG recommended enhancing the existing sidewalk on the west side by creating "Y" sidewalk access around the western most RR bungalow, installing plastic feelers along platform fence, extending the inter-track fence to Banyan Boulevard, landscaping the existing trail on the west side of the ROW, and enhancing static wayfinding signage. The SUG recommended a targeted pedestrian blitz aimed at Tri-rail, Amtrak, and Palm Tran riders, along with enforcement campaign emphasizing delayed or denied boarding for trespassers.


Recommended Sidewalk
Recommended Removing part of the existing Fence
Recommended Fence and Landscape Extension
Recommended Inter-track Fence Extension
Existing Sidewalk
Recommended Landscaping
Existing Inter-track Fence
Existing Fence
Recommended Plastic Feelers
N Tamiami Trl
Legend
Existing
Fencing
Sidewalk
Recommended
Fencing
Sidewalk
Wayfinding Signage
Landscaping
N

Location ID: A20
Description: Mockingbird CP

Priority Score: 12.5
Risk Class: B (Medium Risk)

Trespass History:

13 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)

2 trespass events noted via Veolia reports (04/07/10-04/19/10)

Trespass Characteristics

Most events involve rail and/or bus system users walking between west side of the ROW and east side station platform or Tamarind Avenue. Many trespassers are students at the Alexander W Dreyfoos Jr School on Tamarind Avenue.

Potential Mitigation Strategies

Engineering

- The creation of a Pedestrian-Only Grade Crossing south of the station could provide pedestrians with a safe, closer at-grade alternative for reaching destinations south and east of the station.
- The Extension of the Inter-Track Fence could eliminate the hazards of unsafe trespass behavior but could also have negative impacts on the rail system users.
    - The Extension of the Existing Fence west of the ROW could also reduce access to the ROW at this location.
- The Continuation of a Tri-Rail Operational Change, whereby southbound trains are routed to the East track for afternoon service, could also be maintained as a solution to minimize unsafe behavior.

Education

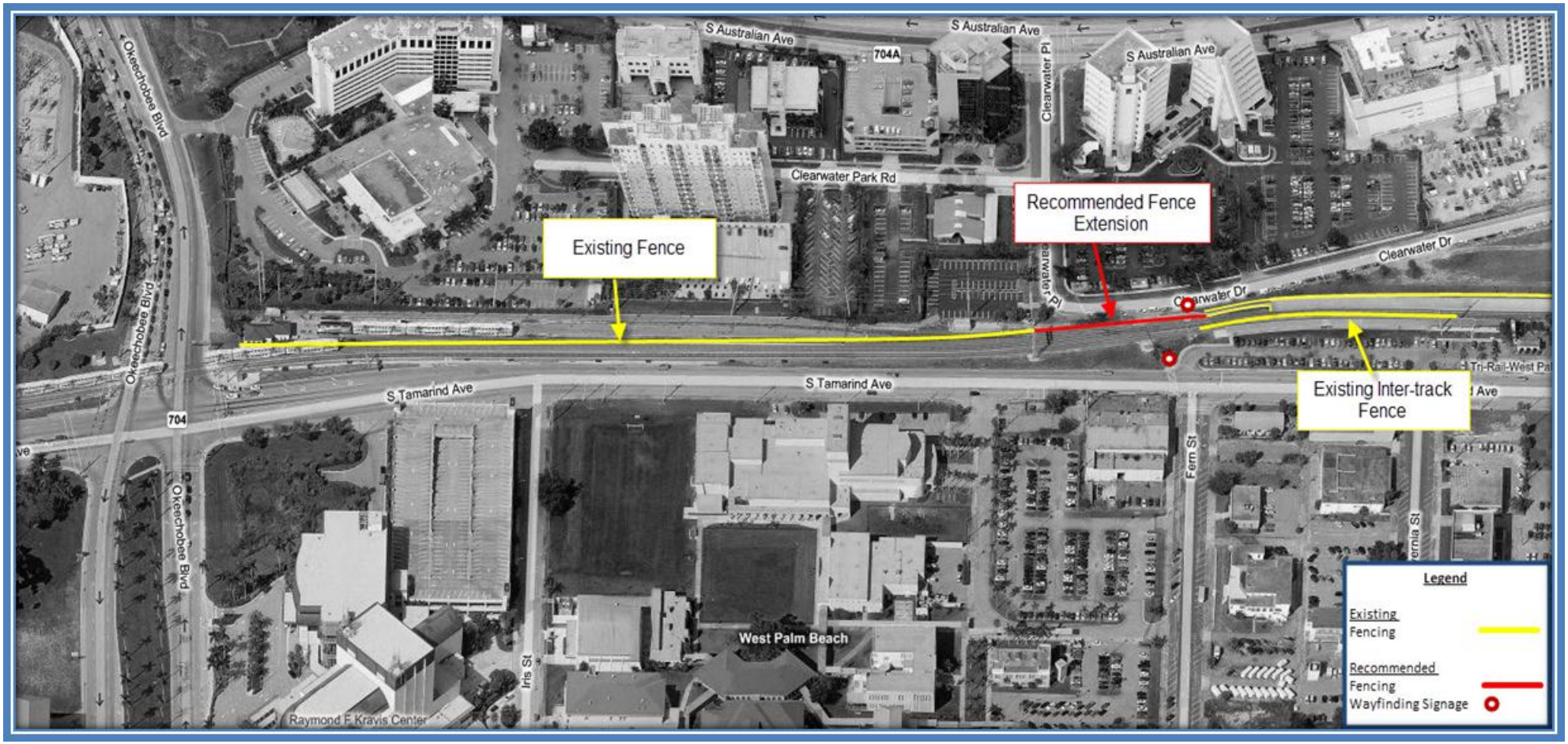
- A Targeted Pedestrian Blitz aimed at Tri-Rail, Amtrak, Palm Tran riders, and Dreyfoos students could be implemented to enhance pedestrian awareness.

Enforcement

- A Targeted Enforcement Campaign at the station could support an education campaign while gaining further publicity for safe crossing practices. Stiff penalties such as delayed or denied boarding after a trespass violation could help deter future unsafe behavior.
- Better Display of Penalties, including posted signs with signal-violation penalties, can also serve as an effective deterrent.

SUG Recommended Risk Control Measures

The SUG recommended an extension of the outer fence on the west side to connect with existing fence at the West Palm Beach Station to prevent pedestrians from walking on the ROW and crossing the track. The SUG recommended a targeted pedestrian blitz aimed at Tri-rail, Amtrak, Palm Tran riders, and Dreyfoos students, along with an enforcement campaign with penalties such as delayed or denied boarding for trespassers.



Notes

- Initial considerations include the installation of a pedestrian at-grade crossing south of the station near Fern Street. However, this proposal of a pedestrian at-grade crossing conflicts with Florida Department of Transportation Policy 000-725-002 which states that any added pedestrian crossing will need to be grade-separated.
- Initial considerations also include extending the Inter-Track fence. However, the SUG proposed extending the outer fence instead of extending the Inter-Track fence.

Location ID: A17
Description: ROW between 7th Street and Banyan Boulevard

Priority Score: 10.5
Risk Class: B (Medium Risk)

Trespass History:

21 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)

1 trespass event noted via Veolia reports (04/07/10-04/19/10)

Trespass Characteristics

Most events involve trespassers walking along the east side of the ROW parallel to Tamarind Avenue. A substantial number of trespassers walking southbound to Banyan Boulevard cross the tracks before they reach the grade crossing.

Potential Mitigation Strategies

Engineering

- A Pedestrian Channelization System offering a route of safe passage could involve the installation of a Sidewalk on the west side of Tamarind Avenue.
    - Coupled with Fencing or a Landscape Barrier, the sidewalk could serve as an effective channelization measure along the 1/3 mile corridor between the two grade crossings.
- Enhancing access to the existing crosswalk leading pedestrians across Tamarind Avenue at Banyan Boulevard could also guide pedestrians to an alternate route of safe passage.
    - A Static Wayfinding Signage system or pavement markings could help guide pedestrians along the safest, designated route.

Education

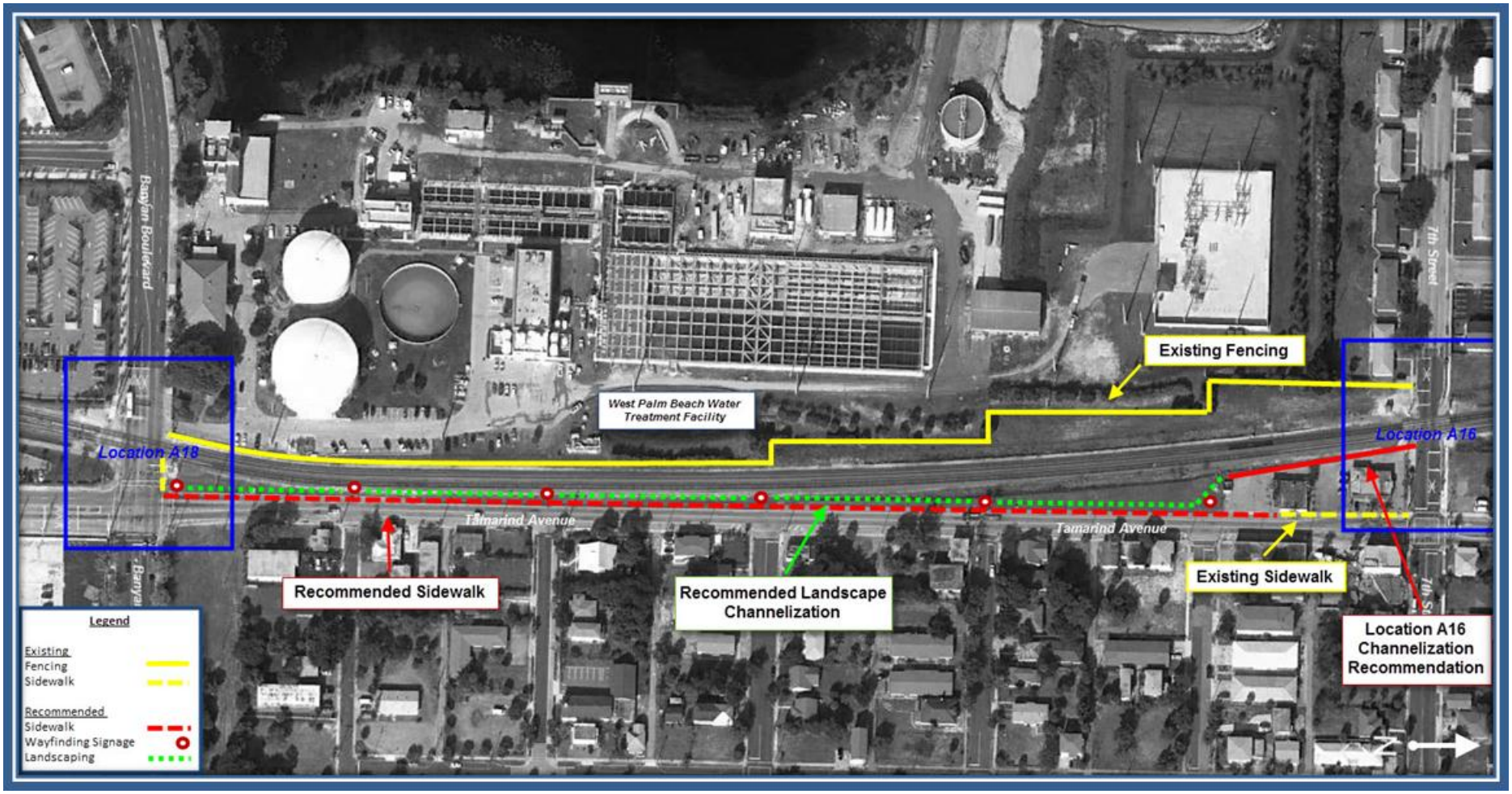
- A System-Wide Education Program could also enhance pedestrian awareness and compliance with posted signs and regulations.

Enforcement

- Posting No TRESPASSING signs with penalties and adequate wayfinding signage directing pedestrians to appropriate crossing points could be implemented in conjunction with a Targeted Enforcement Campaign.

SUG Recommended Risk Control Measures

The SUG supported the engineering recommendations to more clearly delineate a route of safe passage along the ROW. Though more costly than simply guiding pedestrians to the existing sidewalk on the east side of Tamarind Avenue, the SUG noted that the construction of a sidewalk on the west side would more clearly identify the safest route while increasing connectivity. Alternatively, the group supported channelization to the existing Tamarind Avenue crosswalk with a sidewalk, physical barrier, and wayfinding signage. The SUG suggested that a system-wide education program would be most applicable at this location and an enforcement campaign should be conducted subsequent to the installation of new wayfinding and No Trespassing signage, if necessary.



Notes:

- Further evaluation of the ROW width is necessary before proceeding with the proposed sidewalk on the west side of Tamarind Avenue. Should the ROW not contain sufficient space, the plan shall be revised to direct pedestrians to the existing sidewalk on the east side of Tamarind Avenue.

Location ID: A29
Description: ROW between Caroline and Boyd Streets

Priority Score: 10.5
Risk Class: B (Medium Risk)

Trespass History:
- 1 fatality (05/03/08)
- 5 trespass events recorded via Tri-Rail locomotive video (03/05/10-07/05/10)
- 2 trespass events noted via Tri-Rail reports – 1 noted as a near miss (10/11/04), 1 noted as forcing train to stop (02/21/10)

Trespass Characteristics

Most trespass events involve trespassers crossing the ROW at the closed crossing on Boyd Street. The closest alternate crossing locations are at Caroline Street approximately 1,600 feet north or at Belvedere Road approximately 1,200 feet south.

Potential Mitigation Strategies

Engineering

- Reinstating access to the Boyd Street crossing for pedestrians with a Pedestrian Grade Crossing could help eliminate unsafe crossing and trespass incidents.
- The closure of the crossing could be reinforced using a higher security fencing and channelization to the existing crossings located to the north and south.
  - The development of a Trail parallel to the ROW of the railroad and the canal could serve as a municipal beautification project while promoting safe crossing practices by guiding pedestrians and cyclists to the safest crossing points.
- The removal of the existing earthen "bridge" over canal could create an impenetrable barrier.

Education

- A System-Wide Education Program could enhance pedestrian awareness of and compliance with posted signs and regulations.

Enforcement

- Posting No TRESPASSING signs with penalties and adequate wayfinding signage directing pedestrians to appropriate crossing points could be implemented in conjunction with a Targeted Enforcement Campaign.

SUG Recommended Risk Control Measures

In lieu of reinstating a dedicated pedestrian crossing at Boyd Street, the SUG noted that an adequate channelization system, buttressed by wayfinding and No Trespassing signage, could be implemented to guide pedestrians to safe crossing points both north and south. A multi-use trail parallel to the ROW is one example of channelization that could dissuade trespass activity. The SUG supported the implementation of a system-wide education campaign to address education concerns and targeted enforcement at the closed Boyd Street crossing after adequate wayfinding and channelization measures had been made.

Notes:

- Initial considerations include the installation of a pedestrian at-grade crossing south of the station near Fern Street. However, this proposal of a pedestrian at-grade crossing conflicts with Florida Department of Transportation Policy 000-725-002 which states that any added pedestrian crossing will need to be grade-separated.
- Removal of the earthen dam and associated water flow control utilities integrated with the closed Boyd Street crossing were deemed unfeasible and/or too costly for the scope of recommendations.

Abbreviations and Acronyms

APTA	American Public Transportation Association
CAD	Computer Aided Dispatch
CARE	Community, Analysis, Response, Evaluation
CM	Countermeasures
DOT	United States Department of Transportation
DS	Debris Strikes
FA	Fatal Incidents
FDOT	Florida Department of Transportation
FEC	Florida East Coast Railway Company
FRA	Federal Railroad Administration
FS	Fatal Suicides (and attempts)
FTA	Federal Transit Administration
ID	Identification
LIRR	Long Island Rail Road
NJT	New Jersey Transit
OLI	Operation Lifesaver
PS	Priority Score
R&D	Research and Development
ROW	Right of Way
RSIA	Rail Safety Improvement Act
SFRC	South Florida Rail Corridor
SFRTA	South Florida Regional Transportation Authority
SSPP	System Safety Program Plan
SUG	Stakeholder Users Group
TCCX	Tri-County Commuter Rail Authority
TLSA	Trespass Severity Location Analysis
TPRS	Trespass Prevention Research Study
TR	Trespass Report
TSF	Trespass Severity Factor
US	United States

Volpe Center	Volpe National Transportation Systems Center
WPB	West Palm Beach