Section 4

Traffic

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COLORADO

Department of Transportation

Office of the Chief Engineer

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4.01 Traffic Data

The Form 463, Design Data, provides a section for information on traffic data for both the current and future (usually 20 years, but can be less) average daily traffic, design hourly volume, and the percentage of trucks. This information, along with the highway functional classification, is used to determine the appropriate design standards (e.g., typical sections or travel lanes) for a project.

The project manager is responsible for obtaining the latest traffic data. Traffic data is available from the Division of Transportation Development (DTD) or is accessible at Colorado Department of Transportation's (CDOT) Online Transportation Information System. For non-CDOT controlled roadways, the local Transportation Planning Region (TPR) or Metropolitan Planning Organization (MPO), such as the Denver Regional Council of Governments, may furnish traffic data.

The project manager will usually request any turning movement volumes from the Division of Transportation Development.

The following items consist of traffic information that should appear on the Form 463, the Title Sheet, or elsewhere on the plans as appropriate:

1. Traffic data – includes projected and existing average daily traffic, design hourly volume, percentage of trucks and directional traffic distribution (Form 463, Title sheet, Traffic Movement Diagram plan sheet).
2. Roadway functional classification – such as interstate, freeway, collector, or arterial can be obtained from the DTD web page referenced above (Form 463).
3. Terrain type – obtained from the same web page (Form 463).
4. Number of lanes – geometric design type or typical section, can be determined from the CDOT Design Guide, the Transportation Research Board (TRB) Highway Capacity Manual, or associated software (Form 463, Typical Sections, Plan and Profiles).

Additional Resources:

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

CDOT Procedural Directive 512.1, Project Scoping and the Design Scoping Review (DSR)

State Highway Access Code

For forms, see CDOT online forms library CDOT Forms Catalog

4.02 Request and Analyze Crash Data

The Traffic Safety & Engineering Services (TSE) Branch periodically reviews the safety performance of all roads on the state highway system and identifies locations that have the potential for crash reduction. This data is available to the Designer through the TSE Branch.

Under Section 148 of Title 23, United States Code (23 USC 148), each state is to maintain the Highway Safety Improvement Program (HSIP) by surveillance and identification of crash locations statewide. This program is part of the state's overall Statewide Safety Program and is administered by the TSE Branch.

In the Colorado HSIP developed by the Colorado Department of Transportation (CDOT), a program is described to reduce the number and severity of traffic crashes on all public roadways, including non-state-owned roads and roads on tribal land. All crash reports are supplied to the Department of Revenue (DOR) by the Colorado State Patrol and other local law enforcement agencies. DOR, in turn, provides information and makes crash report data available to CDOT for safety performance measures and engineering analysis.

The TSE Branch, with crash data supplied by DOR, is responsible for identifying locations that have the potential for crash reduction. Some of the methods of identifying highway and traffic safety issues are:

1. Safety Performance Functions (SPF) / Level of Service of Safety (LOSS) analysis
2. Network Screening
3. Crash Pattern Recognition and Diagnostics
4. Road Safety Audits (RSA)
5. Prioritization Studies

As part of the Operations Evaluation process (see Section 4.12), a safety analysis is routinely provided by the Region Traffic Engineer or the TSE Branch on all highway type projects, such as non-interstate routes, interstate, "safety enhancement" type and Resurface, Restoration and Rehabilitation (3R) type.

Additional Resources:

23 US Code (USC) Section 148, Highway Safety Improvement Program

23 Code of Federal Regulations (CFR) Part 655F, Traffic Control Devices on Federal-Aid and Other Streets and Highways; Part 924, Highway Safety Improvement Program; Part 1205, Highway Safety Programs; Determinations of Effectiveness

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)

4.03 Turning Movements Request

Traffic volume data are used to analyze the level of service of proposed designs as described in Section 4.01. Average daily traffic volumes and design hourly volumes are usually projected for 20 years for each traffic movement at an at-grade intersection or interchange.

The project manager will initiate a request to the Division of Transportation Development for turning movement volumes prior to designing the intersection or interchange. The request will be in email or letter form adequately describing the location and type of data needed.

It is important that the request properly describes the proposed improvement so that any new traffic patterns can be predicted. The request should also include a list of alternative design concepts, if applicable. If the current project is part of a corridor, then the overall corridor traffic should be used in the prediction.

In urban locations it is desirable to have peak hour traffic counts both in the morning and in the evening, so that the design hourly volume is properly selected.

It may be necessary for the Division of Transportation Development to conduct a current traffic count at the site prior to applying an expansion factor. In some areas, the local agency may have a current count and may have a planning model predicting traffic.

The Division of Transportation Development may provide a traffic diagram (see Section 4.04) to the Designer showing the requested traffic information.

On larger projects or corridor projects, a traffic model may be prepared, based on future growth and land uses, to forecast the expected volumes. The project manager may include this modeling need in the Design Engineer's scope of work.

The turning movement volumes should be documented in the project file, or in the intersection or interchange report, as supporting documentation for the chosen design.

Additional Resources:

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

Colorado Department of Transportation (CDOT) Roadway Design Guide Business – Bulletins and Manuals – CDOT Roadway Design Guide 2023

CDOT Procedure Directive 512.1, Project Scoping and the Design Scoping Review (DSR)

4.04 Traffic Movement Diagram

The traffic movement diagram illustrates, in the plans, the design traffic volume predicted for each movement within an intersection or interchange. It is used as data to confirm acceptable levels of service and to justify design features such as turning lanes and storage lengths.

The traffic movement diagram is a graphic representation of the data received from the request that is described in Section 4.03. The diagram is placed on the plan sheet showing the proposed intersection or interchange design and provides a permanent record, in the plans, of the data that justified the design features of the intersection or interchange.

The diagram will show the design hourly volume for each movement within the intersection or interchange. The diagram may also show the current average daily traffic and the current hourly volume. The diagram will show the current year and the 20-year projection of traffic movements. Signal project movements may be projected for 10 years.

The project manager is responsible for assuring that the traffic movement diagram and data are placed on the appropriate plan sheet, as needed. Placing the diagram on the plan sheet provides permanent documentation of the traffic data used for design of the project.

If the turning movement data will be more than two years old at the time of advertisement, the Division of Transportation Development should be contacted for updated information, and the design assumptions for the new traffic predictions should be verified.

Additional Resources:

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

Colorado Department of Transportation (CDOT) Roadway Design Guide Business – Bulletins and Manuals – CDOT Roadway Design Guide 2023

Transportation Research Board (TRB) Highway Capacity Manual

4.05 Signal Warrants

A thorough investigation of traffic conditions, crash history, and physical characteristics of the location is necessary to establish warrants for the installation of a traffic signal. Warrants should be established prior to any engineering work, since the design criteria for a signalized intersection will be different from that of a stop-controlled intersection.

The Region Traffic Engineer will conduct the signal warrant study for the roadway intersection together with all the necessary calculations, documentation and traffic signal warrant justification for each location.

The Region Traffic Engineer shall certify that warrants have been met by documenting them in the form of a letter justifying the need for traffic control signals. Traffic Control Signals can be justified when warrants are met as indicated in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), Part IV. The letter should state which of the warrants as shown in the MUTCD are applicable. It is important to note that a location meeting signal warrants does not automatically mean that installation of a traffic signal is the solution. Engineering judgment should be exercised before making a final decision.

Additional Resources:

23 Code of Federal Regulations (CFR) Part 655F

23 US Code (USC) 109(d), Standards

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

4.06 Intersection and Interchange Design

Project design should efficiently and safely move traffic through various conflict points arising at the crossing of highways.

The crossing of two or more highways can be accomplished in three manners: at-grade intersections, grade separations, and interchanges. The most common at-grade intersection configurations are “4-leg,” “T,” and “Y,” with or without separate auxiliary lanes or channelization. At-grade intersections require some form of traffic control, which could range from stop signs or traffic signals to a modern roundabout. Grade separations allow one roadway to pass over another with no provision for turning movements. Interchange design allows for one roadway to pass over another with turning movements. Common interchange types are “diamond”, “cloverleaf”, “directional”, “urban”, “Y”, and “trumpet”. The decision to use interchanges depends on traffic counts, highway classification and access requirements.

Concepts, including signal warrants and truck-turn templates, for use in intersection design can be found in the References listed at the end of this section. Truck-turn templates account for the off-tracking of large vehicles as they turn through at-grade intersections.

The project manager is responsible for the justification and design of new or modified intersections or interchanges. The use of the Intersection Control Assessment Tool (ICAT) to

compare alternatives and recommend the preferred configuration is required when significant changes are being made. This includes any intersection, ramp termini, or interchange (new intersection, widening/reconstruction corridor project, or work requiring an access permit that affects an intersection) when 1) The intersection includes at least one roadway designated as a state highway or part of the national highway system, 2) The intersection will be designed or constructed using state or federal funding, 3) the intersection is included in Access Control Plans, Planning and Environmental Linkages (PEL), Corridor Planning Studies, or Traffic Impact Studies (TIS), 4) requested by the Region Traffic Representative (RTR), or 5) there are significant modifications to the operation of the interchange or intersection.

Use of the Intersection Control Assessment Tool (ICAT) shall **Not** be required when the proposed work does not include any geometric or capacity changes to the intersection design such as (but not limited to): resurfacing pavement projects, striping projects, routine maintenance projects, traffic signal retiming projects (that do not include adding a phase), a proposed Right-in/Right-out (RIRO) intersection that meets the Colorado State Highway Access Code, or signal maintenance projects (to upgrade deficient equipment). A waiver eligibility form must be completed by the project manager and submitted to the RTR, and if approved, the project shall be exempt from ICAT requirements. Region and Headquarters Traffic Engineers can assist with the application of the ICAT.

Turning movements are discussed in Section 4.03 and signal warrants in Section 4.05 of this manual.

For a new or modified intersection justification, factors usually addressed are:

1. Traffic factors include: capacity, turning movements, signal warrants, cause of crashes and their type and frequency, the needs of pedestrians and bicycle users when justified in urban or rural areas.
2. Physical factors include: topography, improvements, physical requirements, and physical constraints.
3. Economic factors include: the cost of the improvements and economic effects on abutting businesses.
4. Human factors include: driving habits, decision and reaction times, driver expectations, and natural paths of movement.

When signal warrants are not initially met but are expected to be met in the future, the Region Traffic Engineer should specify the requirements that must be met to justify signalization of the intersection.

For new or modified intersection design, the following data is required for initiating a final design:

1. Basic data – relative to traffic, physical and economic factors.
2. Preliminary design – aerial photos (when available), topographic maps, preliminary sketches of plan and profiles for alternative designs. Preferred alternative should be determined no later than the Field Inspection Review stage.
3. Comparative costs – cost estimates of alternative designs.
4. Selection of suitable design – from the standpoint of traffic adequacy and economy and safety considerations.
5. Final plans – design approval of intersection configuration, complete calculations, plan and profiles, traffic flow diagrams showing the design hourly volume and the design year of all anticipated traffic movements, and proposed construction Traffic Control Plan.

For interchange design, the above factors also apply, along with addressing highway classification, character and composition of traffic, design speed, and degree of access control. Design of new interchanges or modification to existing interchanges are subject to additional approval and reporting requirements. All new or modified interchanges in Colorado must be reviewed and approved following the policy set forth in the Colorado Department of Transportation (CDOT) Policy Directive 1601.0, Interchange Approval Process, and the procedures outlined in CDOT Procedural Directive 1601.1, Requests for Interchange Access and Modifications to Existing Interchanges on the State Highway System.

Procedural Directive 1601.1 outlines the level of detail a traffic study related to new or modified interchanges must include depending on the type of improvement. Additionally, Federal Highway Administration (FHWA) approval is required for new interchanges or modification to existing interchanges along the interstate system. State Departments of Transportation (DOT's) must submit requests for proposed changes to interstate access to their FHWA Division Office for review and action under 23 US Code (USC) 106 and 111(a), and 23 Code of Federal Regulations (CFR) 625.2(a). FHWA's Policy on Access to the Interstate System may be referenced for additional information.

Additional Resources:

23 CFR Part 771

American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets

AASHTO A Policy on Design Standards – Interstate System

Bicycle and Pedestrian Facilities (see Section 2.10 of this manual)

Colorado Department of Transportation (CDOT) Roadway Design Guide Business – Bulletins and Manuals – CDOT Roadway Design Guide 2023

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)

Transportation Research Board (TRB) Highway Capacity Manual

For forms, see the CDOT online forms library CDOT Forms Catalog

Intersection Control Assessment Tool (ICAT) – Onbase – ICAT Training

4.07 Traffic Signal Plan

A traffic signal plan is used to establish control of vehicular and pedestrian traffic flow at intersections, consistent with the assumptions used in Section 4.06 Intersection and Interchange Design. Prior to design of signal plans, the project manager confirms that the signals are warranted and that documentation is in the project file.

Traffic signal plans will include a complete geometric layout of the intersection showing the location of the traffic signal poles, conduit, signal cabinet, power source, and existing utilities. A sketch of the signal faces, a phasing diagram, a legend, general notes pertaining to the signalization, and a summary of approximate quantities will be included.

The Project Traffic Engineer or a consultant prepares the signal plan according to the decisions made at the Design Scoping Review and the Field Inspection Review meetings. The Region Traffic Engineer reviews and approves signal plans.

The project manager will be responsible for providing an updated intersection layout to the Project Traffic Engineer to use in designing the signal plan.

The Project Traffic Engineer completes all the necessary calculations for documentation of the signal warrant study, prepares the traffic signal design, computes quantities, drafts specifications, and completes drawings for the final signal plans. The Project Traffic Engineer also certifies that all traffic plans conform to the MUTCD and CDOT S-Standard Plans. Some signal installations may need to conform to the local entity specifications, if they are a part of an integrated signal system.

Additional Resources:

23 Code of Federal Regulations (CFR) Part 655

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

Federal Highway Administration (FHWA) 23 US Code (USC) 120

Transportation Research Board (TRB) Highway Capacity Manual

4.08 Lighting Plan

A lighting plan is prepared by a qualified engineer to provide roadway lighting for improved driver vision at night and to enhance the safety of pedestrian and vehicular traffic.

The purpose of roadway lighting is to improve nighttime highway safety by reducing the possibility of motor vehicle collisions with pedestrians, fixed objects, or obstructions on the roadway. The quantity of light does not necessarily indicate a good lighting system. What's important is to provide effective lighting. Effective lighting refers to the ability of the light to provide contrast between objects and background so that motorists can detect conflicts in sufficient time to take evasive action. Many interrelated factors contribute to effective lighting, such as reducing glare to help improve driver performance.

The Colorado Department of Transportation (CDOT) Roadway Design Guide provides a description of illumination, including design guides, methods, and types. Design software may be available through the Region.

Warrants for lighting are outlined in the AASHTO Informational Guide for Roadway Lighting. Warrants are not required for minimum interchange lighting.

The CDOT Lighting Design Guide should be used when preparing lighting plans or determining lighting warrants. The CDOT Lighting Design Guide is based on the Illuminating Engineering Society of North America (IESNA) Lighting Handbook Tenth Edition, the American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting/ Illuminating Engineering Society (ANSP/IES RP-8-18) and the AASHTO 2005 Roadway Lighting Design Guide. It represents the current recommended practice for roadway lighting and includes criteria for typical applications found in the state of Colorado. The CDOT Lighting Design Guide should be used in conjunction with the latest version of these three references. Exceptions to these guidelines should be thoroughly evaluated and documented in accordance with CDOT's design exception policies.

All projects that include lighting installation or modification require plans and specifications that show the type and locations of the lighting equipment and a summary of quantities. The lighting design will be incorporated into the final plan set by the project manager.

The following documentation and procedures are to be followed for the design of highway lighting:

1. The project manager, through the Region Utility Engineer, will coordinate with the utility company to ensure proposed materials are compatible with utility inventories. If applicable, a lighting agreement will be negotiated between Colorado Department of Transportation (CDOT) and the local agency.
2. The Region Utility Engineer will designate the power source locations and negotiate with the utility company to supply the power.
3. In special lighting situations (e.g., use of ornamental or decorative lighting), the state and federal shares of costs shall not substantially exceed the estimated cost of conventional highway lighting, unless such special lighting is within the scope of the project (such as enhancement projects or historical areas) or is otherwise justified by the public interest. The project manager will negotiate the local share, if any, of special lighting costs.

The following information will be shown on the lighting plan:

1. Circuit type, voltage, and location of power source.
2. Luminaire type, lumens, and locations.
3. Light standard type, mounting height, bracket arm type and length, and foundation details.
4. Size and location of electrical conduit, conductor size, location of direct burial cable, and locations of pull boxes and junction boxes.

All final plans for lighting should be reviewed by a qualified Lighting or Electrical Engineer for proper wiring or other electrical details.

Additional Resources:

CDOT Roadway Design Guide Business – Bulletins and Manuals – CDOT Roadway Design Guide 2023

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

Illuminating Engineering Society of North America (IESNA) Lighting Handbook

AASHTO Lighting Guide

The American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting/Illuminating Engineering Society (ANSP/IES RP-8-18)

Colorado Department of Transportation (CDOT) Lighting Design Guide Business – Bulletins and Manuals – 2020 CDOT Lighting Design Guide

4.09 Permanent Signing and Pavement Marking

The proposed final signing and pavement marking plan will be included in the project Plans, Specifications, and Estimate package.

The Project Traffic Engineer or a consultant is responsible for the design of the signing and pavement marking plans for the construction project. Signing and marking should be considered during the early phases of project design, especially for interchange projects, which require effective signage to be constructable.

The preparation of permanent signing and pavement marking plans includes the following activities:

1. Plan sheets showing the roadway, edge of traveled way, shoulders, structures, and topography are drafted for traffic engineering plans by the Designer, and electronic files provided to the Project Traffic Engineer or consultant, when required.
2. The Project Traffic Engineer or consultant collects and tabulates the field inventory of existing traffic controls.
3. The Project Traffic Engineer or consultant draws existing signs on the plan sheets.
4. The Project Traffic Engineer or consultant locates and places the required traffic controls, such as pavement markings or signs, on the plans.
5. The Project Traffic Engineer or consultant prepares the traffic plan that includes the tabulations of signing and striping quantities.
6. The Project Traffic Engineer or consultant prepares required specifications and special provisions.

The Project Traffic Engineer or consultant submits the traffic plans and specifications to the project manager for incorporation into the final plan set .

Additional Resources:

23 Code of Federal Regulations (CFR) Part 655F

American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets

CDOT S-Standard Plans

Colorado Department of Transportation (CDOT) Roadway Design Guide Business – Bulletins and Manuals – CDOT Roadway Design Guide 2023

CDOT Standard Specifications for Road and Bridge Construction

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)

CDOT Pavement Marking Practices Guide Safety – Traffic Documents and Publications – CDOT Pavement Markings Practices Guide

CDOT Sign Design Manual Safety – Traffic Documents and Publications – CDOT Guide Sign Design Manual

4.10 Construction Transportation Management Plans

A Transportation Management Plan (TMP) lays out a set of coordinated strategies and describes how these strategies will be used to manage the work zone impacts of a project. The scope, content, and degree of detail of a TMP may vary based on the expected work zone impacts of the project. All projects must comply with the Region's Lane Closure Strategies. The Region Traffic Engineer must approve all work that does not comply with the Region's Lane Closure Strategies (Safety – Lane Closure Strategies).

The components of the TMP will depend on whether it is a "significant project." A significant project is defined as one that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts at a location for three or more consecutive days with either intermittent or continuous lane closures. A significant project impacts the traveling public at the metropolitan, regional or the interstate level and has a moderate to very high level of public interest. It will directly impact a moderate to very large number of travelers and will have moderate to very high user cost impacts. A TMP may consist of the following components:

1. Traffic Control Plan (TCP) – **Required Component**

   Traffic control devices are all types of signs, signals, and temporary or permanent pavement markings that are used on streets or highways to regulate, warn, or guide traffic during the construction phase of a project. Traffic control is also required for maintenance, utility, and emergency operations. The safety of all forms of transportation such as cars, trucks, pedestrians, and bicycles should be considered throughout the construction phases of the project.

   All construction plans that require temporary signing, signals, and pavement marking shall have a Traffic Control Plan layout sheet (which may be a reference to one or

more of the cases illustrated in the CDOT S-Standard Plans) showing the different phases of construction and the locations of signs, signals, and pavement marking. The Traffic Control Plan (TCP) shall be consistent with the provisions of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction, CDOT M&S Standard Plan, Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), and any applicable incident management plans. A tabulation of pavement markings, signing quantities, schedule of construction traffic control devices, and project specifications are also required.

The Traffic Control Plan may be developed by the Region Traffic Unit or a consultant. Coordination with the region, local agencies, utility companies, railroads, and entities is essential during project development. The Region Traffic Engineer or designee is responsible for reviewing Traffic Control Plans. The project manager is responsible for providing the construction phasing plan and ensuring that a Traffic Control Plan is included in the final plan set.

2. Transportation Operations – **Required Component**

The Transportation Operations component of the Transportation Management Plan (TMP) consists of compliance with the Region's Lane Closure Strategies. (The Region Traffic Engineer must approve all work that does not comply with the Region's Lane Closure Policy.) In addition, Transportation Operations strategies should be identified that will be used to mitigate impacts of the work zone on the operation and management of the transportation system within the work zone impact area. Typical Transportation Operations strategies may include, but are not limited to, demand management, corridor/network management, work zone safety management, and traffic/incident management and enforcement.

More strategies are listed in the "Work Zone Safety and Mobility Rule Procedures Document", CDOT Work Zone Safety and Mobility Rule Procedures Document.pdf. The scope of the Transportation Operations component should be determined by the project characteristics, and the identified transportation operations and safety strategies.

3. Public Information (PI) – **Required Component for Significant Projects**

The PI component of the TMP includes communications strategies that inform affected road users, the general public, area residences and businesses, and appropriate public entities about the project, the expected work zone impacts, and the changing conditions on the project. The PI component may be customized by use of the "Public Information Services" project special provision worksheet (Business – Recently Issued Special Provisions). This may include motorist information strategies. The scope of the

PI component should be determined by the project characteristics and the identified public information and outreach strategies. Public information should be provided through methods best suited for the project and may include, but not be limited to, information on the project characteristics, expected impacts, closure details, and commuter alternatives.

Preparation and implementation of a Transportation Management Plan (TMP) for a highway project includes:

1. The Project Traffic Engineer will prepare a Traffic Control Plan (TCP), Transportation Operations, and Public Information (PI) (optional for non-significant projects) to be included in the Plans, Specifications and Estimate package, including project special provisions for traffic control, general notes, and pay items for all traffic control devices, when requested by the project manager. Transportation Operations strategies must be specified in the general notes and include all contract language, plan sheets, and specifications required to implement the selected strategies. Projects requiring a PI component must utilize the Public Information Services project special provision worksheet.
2. The project Traffic Engineer will select traffic control devices that conform to the version of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) adopted by the Transportation Commission and amended by the Colorado Supplement for Colorado Department of Transportation (CDOT) use, the CDOT Guidelines on Variable Message Signs, the Standard Specifications, and the CDOT S-Standard Plans.
3. Work zone speed limits shall be set in accordance with the procedures established by CDOT Form 0568 CDOT Temporary Speed Limit Reduction Form 568 (or in an online tool if available), in CDOT's Update on Signing for Double Fines memo, and any others communicated to the Region Transportation Directors and Branch heads.
4. The project manager will ensure adherence to all parts of the CDOT Work Zone Safety Guidelines for Engineering and Maintenance:

Additional Resources:

23 Code of Federal Regulations (CFR) Parts 630J and 655F

CDOT S-Standard Plans

CDOT Guide Signing Practices and Procedures

CDOT Work Zone Safety and Mobility Rule Procedures Document

4.11 Engineering Judgment and the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) Request Options

The controlling federal document for designing roadway signage is the MUTCD, published by the Federal Highway Administration (FHWA). In some cases, deviations from the standards set forth in the MUTCD are allowed on the basis of engineering judgment.

The MUTCD contains two basic types of statements, Standard statements and Guidance statements. Standard statements contain the word “shall” and are considered mandatory. Guidance statements contain the word “should” and are considered suggestions. Under certain circumstances, a Project Engineer may deviate from a Standard statement based on engineering judgment.

However, deviations may be allowed only if the deviation is location or site-specific. For example, a Project Engineer may use engineering judgment to justify specifying narrower signs in the median of a specific portion of a project where signs of standard width would protrude into the travel lane. The Project Engineer would only need to document the reasons in the project files to justify the decision.

Any deviation using engineering judgment can affect only a specific area of the project; deviations from the MUTCD standard cannot be made on a project, corridor, area, or statewide basis. For example, a Project Engineer cannot use engineering judgment to justify using unique sign layouts on a corridor project, because the decision could have corridor, region, or statewide implications. Instead, to make changes on a project-wide basis, the Project Engineer could make use of one of the MUTCD requests:

1. Request for Interpretation
2. Request for Permission to Experiment
3. Request for Interim Approval
4. Request for Change

A request for interpretation involves asking the Federal Highway Administration (FHWA) to render an official opinion on the application and operation of standard traffic control devices, official meanings of standard traffic control devices, or the variations from standard device designs.

A request for permission to experiment involves asking FHWA’s permission to field test or evaluate a new traffic control device, its application or manner of use, or a provision not specifically described in the MUTCD.

A request for interim approval involves asking Federal Highway Administration (FHWA) for interim use, pending official rulemaking, of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD). However, any other jurisdiction that desires to use a traffic control device for which FHWA has issued an interim approval must still request permission from FHWA.

A request for change involves asking FHWA to consider use of a new device to replace a present standard device, an additional device to be added to the list of standard devices, or a revision to a traffic control device application or placement criteria.

All requests must be submitted to the FHWA Office of Transportation Operations MUTCD team for consideration (see MUTCD Section 1A.10 for details). All Colorado Department of Transportation (CDOT) requests should be developed with the assistance of the appropriate Region Traffic Engineer and the Headquarters (HQ) Traffic Safety and Engineering Services Branch. Requests submitted by local entities in Colorado do not require CDOT approval or involvement. However, the FHWA does provide CDOT Traffic Safety and Engineering Services with a copy of the local entity's request and FHWA's reply. CDOT Region personnel who become aware of a pending request by a local entity should inform the appropriate Region Traffic Engineer, as well as the State Traffic Engineer, to ensure the CDOT is informed of the request.

Should you have any questions, or should you require assistance in submitting a request, contact the Safety and Traffic Engineering Branch.

Additional Resources:

Manual on Uniform Traffic Control Devices for Streets and Highways

4.12 Operations Evaluation (formerly Transportation Systems Management and Operations [TSM&O])

Beginning January 1, 2016, all projects with a Design Scoping Review on or after February 1, 2016, require a TSM&O Evaluation. On January 21, 2021, the TSM&O Evaluation was renamed to the Operations Evaluation and deployed as an OnBase web tool. The Operations Evaluation is an evaluation that consists of three parts, a Safety Analysis, an Operations Analysis, and an Access Management Analysis. The purpose of the Operations Evaluation is to analyze the project area. This analysis enables the making of project-specific recommendations related to safety and mobility to the project team. To initiate the Operations Evaluation, the project manager will take the following steps:

- Create your project in PMWeb and enter information in all of the required project tab fields for the Operations Evaluation.
- An Operations Evaluation request will be automatically generated in PMWeb and sent to the OnBase Operations Evaluation Tool.

The Operations Evaluation will be reviewed and coordinated by a Region Traffic Representative Liaison (RTRL) (Professional Engineer II Traffic Engineer). The RTRL will then assign the evaluations to the appropriate region, access managers, and headquarters personnel.

The Operations Evaluation has two levels for each analysis for Traffic Operations, and Safety. Level One Analyses generally take two–four weeks and are typically conducted by the region traffic teams. The Operations Evaluation has one level of analysis for Access Management. The Access Management Analysis generally takes two–four weeks and is typically conducted by the region access manager.

After the Operations Evaluation analyses are complete, you will receive a notification from PMWeb that recommendations are available for your concurrence.

Level One Analyses should be conducted before, during, or right after the Design Scoping Review Meeting so recommendations can be agreed to and included in the design for the Field Inspection Review (FIR).

Level Two Operations and Level Two Safety Analyses can be done by consultants or headquarters staff. Level Two Analyses should be conducted before the FIR meeting so recommendations can be discussed at the meeting, agreed upon, and included in the final design.

If there are project technology needs or impacts to technology resulting in new or replacements, please refer to 4.13 Systems Engineering Analysis (SEA) for how to proceed.

4.12.01 Background

The Transportation Systems Management and Operations (TSM&O) Reorganization Report of May 2013 recommended that all Colorado Department of Transportation (CDOT) projects conduct an operational analysis to ensure improved systematic and integrated delivery of statewide operations. Per federal regulations, the Federal Highway Administration (FHWA)-CDOT Stewardship Agreement, and CDOT policy, CDOT is required to conduct safety analyses and operational engineering analyses as applicable on CDOT Projects. The Operations Evaluation combines all these analyses—safety, operational, and access—into one coordinated process to ensure that every CDOT project considers improvements for the safety and efficiency of the traveling public.

Another purpose of the Operations Evaluation is to enhance regional partnerships that support collaborative investment and implement Transportation Systems Management and Operations (TSM&O) strategies that benefit the region and its stakeholders. This requires collaboration by Maintenance, Access, Regions, Operations, Safety, Access Management, Federal Highway Administration (FHWA), and other stakeholders to identify and consider operational strategies for implementation early in the project lifecycle. This will help provide the ability to implement new or additional operational strategies at the opportune time during the project lifecycle. Additionally, the Operations Evaluation creates enhanced opportunities to provide safety improvements, accountability to stakeholders, increased ability to document and reference lessons learned, and streamline business processes while increasing system reliability.

After three years of use, the Operations Evaluation support group identified a significant opportunity for automation that would lead to improved tracking, coordination, communication, and documentation. Between 2019 and 2021, the Operations Evaluation support group led an initiative to evolve the Operations Evaluation into an OnBase web tool. This initiative was completed on January 20, 2021. Now, all new projects or projects on the shelf for more than two years must be entered into the Operations Evaluation web tool for analysis or exemption.

4.12.02 Operations Definition

Operations at the Colorado Department of Transportation (CDOT) refers to several innovations and strategies used to improve the volume and flow of traffic to maximize the efficiency and benefit/cost of our roadways. These strategies include the use of traffic control devices, use of shoulders, narrow lanes, variable speed, traffic incident management, quick clearance, adaptive and efficient signal timing, traffic control, demand management (metering), appropriate and pertinent speeds, alternative and innovative intersections, and coordinated work and response efforts. CDOT is committed to improving system operations and safety and is implementing this formal process, the Operations Evaluation, building these strategies into CDOT’s roadway projects.

4.12.03 Roles and Responsibilities

4.12.03.01 Project Manager

To the project manager, this process will look somewhat similar to the current process for the Safety Assessment report, whereby the project manager requests an evaluation, receives recommendations, reports, and documentsfrom the OnBase web tool and sent to the project PMWeb portal when the Evaluation is complete. The project manager considers the recommendations that can be integrated into the scope of the project and concurs on which recommendations will be in the final design. The project manager will be responsible coordinating with the Region Traffic Representative Liaison (RTRL) for the status of the

Operations Evaluation process, and discussing recommendations for implementation with their project manager.

The project manager is also responsible reporting in PMWeb on what recommendations were integrated into the design of the project and which recommendations were constructed during the Finals process.

4.12.03.02 Region Traffic Representative Liaison

The Region Traffic Representative Liaison (RTRL) referred to in the process is the Traffic Engineer (Professional Engineer II) assigned to the project being evaluated. The RTRL is the single point of coordination for the Operations Evaluation for the project. The RTRL reviews the project request, project documentation, and coordinates with the project manager in this role. The RTRL then assigns Region Traffic Representatives (RTR's) to complete the Level One Safety Operations, and Access Analyses. When the RTR's complete their analyses, the RTRL's review the Level One analyses to determine if Level Two analyses are warranted. The RTRL's will assign region or headquarters staff to conduct the analysis. The RTRL's can also assign a region RTR for Level Two and hire a consultant to do the analysis coordinating with the Operations Evaluation Support Groups.

4.12.03.03 Region Traffic Representative and Access Managers

The RTR referred to in the process is the Traffic Engineer assigned to the project being evaluated. In this role the RTR completes the Level One Safety or Operations Analyses, or both. There could be two or more RTR's assigned to a project evaluation.

The region access manager is the access manager RTR assigned to the project being evaluated. The region access manager RTR will complete the access management analysis.

The RTR's also provide support to the project manager and coordinate and consolidate the key recommendations of the Evaluation from the Operations Evaluation support groups, Safety, Operations, and Access Management. The RTR will be the lead for documenting recommendations from the Safety, Operations, and Access Management. And for more information conducting the Systems Engineering Analysis (SEA) see it detailed in Section 4.13 Systems Engineering Analysis.

The Region Access Manager (RAM) is the access manager RTR assigned to the project being evaluated. The region access manager RTR will complete the access management analyses.

4.12.03.04 Operations Evaluation Support Groups

The Operations Evaluation support group consists of Headquarters (HQ) Traffic, Safety, Operations, and Access Management (infrastructure). Each specialty is responsible for providing detailed analysis and recommendations for each of its respective disciplines. The Operations Evaluation support group will coordinate directly with the Region Traffic Representative Liaisons (RTRL's) and Region Traffic Representatives (RTR's). The Operations Evaluation support groups will also be responsible for reviewing and following up with the regions on the overall effectiveness of the process.

Additional Resources:

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)

Design Bulletin DB 2014-3, Milestone Dates in Systems, Applications and Products in Data Processing (SAP) Business – Design Bulletins – Milestone Dates in SAP Project Builder (CJ20N)

Design Bulletin DB 2016-1 Business – Design Bulletins – Transportation Systems Management and Operations (TSM&O) Evaluation

Design Bulletin DB 2021-2 Business – Design Bulletins – Operations Evaluation (formerly TSM&O)

Design Bulletin DB 2021-3 Business – Design Bulletins – Systems Engineering Analysis (SEA) Process

4.13 Systems Engineering Analysis

SEA is a project delivery process for technology. This includes any technology that impacts the safety or efficiency of the roadway. The SEA process takes project managers step by step through the design of technology using templates. It is structured to prompt and document critical discussions at the proper time in design. It is also intended to reduce risk by facilitating additional planning during the design phase.

Project managers will take the following steps to initiate the SEA process:

- During prescoping, complete the Technology/SEA Assessment template. All projects must complete and submit this form which is in OnTrack. This document can also be found on the Intelligent Transportation Systems (ITS) & Network Services site.
- SEA Documents Website (Programs – SEA Documents). This template will walk a project manager through determining if a project has technology and therefore

requires a Systems Engineering Analysis (SEA). Even if a project does not have technology and no SEA is required, it is still important to document that no additional SEA documentation is required.

- If an SEA is required, the Technology/SEA Assessment template will guide the Project Manager (PM) through determining which of the 10 additional required SEA documents already have an existing document that can be modified to be project specific. If there is no previously prepared work, the PM will need to develop the document using the templates which can be found on the ITS & Network Services Branch website Programs – Systems Engineering Analysis (SEA).
- The remaining 10 SEA documents build on each other. In PMWeb, the SEA deliverables are tied to particular stage gates to ensure the documents are prepared at the correct time. The submission schedule can also be referenced using the Intelligent Transportation Systems (ITS) & Network Services – Document Submission Website (Programs – SEA Document Submission). For templates of all SEA documents reference the ITS & Network Services – SEA Documents website Programs – SEA Documents.
- The date of the completion of the SEA process will need to be populated in the Form 1180.

4.13.01 Background

The SEA is required per 23 Code of Federal Regulations (CFR) 940. Historically it has been housed in the Operations Evaluation Tool. On September 1, 2021 the SEA was removed from the Operations Evaluation Tool and moved to PMWeb

The SEA is a project delivery process for technology making OnTrack the appropriate tool for the SEA process. The SEA process was revamped in 2021 through the collaborative work of a project team led by the ITS & Network Services Branch involving subject matter experts from all five regions and Headquarters (HQ). This effort was sponsored by the Federal Highway Administration (FHWA) who was another integral component of the team.

The revamp was structured to ensure compliance with 23 Code of CFR 940. Another objective was to ensure consistent technology design at the Colorado Department of Transportation (CDOT) through the use of the ITS Architecture Plan. The SEA focuses on the design of technology and ensures appropriate planning is in place for the technology to remain useful for its full lifecycle. This is why the SEA prescribes planning maintenance and asset management resources before the technology is implemented. The ultimate goal of the SEA is to ensure money and time spent deploying technology results in successful systems along with the longevity of technology solutions.

4.13.02 Roles and Responsibilities

4.13.02.01 Project Managers

The Project Managers (PM's) are responsible for determining the need for a Systems Engineering Analysis (SEA) on a project through the use of the Technology/SEA Assessment template. If no SEA is needed, the PM only needs to complete the top portion and submit the form for verification of the correct assessment. No additional SEA documentation will be needed.

Should an SEA be required, the PM is responsible for preparing and submitting all 10 additional SEA documents. If the PM needs additional help, they can reach out to the Intelligent Transportation Systems (ITS) & Network Services Branch or the SEA Lead for support.

The PM will also be responsible for completing the Form 1180 which documents completion of the SEA process.

4.13.02.02 ITS & Network Services Branch

The Branch will be timely in their reviews of submitted SEA templates. The Branch will also maintain the ITS specifications published on the ITS & Network Services Branch – Specifications website (Programs – Specifications and Standard Procedures). These specifications will have to be referenced in completing the SEA documentation.

4.13.02.03 SEA Lead

The SEA lead will be the point of contact in the ITS & Network Services Branch to support PM's going through design. The SEA lead will coordinate all review of SEA documents, compile all comments, and return comments to the PM. This position will also assist PM's as they prepare SEA documents. This includes explaining the templates and the ITS Architecture Plan, coordinating support for the ITS & Network Services Branch, and any other additional support a project may need.

4.13.02.04 Federal Highway Administration (FHWA)

The FHWA Project Level Stewardship and Oversight Agreement (when applicable) will provide additional instructions on FHWA involvement with the SEA.

Additional Resources:

Design Bulletin DB 2021-3 Business – Design Bulletins – Systems Engineering Analysis (SEA) Process

Intelligent Transportation Systems (ITS) & Network Services SEA website, Programs – Systems Engineering Analysis (SEA) for additional information.