Hillsborough County Florida
EST. 1834

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TRANSPORTATION DESIGN MANUAL BULLETIN 23-03

DATE: January 11, 2023

TO: County Director of Engineering & Operations Department,
County Director of Capital Programs Department,
County Manager of Construction Services,
County Director of Transportation Maintenance Division,
County Project Managers, and Project Engineers of Record

FROM: County Engineer,
County Director of Technical Services Division

COPIES: County Director of Performance Data and Analytics Department

SUBJECT: **MULTIMODAL SAFETY ANALYSIS GUIDANCE FOR TRANSPORTATION PROJECTS**

This bulletin provides guidance for the implementation of new Multimodal Safety Analysis for Hillsborough County Transportation Projects.

REQUIREMENT

A Multimodal Safety Analysis is required to be conducted following the methodology provided in Pages 3 to 12 for all Hillsborough County Transportation Projects on context classified arterial and collector roadways.

BACKGROUND

Hillsborough County has the goal of reducing fatalities and serious injuries on County roads and intersections. As an action toward this goal, the County developed a Multimodal Safety Analysis methodology for all Transportation Projects in an effort to ensure that projects include a comprehensive multimodal safety analysis. The County has developed a methodology that provides a consistent multimodal safety approach that uses the most current safety practices.

This safety methodology is based on the most recent (as October 2022) versions of: American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM 1st Edition, 2013 with Errata), Federal Highway Administration (FHWA) Signalized Intersections Informational Guide (2nd Edition, 2013), National Cooperative Highway Research Programs (NCHRP), Florida Design Manual (FDM 2022), Florida Department of Transportation (FDOT) Safety Analysis Guidebook for PD&E Studies (FSAG, 2019), FDOT Traffic Engineering Manual (2022) and FDOT Manual on Uniform Traffic Studies (MUTS, 2016). Should any updated versions of the above referenced manuals or guides be published, the safety methodology would be based on the most recent versions of the aforementioned.

The Safety Analysis methodology provides for:

- Understanding of each crash by the examination of events before, during and after the crash.
- Understanding of the road users and potential safety issues through the application of Context Based Classification, multi-modal needs, and future community needs.
- Data driven approach which provides quantitative differences in safety performance between alternatives.

IMPLEMENTATION

This bulletin will be utilized on all project types listed in Table 1 of this bulletin for new projects, projects that are in scope and staff hour negotiations, or projects that have a change in scope and/or design concept.

CONTACT

Please use the email link below to address any questions or comments in reference to this Design Bulletin:

PW-Standards_Inquiry

Recommended / Date:

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Michael J. Williams, Professional Engineer
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PREVIOUS SAFETY ANALYSIS

A Safety Analysis is typically required for all project development tasks including Project Development and Environment (PD&E) Report and Preliminary Engineering Reports (PER). If a Safety Analysis was previously performed, it should be reviewed to determine if the procedures below were applied. Additionally, if any changes of land use, user behavior, crash rate, fatal/serious injury rate have occurred since the most recent Safety Analysis was performed, an engineering review should be performed to determine if an updated Safety Analysis is required. The Engineer of Record must obtain documented approval from the County's Technical Service Division for all Safety Analysis recommendations.

MULTIMODAL SAFETY ANALYSIS OUTLINE

The following Multimodal Safety Analysis procedures are required for all County Transportation Projects on context classified arterial and collector roadways and must be coordinated with the County Project Manager (PM) to obtain documented approval from the County's Technical Services Division, Traffic Engineering Section. The analysis procedures are outlined into 4 sections as described below. The Safety Analysis report should follow the outline and include all following sections:

- Crash Data Collection and Review
    - Crash Data Collection
    - Crash Data Summary
    - Collision Diagram
- Multimodal Safety Diagnosis
    - Review of Supporting Documents
    - Assessment of Field Conditions
    - Crash Contributing Factors (Haddon Matrix) and Potential Safety Concerns
- Selection of Countermeasures
    - Develop Countermeasures
    - Safety Effect Evaluation
    - Benefit Cost Analysis
- Recommendations:
    - Recommended Countermeasures/Solutions
    - Consideration of Innovative Solutions Beyond Countermeasure Selection
    - Countermeasure Implementation Plan

CRASH DATA COLLECTION AND REVIEW

Crash Data Collection

Crash data is the basis for the Multimodal Safety Analysis. Crash data should be collected following the requirements below:

1) Analysis Area:
   The study limits of a Multimodal Safety Analysis should be the project limits and the adjacent areas of influence which may extend beyond the project limits. The adjacent area of influence should consider all users (for example, vehicles, bicyclists, pedestrians) and their exposure to the project. The influence area proposed by the Engineer of Record should be coordinated with the County PM to obtain documented approval from the County's Technical Services Division, Traffic Engineering Section.
2) Analysis Period:
   Multimodal Safety Analysis will be performed by analyzing the most current five years of complete historical crash data.
3) Crash Data Source:
   For facilities owned or maintained by the County, crash data should be obtained from Crash Data Management System (CDMS). If other crash data sources are used, including University of Florida's Signal Four Analytics or FDOT's Safety Office CDMS Crash Analysis Record (CARS), the crash data must be coordinated with the County PM to obtain documented approval from the County's Technical Services Division, Traffic Engineering Section.

Documentation

The results of Crash Data Collection and Review must include:

- A crash data summary table reporting:
  - Statistical data summary of crash patterns based on crash severity level to identify high-risk conditions.
  - Calculate crash rates and compare with FDOT's statewide average crash rate minus 1 standard deviation for a similar facility type.

  The Crash Data Summary Table is provided in Appendix B1 and can be found in excel format at the following link: *Hillsborough County Public Work Crash Data Summary Table*.

- A collision diagram to provide a visual representation of crash patterns and help identify crash clusters by crash location. The collision diagram should follow the requirements in the most current version of FDOT's MUTS.

- A summary of identified crash patterns from the crash data summary table and the collision diagram.

MULTIMODAL SAFETY DIAGNOSIS

A Multimodal Safety Diagnosis must be performed to identify contributing factors and potential safety concerns. The diagnosis will involve reviewing supporting documentation and assessing field conditions, which provides an additional perspective to the Crash Data Collection and Review.

Supporting Documentation
Reviewing supporting documentation can provide additional information which can explain the observed crash patterns from the Crash Data Collection and Review and assist into identifying safety concerns for newly planned developments near the project location. Supporting documentation includes, but is not limited to, Context Based Classification, community plan needs as identified in the Comprehensive Plan's Livable Communities Element, current traffic volumes for all travel modes, and recent transportation studies.

Field Observations
Field observations can serve to validate the safety concerns in the Crash Data Collection and Review and from the supporting document assessment. The required field review should address how users of different modes travel through the project limits, particularly those more vulnerable in crashes. Vulnerable users within the project context should include the elderly, children, disabled populations, pedestrians, bicyclists, and motorcyclists. The criteria and conditions experienced within the decision sight distance limits must be identified. Field observations must be conducted for both daytime and nighttime conditions. An assessment of filed conditions include considerations of, but not limited to, traffic operations, geometric conditions, physical conditions and weather, traveler behavior, transit, pedestrian, bicycle and other vulnerable road user activity, heavy vehicle activity. A Field Assessment Form is provided in Appendix B2 at the end of this document.

Crash Contributing Factors (Haddon Matrix) and Potential Safety Concerns
Crash contributing factors are distributed into three categories: human, vehicle, and roadway/environment, and they should be examined in three crash phases, including:

1) **Before the Crash** phase includes vehicle movements and dynamics between movements and roadway conditions and geometry, as well as the critical event immediately prior to a crash. (For example, motorist behavior and conditions).

2) **During the Crash** phase includes the crash description about critical event (for example, vehicle direction, location), crash type and physical condition when each crash occurred (for example, crash time, pavement condition, sight obstructions, roadway geometry - horizontal and vertical, and lighting condition).

3) **After the Crash** phase includes the results of a crash (for example, crash severity, injuries, and fatalities).

The three-phase analysis of crash contributing factors, or commonly referred to as the Haddon Matrix, can be conducted for each crash by reviewing crash data, field assessment and project historical aerial when the crash occurred (for example, Google Earth Historical Imagery or FDOT Aerial Photo Look Up System). The detailed evaluation factors for developing Haddon Matrix are included in the table below. Due to data availability issue, vehicle factors for the phase of after the crash, such as integrity of fuel system, ease of access and fire risk, and roadway/environmental factors, such as distance from trauma center, incident management, roadway congestion, are not applicable for transportation improvement projects.

PHASES	HUMAN FACTORS	VEHICLE FACTORS	ROADWAY/ENVIRONMENTAL FACTORS
BEFORE THE CRASH	• Driver vision • Impairment • Driver attention • Driver age	• Speed of vehicle	• Road design and markings • Intersection configuration • Roadway lighting • Speed limit
DURING THE CRASH	• Use of restraints/ Child restraint use • Airbag use • Driver action • Non-Motorist action	• Vehicle size • Vehicle year	• Presence of fixed objects near roadside • Roadside embankments • Guard rails and median barriers • Crash light condition
AFTER THE CRASH	• Severity of injuries • Age of occupant	Not Applicable	Not Applicable

The key contributing factors should be identified to each crash and summarized for each crash pattern and safety concern. Examples of contributing factors are provided in the Section of 6.2.2 of HSM (1st Edition, 2010) and discussed in detail in NCHRP Report 500. If three-phase crash data review (Haddon Matrix) is not conducted for all crashes, a justification should be submitted to the County PM to obtain documented approval from the County's Technical Services Division, Traffic Engineer Section.

<u>Documentation</u>

The results of the Multimodal Safety Diagnosis should include:

- Summary of supporting documents and potential safety concerns.
- Summary of field observations and potential safety concerns. (Appendix B2)
- Haddon Matrix development and key contributing factors for each crash.
- Crash contributing factors summary for identified crash patterns and for any safety concerns identified above.

SELECTION OF COUNTERMEASURES

Countermeasure selection must be conducted after completing the Data Collection and Review and Multimodal Safety Diagnosis.

Develop Countermeasures

After identifying contributing factors based on crash data analysis results from Data Collection and Review and identification of safety concerns from the Multimodal Safety Diagnosis, countermeasures must be developed. More than one countermeasure may be applied to address each of the identified contributing factors and potential safety concerns. Innovative countermeasures with analyses of human behavior are encouraged but must be documented before application and be consistent with the Vision Zero principle of reducing fatal/serious injury crashes. To help facilitate the development of countermeasures, several national best practice resources are available through Federal Highway Administration's (FHWA) website.

Evaluate Crash Reduction Effectiveness

The crash reduction effectiveness of all potential countermeasures should be evaluated quantitatively by calculating the potential changes of crash frequencies after countermeasure implementation. Some countermeasures proposed may not have available or sufficient data to evaluate crash reduction effectiveness, thus, these improvements must be coordinated with the County PM to obtain documented approval from the County's Technical Services Division, Traffic Engineering Section. The potential changes of crash frequencies can be calculated using either of the two methods as discussed below:

1) Crash Modification Factors (CMF) Method:
   CMFs can be obtained from the FHWA *CMF Clearinghouse* (star quality rating should be at least 3 stars). Details for selecting an appropriate CMF, applying multiple CMFs and comparison of CMFs can be found in Section of 5 in the FSAG (FDOT, 2019).

2) HSM Predictive Method:
   This method can be used to evaluate current and future safety performance of road projects. Details for applying the predictive method in Florida and available calculation tools can be found in Section of 6 in the FSAG (FDOT, 2019).

The appropriate method depends on many issues including the type of project proposed, safety issues and availability of Safety Performance Functions (SPFs), calibration factors and data. The suggested recommendation for selecting the appropriate method for different Transportation Projects is provided in the table below. If the selected methodology differs from the table, coordinate with the County PM to obtain documented approval from the County's Technical Services Division, Traffic Engineering Section.

Table 1 Methodology Selection

PROJECT TYPE	CMF METHOD	HSM PREDICTIVE METHOD
CORRIDOR RECONSTRUCTION		✓
NEW CONSTRUCTION		✓
RESURFACING, RESTORATION, AND REHABILITATION (RRR)	✓	
INTERSECTION MODIFICATIONS AND SIGNALIZATION UPDATES [1]	✓	✓
PEDESTRIAN/BICYCLE CORRIDORS	✓	✓
TRAILS CROSSINGS	✓	
BRIDGES WIDENING	✓	
SCHOOL ROUTES SAFETY IMPROVEMENTS	✓	
OTHER SAFETY AND MOBILITY PROJECTS [2]	✓	✓
COMPLETE STREETS	✓	✓

[1] For Intersections and Signalization Projects, the HSM Predictive Method will be required where there are major differences including changes in: traffic control, number of thru lanes, exceed one additional turn lane, right-of-way needs and future land use.

[2] Midblock Crossings, Access Management Improvements, Safety Lighting, Safe Route to Transit, Corridor Speed Management.

Benefit Cost Analysis

To rank the selected countermeasure or combination of countermeasures, Benefit Cost Analysis (BCA) must be performed by monetizing safety benefits associated with the projected reduction in crash frequencies. Ranking the societal costs is a summary of the construction, operation, maintenance, and other costs anticipated over the life of the project. Detailed BCA parameters, methods, and crash cost data are included in FDM Chapter 122.6 (FDOT, 2022). Either Net Present Value or Benefit Cost (B/C) Ratio can be the measurement to compare benefits to costs and prioritize the countermeasures. Some consideration factors cannot be monetized, including community vision and environment, public demand, public perception and acceptance, road user needs, and so on. To determine the recommended countermeasure or combination of countermeasures, a benefit-cost analysis in monetary terms may serve as the primary decision-making tool, with secondary consideration of qualitative (non-monetized) factors.

Documentation

The results of the Countermeasure Selection should include:

- List of countermeasures for the identified contributing factors and potential safety concerns.
- Evaluation method and results of crash reduction effectiveness for each countermeasure or combination of countermeasures.
- BCA Results and qualitative factor considerations

RECOMMENDATIONS

Recommendations of a countermeasure or a combination of countermeasures with supporting explanation must be provided based on the BCA and qualitative evaluation results. Innovative solutions beyond countermeasure selection are encouraged, but the effectiveness of reducing fatal/severe injury crashes and implementation concerns should be documented. The implementation plan for recommended countermeasures should be discussed and documented.

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APPENDIX B2

SAFETY ANALYSIS
FIELD ASSESSMENT FORM

General Information

County Street Name and/or Road Number: ______________________
Project Description (limits): ______________________
County Capital Improvement Program Number: ______________________
Date:

1. Traffic Operations

- ☐ Traffic control devices
- ☐ Traffic signal operations (support, type of detection, backplates, indications, cycle length, phasing, displays, intervals, phase sequence, clearance times, detection, pedestrian signals, timing, and so forth) NOTE: These factors need to be documented for rear-end, left-turn, right angle, right-turn, pedestrian and bicycle crashes
- ☐ Queue on the intersection approaches, adequate capacity?
- ☐ Access management: mainline access to adjacent land negatively influence traffic operations

2. Geometric Conditions

- ☐ Visual obstructions (trees/scrubs blocking signs, pedestrians, parked vehicles, advertising signs, and so forth)
- ☐ Decision Sight Distance
- ☐ Road side private property (bright signage, glare, detractions, and other items impacting drivers)
- ☐ Clear zones (roadside objects, pedestrian standing areas, bus stops, and so forth)
- ☐ Recent roadway geometry changes
- ☐ Site design compares to Hillsborough County design criteria and other related guidelines
- ☐ Transition area (area where drivers are alerted that the roadway conditions are changing)

3. Physical Conditions & Weather

- ☐ Road conditions including pavement and friction
- ☐ Roadway, separator, and shoulder tire marks
- ☐ Sequence and spacing of signs (measured relative to posted speed limit)

- ☐ Too many signs for drivers to evaluate and react
- ☐ Signs and pavement markings deliver right messaging for conditions
- ☐ Placement of stop bars
- ☐ Sign legibility at night and poor weather conditions
- ☐ Environment (sun, shadowing impacting perception and visibility especially during dawn and dusk for east/west roadways)
- ☐ Roadside erosion resulting in drop-off conditions
- ☐ Pavement markings obscured by water or lack of contrast
- ☐ Daylight evaluation
- ☐ Darkness evaluation especially lighting conditions at intersections and crosswalks
- ☐ Headlights from oncoming traffic
- ☐ Glare and reflection from windows, metal, and pavement making signs and markings hard to see
- ☐ Pavement marking retroreflectivity at night

4. Traveler Behavior

- ☐ Driver behavior:
  - Aggressive driving
  - Speeding
  - Ignoring traffic control
  - Failing to yield to pedestrians
  - Making maneuvers through insufficient gaps in traffic
  - Belted or unbelted
  - Elderly drivers
- ☐ Bicyclist behavior:
  - Riding on the sidewalk instead of the bike lane
  - Riding excessively close to the curb or travel lane within the bicycle lane
  - Ignoring traffic control
  - Not wearing helmets
- ☐ Pedestrian behavior:
  - Ignoring traffic control to cross intersections or roadways
  - Insufficient pedestrian crossing spaces and signal time, Roadway design that encourages pedestrians to improperly use facilities

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5. Transit, Bicycle Pedestrian and Other Vulnerable Road User Activity

- ☐ Location of pedestrian generators and attractors
- ☐ Placement of crosswalk markings
- ☐ Waiting time for pedestrians
- ☐ Potential to introduce other travel modes (e.g. new bus stops, sidewalks, bike lanes, or multi-use trail)
- ☐ Placement of bus stop
- ☐ Continuous bicycle or pedestrian network
- ☐ The way of vulnerable road users interacting with the road facilities
- ☐ Visual clues exist to alert motorists to pedestrians and bicycles (e.g. striped bike lanes, curb extensions at intersection for pedestrians)
- ☐ Other multimodal concerns:
    - Roadway shoulders and edge treatments
    - Exclusive or shared transit lanes
    - Adjacent parking

6. Heavy Vehicle Activity

- ☐ Percentage of heavy vehicle
- ☐ Heavy vehicle concerns:
    - Sight Distance
    - Signal Operations
    - Emergency vehicle
    - Freight truck maneuvers in the site vicinity
    - Presence of road maintenance or farm vehicles