

Napa County Left Turn Lane Screening Update

Internal Document – For County records only



A Tradition of Stewardship
A Commitment to Service

Prepared for:
County of Napa
Department of Public Works

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Introduction

Background

The County currently relies on an established left-turn lane warrant to guide decisions regarding the installation of left-turn lanes at intersections. As traffic conditions, safety considerations, and industry best practices evolve, it is important to periodically review its evaluation process to confirm they remain technically sound, consistently applied, and aligned with current research and peer-agency practices. Recent applications of the County's warrant, along with ongoing national research into left-turn operations and safety, provide an opportunity to evaluate whether refinements or updates to the existing criteria may be appropriate.

Purpose

The purpose of this effort is to evaluate the County's existing left-turn lane warrant, compare it to current research and practices used by similar jurisdictions, and develop potential options for revising, amending, or replacing the current process. This work is intended to support informed, transparent, and defensible engineering decisions related to left-turn lane implementation, while maintaining consistency with accepted traffic engineering principles.

Study Approach

To achieve this purpose, Fehr & Peers conducted a focused review of recent County warrant applications, relevant County research, and national guidance related to left-turn lane screening, including National Cooperative Highway Research Program (NCHRP) Report 457. In addition, left-turn lane screening criteria from peer agencies were reviewed to provide context on how other jurisdictions address similar operational and safety considerations.

Based on this research and review, Fehr & Peers has prepared this report summarizing key findings and observations for County review. Following County feedback, this report presents a set of draft recommendations outlining an approach for revising the County's left-turn lane screening process. Our recommended process is supported by its engineering basis, anticipated data and analysis requirements, and a discussion of how the revised process would be implemented by the County and completed by potential applicants.

For consistency with the County's existing terminology, this report uses the term "warrant" when referring to the County's current evaluation process. However, the term "screening" is generally more appropriate for the methodologies reviewed and recommended in this report. Unlike a regulatory warrant, which implies that a specific condition definitively justifies or requires a treatment, a screening process is intended to identify locations where a left-turn lane may be beneficial and merit further engineering review. Accordingly, the recommended approach is best understood as a screening tool that supports, rather than replaces, engineering judgment and consideration of site-specific factors.

Report Structure

This report includes the following sections to summarize the work done to date and our recommendations:

- Existing Process
- Research Review
- Proposed Revised Process
- Recommendations
- Implementation

Existing Process

The Department of Planning, Building & Environmental Services of County of Napa maintains the *Napa County Road & Street Standards*. This document outlines requirements for County maintained roads such as classification, design criteria, and the left turn lane warrant graph found in the traffic control devices section.

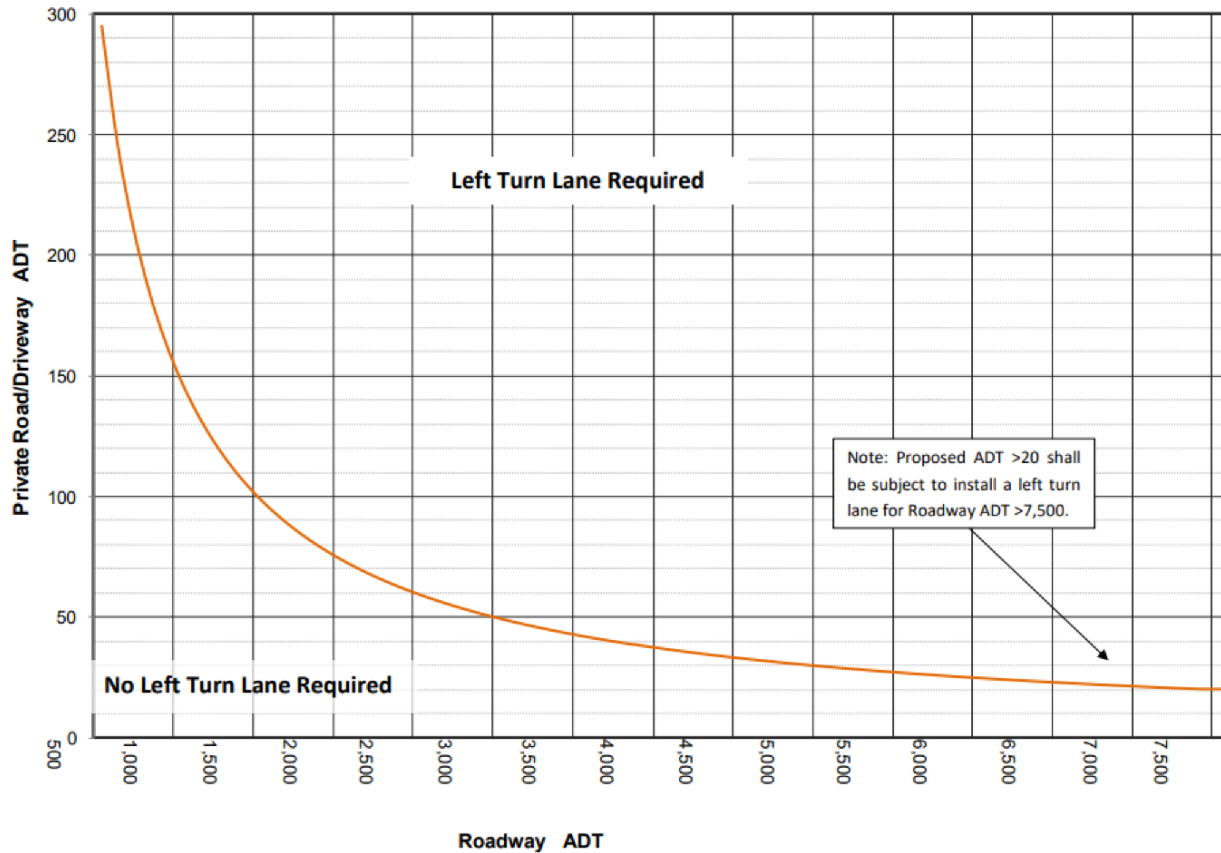
The left-turn lane warrant would necessitate a left-turn lane based on the following criteria:

- Application of the Left-Turn Lane Warrant Graph (shown below) based on road average daily traffic (ADT) and the projected ADT of the proposed use. A left-turn lane will not be considered for uses generating an ADT of 10 or less.
- If the corner sight distance in advancing direction, measured from the driveway, is less than required per Caltrans design standard, a left-turn lane shall be installed.
- If traffic conditions or turning movements pose a considerable threat to public safety, as determined by the Director or Public Works, a left-turn lane shall be installed.

Should the project warrant a left-turn lane, the design of the left-turn lane shall be prepared based on the County Standard Detail LTL-1.

The data inputs the existing process requires to determine the need for a left turn lane is the daily trips generation of the proposed land use.

LEFT TURN LANE WARRANT GRAPH



Research

Fehr & Peers was asked to review relevant national research and guidance to understand current best practices for left-turn lane warrants, and to support a review of the County's existing left-turn lane warrant process and methodology, including opportunities for refinement.

This review compiles key national guidance documents, agency standards, and research studies spanning more than five decades, dating back to 1967. The review began with NCHRP Report 745, which represents the most recent national guidance on left-turn lane warrants. The AASHTO Green Book, which serves as the foundation for many agency roadway design manuals, references NCHRP 745 as the primary basis for left-turn lane warrant guidance.

NCHRP 745 itself builds upon earlier work published in Development of Left-Turn Lane Warrants for Unsignalized Intersections (NCHRP Web-Only Document 193, 2013). Tracing further back, the first edition of the Green Book (1984) cites Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections (Harmelink, 1967). Our review found that this 1967 study has served as the foundational basis for many subsequent national and agency-level guidelines.

Neighboring Agencies Standards for Left Turn Lanes

Requirements for evaluating the need for a left-turn lane are typically included in formal Traffic Impact Study (TIS) or Traffic Impact Analysis (TIA) guidelines. We conducted a review of publicly available guidelines from over 50 California cities and counties, including Marin, Solano, Mendocino, Yolo, and Lake Counties. While most agencies require that projects be studied for potential intersection channelization improvements, such as left- or right-turn lanes, the vast majority do not provide explicit guidance on how to determine whether a turn lane is warranted. Only Sonoma County and Napa County include a clear, formal statement about how a project should determine whether a left-turn lane is required.

Some agencies, including the Cities of Riverside, Banning, Murrieta, and Redding, incorporate traffic control and turn-lane needs as part of the overall safety and operational elements that a TIA or TIS is required to study. In these cases, left-turn lanes are considered as potential mitigation for operational deficiencies, queuing, or safety concerns. However, these guidelines generally do not provide an explicit methodology or criteria that a project applicant must apply, leaving the determination to professional judgment or agency review rather than a standardized warrant approach.

Sonoma County's *Guidelines for Traffic Impact Studies* (2016) state that a project's traffic addition is considered to warrant a left- or right-turn lane if the resulting intersection approach meets or exceeds the criteria identified in the Intersection Channelization Design Guide (NCHRP Report 279, Transportation Research Board, 1985) for County roadways. This approach provides a clear methodology for evaluating the operational need for turn lanes and is intended to ensure consistent, defensible application across the County. A discussion of NCHRP Report 279 and its methodology is provided in the following section.

Napa County's TIS guidelines also require an evaluation of whether a project would warrant a left-turn lane. Projects must include a turn-lane warrant assessment as part of either a full TIS or a limited transportation analysis, regardless of the project's size. If the analysis shows that the project meets the County's criteria for providing a left-turn lane—based on turning movement volumes, roadway type, and County standards—the lane is considered required and must be included as a mitigation measure in the project's design.

Review of Guidelines, Publications, and Standards

This section summarizes the key guidelines, research publications, and agency standards reviewed to inform the evaluation of left-turn lane warrants. The review spans nationally recognized research, historical studies, and professional guidance documents, including highway design manuals and traffic impact study methodologies. The purpose is to provide a comprehensive understanding of how left-turn lane warrants have been developed, applied, and referenced by agencies, highlighting both the evolution of methodologies and the most current guidance that could inform County practice.

National Guidance

The National Cooperative Highway Research Program (NCHRP) develops research-based guidance for transportation agencies across the United States. NCHRP reports, such as 279, 457, and 745, provide nationally recognized methodologies for evaluating intersection improvements, including left-turn lane warrants, and form the foundation for many agency standards and the AASHTO Green Book referenced in this review. These documents represent the most authoritative, research-backed national guidance available for determining when left-turn lanes are warranted. The sections that follow summarize each report, highlight key takeaways, and describe their practical application and relevance to County practice.

NCHRP 745: Left-Turn Accommodations at Unsignalized Intersections¹

Key Takeaway: This is the latest national guidance with a robust selection of screening graphs.

The inputs of these screening processes include geographic location, intersection geometry, and hourly volume. The report also outlines design decisions related to left-turn lanes. Warrants were based on a benefit-cost analysis conducted with the Highway Safety Manual (American Association of State Highway Officials, 2010). The full derivation of the left-turn lane warrants is documented in Development of Left-Turn Lane Warrants for Unsignalized Intersections, NCHRP Web-Only Document 193 (2013).

Helpful attributes of the report include:

- **Decision Flow Chart:** Provides a visual tool to quickly identify if a left-turn lane is appropriate before referring to the graphs.
- **Intersection Geometry:** Offers guidance on including a left-turn lane when a project connects to an existing minor road.
- **Distinct Thresholds:** Each warrant graph uses a straight or sloped line. A similar approach in updated warrants prevents ambiguity for projects near curved thresholds.

The pertinent charts for left turn warrant for rural two-lane highways with a side street connection is shown below.

¹ [NCHRP Report 745: Left-Turn Accommodations at Unsignalized Intersections](#), Transportation Research Board, Washington, D.C., 2013

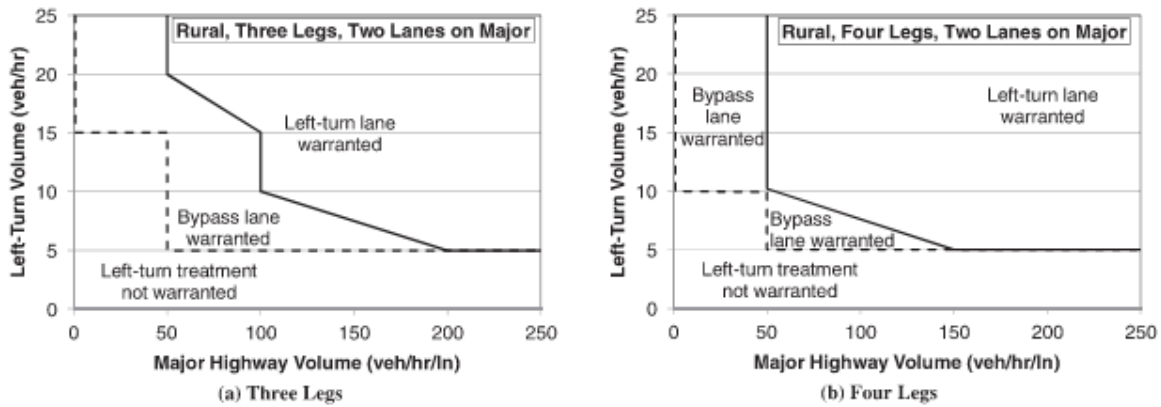


Figure 2. Recommended left-turn treatment warrants for intersections on rural two-lane highways.

NCHRP 457: Evaluating Intersection Improvements: An Engineering Study Guide (2001)²

Key Takeaway: Warrants are the same as NCHRP 279.

This guide also includes suggested turn-bay lengths based on hourly volume. Excel workbooks for each graph allow a user to input values and obtain plotted results, minimizing interpolation errors. However, Caltrans HDM Chapter 400 (2020) establishes design guidance for left-turn channelization. Some of the charts from this document are shown below.

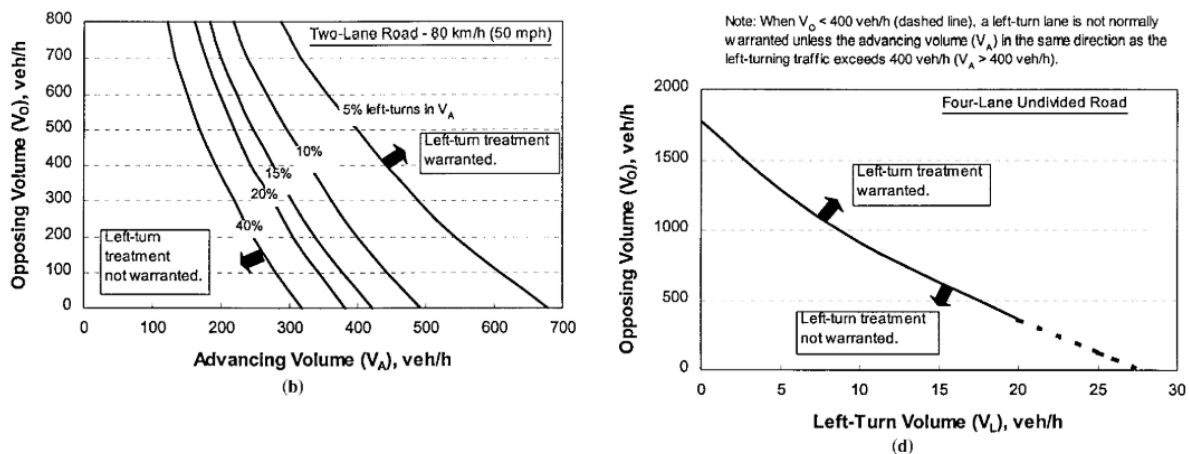


Figure 2-5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

² NCHRP Report 457: Evaluating Intersection Improvements: An Engineering Study Guide, Transportation Research Board, Washington, D.C., 2001

NCHRP 279: Intersection Channelization Design Guide (1985)³

Key Takeaway: Based on a study conducted in 1967. Sonoma County uses this guide for left-turn lane warrants.

The warrants are derived from Volume Warrants for Left Turn Storage Lanes at Unsignalized Grade Intersections (Harmelink, 1967). Harmelink's research forms the foundation of NCHRP 279 and 457, which appears similar to the County's current warrant approach. Graphs generally follow a negative exponential distribution. The report also provides exhibits describing general capacities for left-turn lanes and phases as a planning tool. Some of the charts related to left turn lane warrants from this guide is shown below.

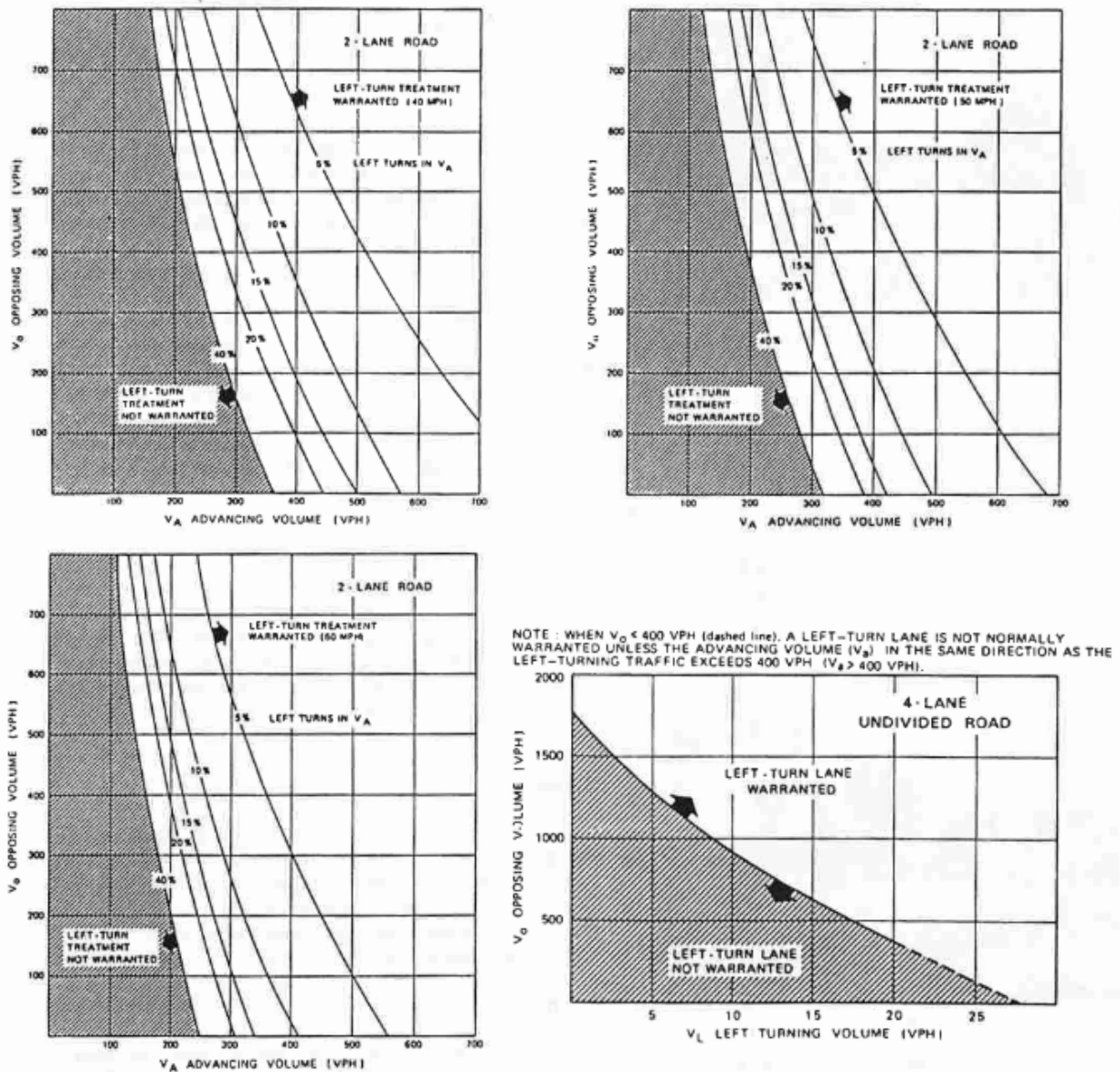


Figure 4-12. Volume warrants for left-turn lanes at unsignalized intersections. (Source: Ref. 4-7)

³ NCHRP Report 279: Intersection Channelization Design Guide, Transportation Research Board, Washington, D.C., 1985

AASHTO Guidance

2018 Edition⁴: Adopts NCHRP 745 into the guidelines (Section 9.7.3.1, “Guidelines for Provision and Design of Left-Turn and Bypass”).

1984 Edition⁵: Adopts Harmelink’s 1967 study for at-grade intersections, citing volume warrants for left-turn storage lanes.

Volume Warrants for Left Turn Storage Lanes at Unsignalized Grade Intersections (1967)⁶

Key Takeaway: This study is the basis for multiple guides and agency standards.

The study derived volume warrants and designed charts for two- and four-lane roadways based on the probability that a left-turning vehicle would impede opposing traffic and cause a queue. It has informed most subsequent national guidance. Below is an example of one of the left turn warrant graphs from this document.

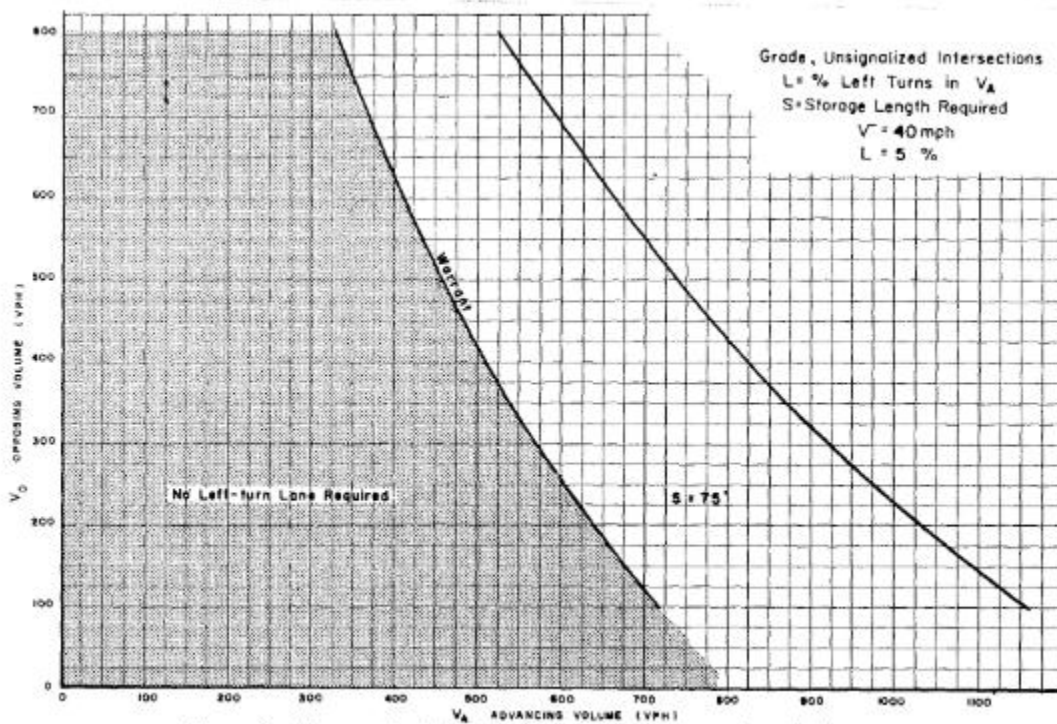


Figure 2. Warrant for left-turn storage lanes on two-lane highways.

⁴ A Policy on Geometric Design of Highways and Streets, “The Green Book,” 7th Edition, AASHTO, 2018

⁵ A Policy on Geometric Design of Highways and Streets, “The Green Book,” AASHTO, 1984

⁶ Volume Warrants for Left Turn Storage Lanes at Unsignalized Grade Intersections, M.D. Harmelink, 1967

State Guidance

Caltrans Guidelines for Reconstruction of Intersections (1985)⁷

Key Takeaway: Appears to use the same warrants outlined in Harmelink’s 1967 study.

The guidelines appear to be similar to the exhibit shown in the 1984 Green Book. After reviewing data provided by the County for previous applications, we found that the Caltrans Methodology will seldom support requiring a left-turn lane since the volume thresholds are much higher than more recent guidance and research.

Agency Use of NCHRP 745

While the Caltrans Highway Design Manual does not explicitly reference NCHRP 745, several agencies in the United States have incorporated it or the 2018 AASHTO Green Book (which contains the same warrant exhibits) into their guidelines:

- **Tennessee Department of Transportation:** Uses NCHRP 745 in the Highway System Access Manual (Volume 3, 2021) to install left-turn lanes and mitigate conflicts at unsignalized locations.
- **Port Authority of New York and New Jersey:** Uses NCHRP 745 in the Roadway Access Management Guidelines (2017) for redevelopment planning.
- **Idaho Transportation Department:** Uses the 2018 AASHTO Green Book in the Traffic Manual (2020) for left-turn lane warrants.
- **Texas Department of Transportation:** Uses the 2018 AASHTO Green Book in the Roadway Design Manual (2024) for rural left-turn lane warrants.

Key Findings

The most recent nationally recognized research supporting left-turn lane warrants is NCHRP 745. Historical studies, including Harmelink (1967), NCHRP 279, and NCHRP 457, provide the foundation for current practices. Based on this review, a recommendation has been developed for the County to adopt a methodology consistent with NCHRP 745. The following section compares previous project applications with the results that would be obtained under NCHRP 745 methodology.

⁷ Guidelines for Reconstruction of Intersections, California Department of Transportation, 1985

Proposed Revised Process

To test the application of NCHRP 745, the County of Napa provided a series of past project applications. While these prior studies offered valuable context, they did not include all the data elements needed to directly apply NCHRP 745 methodology. Missing data included existing peak hour turning movement counts, projected peak hour turning movements for the proposed projects, and proposed trip distribution/assignment. Without this information, applying the methodology would have required making several assumptions based on traffic engineering judgment. To address this, our team supplemented the original studies with additional estimates and carefully considered assumptions, enabling the use of NCHRP 745 to screen for potential left-turn lane needs while minimizing speculation.

Assumptions

As stated above, the data provided to our team from these studies/applications typically did not include hourly project trip distributions, turning movement counts, or traffic assignment details. Because this information was not available, we made the following assumptions based on traffic engineering judgment:

- **Peak hour trip distribution:** The peak hour is assumed to have a 50/50 in/out split.
 - For wineries, the ITE Trip Generation Manual indicates that a 50/50 in/out split is typical during peak hours.
 - Sensitivity testing was conducted using skewed trip distributions to evaluate potential variation.
- **Directionality of left/right turns:** Trips entering or exiting the driveway are assumed to be evenly split between left and right movements.
 - This assumption is recognized as a simplification; actual directionality should be based on local context and patron origin/destination patterns.
 - Sensitivity testing was conducted using skewed left/right distributions to assess impacts.

Case Studies

To test the methodology, we applied three approaches: the current County methodology, NCHRP 745, and Caltrans guidelines. For each case study, we used the data provided by the County along with the assumptions described above.

Case 1: Arrow & Branch

- County Current Warrant – No, does not meet warrant
- NCHRP 745 – No, does not meet warrant (would meet the warrant only if the in/out or left/right splits were at extreme values)
- Caltrans Warrant – No, does not meet warrant

Key Takeaway: None of the warrants are met. However, NCHRP 745 highlights the importance of left/right turn directionality in determining the need for a left-turn lane. At this site, the majority of

patrons are expected to make a right turn into the driveway, which further confirms that a left-turn lane is not required when considering both the site context and the data analysis.

Case 2: Krupp

- County Current Warrant – Yes, meets warrant
- NCHRP 745 – Yes, meets warrant
- Caltrans Warrant – No, does not meet warrant

Key Takeaway: This project meets both the current County warrant and NCHRP 745. It features high peak-hour trips and significant volumes on the adjacent roadway. The Caltrans warrant, however, is not met due to its higher threshold criteria.

Case 3: Paloma

- County Current Warrant – No, does not meet warrant
- NCHRP 745 – No, does not meet warrant
- Caltrans Warrant – No, does not meet warrant

Key Takeaway: All warrants are not met. The volumes on the major roadway are low, and the project's trip generation is also minimal, indicating that a left-turn lane is not warranted under any of the three methodologies.

Recommendations

Based on our review of national guidance and the sensitivity analysis of local case studies, we recommend updating the Napa County left-turn lane warrant to adopt the methodologies outlined in NCHRP Report 745. This would transition the County from a graph-based warrant that relies on daily traffic volumes to an hourly-based assessment that more accurately reflects peak operating conditions and turning movement dynamics.

NCHRP 745 represents the most current nationally recognized guidance for evaluating left-turn lane needs, is endorsed by the 7th Edition of the AASHTO Policy on Geometric Design of Highways and Streets ("Green Book"), and is supported by benefit-cost and safety performance analyses grounded in the Highway Safety Manual.

Benefits of the NCHRP 745 Warrant

Transitioning to this revised process offers three distinct advantages over the existing warrant:

- **Industry Practices:** As opposed to the warrants based on statistical methods from the 1967 Harmelink study, the recommended guideline uses the *Highway Safety Manual* that analyzed crash predictive models to determine the quantifiable benefit of installing left-turn lanes. The new warrant aligns with the Safe System Approach by providing proactive practice which would directly link to the safety benefit outweighing the construction cost.
- **Enhanced Technical Accuracy (Peak vs. Daily):** The existing process relies on daily volume averages, which often mask the time periods caused by intense short-term traffic surges. The new guideline utilizes **peak-hour volumes** and explicit turning movement volumes. This

is particularly beneficial for winery applications where traffic patterns may be heavily skewed during specific hours.

- **Elimination of Ambiguity:** The current warrant relies on curved thresholds that can create "gray areas" where it is unclear if a project falls inside or outside the line. The NCHRP 745 methodology uses distinct linear thresholds. This removes subjectivity, reducing uncertainty for applicants when in practice.

Additional Considerations Related to NCHRP 745 Warrants

While NCHRP 745 includes provisions for bypass lanes, we recommend excluding this option from the County's warrant. Doing so would maintain consistency with the Caltrans Highway Design Manual, which does not recognize bypass lanes as a standard design practice.

We analyzed the relationship between the County's current left-turn lane warrant and the Rural, Three-Leg, Two-Lane Major Road warrant in NCHRP 745 and found that the warrant curves closely align. Based on this finding, we recommend that the County requires project applications to apply the appropriate NCHRP 745 warrant table based on the specific intersection and roadway configuration.

Although the Rural, Three-Leg, Two-Lane Major Road condition is expected to be the most commonly applicable in Napa County, NCHRP 745 includes additional configurations that should be evaluated using the proposed warrant methodology described in the following section, including:

- Rural, Three Legs, Two Lanes on Major (most common condition in Napa County)
- Rural, Four Legs, Two Lanes on Major
- Rural, Three Legs, Four Lanes on Major
- Rural, Four Legs, Four Lanes on Major
- Urban and Suburban Arterial, Three Legs
- Urban and Suburban Arterial, Four Legs

The proposed process, forms, etc. have been developed for the most common application (Rural, Three-Leg, Two-Lane Major Road). In an effort to streamline the proposed new process, only the more common situation where the project proposes a new or modified side street, forming a three-legged intersection, is to be included in the form. In the User Guide for the Form, the applicant will be directed to the NCHRP 745 report for warrant graphs using the same inputs identified in this revised process.

Implementation

Based on the three case studies and the application of NCHRP 745, we recommend the following approach to guide applicants through the proposed left-turn lane screening process. This section outlines the overall framework, key considerations, and specific steps that could be incorporated into the Napa County Road and Street Standards.

Implementation Framework

The implementation framework provides high-level guidance on the purpose of each step in the screening process and the data required to support the analysis. These steps would be taken by the applicant, and the findings reviewed by County staff:

1. Collect Data

- a. Obtain hose counts on the adjacent roadway, including speed, volume, and vehicle classification.
- b. Ensure all traffic studies report hourly volumes for the major roadway.
- c. Identify the peak hour on the major roadway; this information is readily available and does not represent a significant change to current practice.

Note that the data above is identified in the Napa County Traffic Impact Study (TIS) Guidelines as required data for traffic impact studies, so if an applicant is at the stage to identify if a left turn lane may be warranted, the above data should have already been collected.

2. Calculate Travel Demand and Assignment

- a. For wineries, use peak hour trip estimates from the Napa County Winery Trip Generation Worksheet.
- b. For all other land uses, derive peak hour trips using the ITE Trip Generation Manual.
- c. Identify the directionality of both peak hour and daily trips to and from the proposed site, taking into account site-specific access limitations, if applicable.

3. Evaluate Sight Distance

- a. Evaluate available sight distance using the operating speed (i.e. 85th percentile speed) for the adjacent roadway.
- b. Apply engineering judgment to support assumed in/out splits and expected access behavior, particularly to determine whether left-turn movements are likely to be a frequent occurrence at the driveway (as approved by the County Traffic Engineer).

To ensure each applicant calculates the above in a clear, consistent manner, we have developed a proposed methodology to be used, and for projects with proposed winery uses, this approach would be compatible with the County specific winery trip generation worksheet.

Proposed Steps

It is anticipated that the revised left-turn screening process will be incorporated into the approved Napa County TIS Guidelines, either as a standalone section or as an attachment or appendix.

The process assumes that the TIS will include the data collection and travel demand analysis needed to support the left-turn screening evaluation. The County should also establish that each step of the process is subject to review and approval by the County Public Works Department.

The process is proposed to be documented in a simple one-page Excel-based form, with built-in formatting and formulas that calculate key elements based on the user's inputs. Most of the required data is already collected or calculated as part of the formal TIS process.

The form includes several steps that alert the user when the process may not apply, such as when the intersection is located on a Caltrans roadway. It also identifies whether a left-turn lane would be warranted based on the entered data.

A User Guide is included within the form to explain how it should be completed. The description below provides a general overview of the process, while the User Guide provides more detailed step-by-step instructions, including where the evaluation may end based on specific input values.

Prior to proceeding with Step 1, the User Guide prompts the applicant whether the project would connect to a Caltrans facility, Silverado Trail, or a multi-lane arterial/collector roadway. This would inform the applicant that they should still proceed with the left-turn lane screening process; however, this leaves the County additional jurisdiction whether to determine a left-turn lane can be required, regardless of the outcome of the screening process.

To unprotect the external screening Excel form, use the following password: 7R2k

Step 1: Data Input

Step 1 consists of entering data that should already be available from the TIS data collection effort.

The first two inputs are the dates when the daily traffic counts were collected. Based on those dates, the form automatically indicates whether a seasonal adjustment is required in accordance with the TIS Guidelines.

The next input asks whether a 24-hour vehicle count was collected on the major street. The applicant checks a box to confirm the count was collected and enters the applicable count data into the designated cell. The User Guide explains how to determine the appropriate value to enter.

The final inputs in this step relate to speed data. Traffic volume counts collected using roadway tubes can also provide speed data, and applicants are encouraged to collect both speed and volume information as part of their counts. However, if actual speed data is not available, the form allows the applicant to enter the posted speed limit. The form then automatically adds 7 mph to determine an estimated design speed, consistent with methodologies described in industry guidance documents for certain calculations, including sight distance evaluations, when measured speed data is unavailable.

Step 2: Volume-Based Left Turn Lane Warrant Calculation

This step involves entering the applicable traffic volume data for the relevant turning movements, consistent with the instructions provided in the User Guide. Once the required cells are populated, the form automatically indicates whether a left-turn lane would be warranted based on the volume-based criteria.

The form also includes a second page that automatically plots the entered traffic volumes on a graph similar to the warrant charts presented in NCHRP Report 745. This allows the user to visually see where the project data falls relative to the warrant thresholds. The graph, project information, and plotted data points are automatically generated based on the entered inputs.

Step 3: Sight Distance Check

This step uses the speed data entered in Step 1 to calculate the required stopping sight distance.

The applicant then enters the available clear sight distance, measured in accordance with the instructions provided in the User Guide. The form compares the available sight distance to the calculated stopping sight distance and automatically indicates whether an approaching motorist would have sufficient distance to comfortably stop after observing a vehicle waiting to turn left into the minor street.