

Managed Lanes and Ramp Metering Manual

Part 1: Introduction and Policies



Prepared for:



*Nevada Department of
Transportation*



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1.0. PURPOSE

The Nevada Department of Transportation (NDOT) has prepared the Managed Lanes and Ramp Metering Manual to provide a summary of NDOT policies and procedures pertaining to managed lanes and ramp metering facilities on Nevada's highways. The Manual consists of five major parts:

- ▶ Part 1: Introduction and Policies
- ▶ Part 2: Implementation Plan
- ▶ Part 3: Design Manual
- ▶ Part 4: Ramp Metering Performance Measurement Plan
- ▶ Part 5: Public Outreach Primer

This Manual is an update to and replaces the original NDOT “*HOV/Managed Lanes and Ramp Metering*” Manual dated March 2006.

NDOT and other stakeholder agencies can use this series of documents to ensure that procedures are applied successfully and in a consistent manner throughout the State. It is the intent of this document to serve as a guide for the planning, design, implementation, operation, maintenance, and evaluation of various projects and programs that collectively define Nevada’s various managed lane and ramp metering facilities.

Guidance provided in this Manual should be used to design and implement managed lane and ramp metering improvements in a manner that not only improves freeway and ramp operations, but also improves the procedures of the implementing and coordinating agencies. Co-sponsoring these improvements generates a number of additional benefits, including greater acceptance of regional transportation investments, improved intra- and inter-agency support and funding for these investments, and improved public perception of NDOT and other agencies involved in managed lanes and ramp meter implementation.

Managed lanes and ramp metering facilities are to be developed in response to, and consistent with, the various state and federal laws currently guiding transportation improvements on Nevada’s roadway system, including the Nevada Revised Statutes (NRS) Chapter 484, the most recent federal transportation act (MAP-21), and the Federal Clean Air Act Amendments of 1990 (CAAA). Policies are subject to periodic review and reassessment by NDOT and affected agencies.

This Manual does not repeat information (specifically illustrations) from the national and state documents such as the Manual on Uniform Traffic Control Devices (MUTCD), AASHTO Guide for High Occupancy Vehicles, NDOT Road Design Guide, and NDOT Standard Plans. Instead, they are referenced (as appropriate) throughout the Manual.

1.1. Manual Overview

Following is a summary description of the five major parts of the Manual:

Part 1: Introduction and Policies (i.e., this document) addresses state and federal policy guidance regarding managed lane and ramp metering facilities. Part 1 also serves as an introduction to the entire Managed Lanes and Ramp Metering Manual (i.e., all parts) and

provides relevant background information and definitions. A list of abbreviations and a glossary of the common terminology used in this Manual is included as an Appendix in Part 1.

Part 2: Implementation Plan presents guidance on how to plan, implement, and operate managed lanes and ramp meters in an effective and consistent manner.

Part 3: Design Manual presents guidance on how to design managed lanes and ramp meters in an effective and consistent manner.

Part 4: Ramp Metering Performance Measurement Plan presents guidance on how to effectively monitor, evaluate, and report the performance of deployed ramp meters.

Part 5: Public Outreach Primer provides guidance on outreach activities related to managed lanes and ramp metering. This part is not updated from the original 2006 document. Outreach sections related to ramp metering in the original 2006 Implementation Plan are now moved to Part 5 (without any change).

2.0. BACKGROUND AND NEED

Demand for increased mobility throughout Nevada will continue as the State continues to experience population growth. Between 1990 and 2000, Nevada's population increased by 66.3 percent, making Nevada the fastest growing state in the United States. The Las Vegas metropolitan area (Las Vegas) was, by far, the fastest growing major metropolitan area in the United States, growing by an extraordinary rate of 83.3 percent between 1990 and 2000. This trend continued between 2000 and 2010, with Las Vegas experiencing a 42 percent increase in population. In that same time period, Nevada was once again the fastest growing state with a 35.1 percent increase in population. The population of the Reno-Sparks metropolitan area (Reno-Sparks), Nevada's other major metropolitan area, increased by about 24 percent in this same ten year period. The population of Clark County is projected to grow by 42 percent between year 2013 and 2035 as forecast by The Center for Business and Economic Research at the University of Nevada, Las Vegas.

Figure 2-1: Interstate 15 in Las Vegas, Nevada



Nevada residents consistently identify traffic congestion as a serious issue facing the region, much of which is caused by single-occupant vehicle (SOV) trips. According to the 2010 American Community Survey, SOV trips account for 76.5 percent of all work trips in Las Vegas, 77.3 percent in Reno-Sparks, and 78.3 percent in Nevada. By comparison, carpools constitute approximately 11.6 percent of all work trips in Las Vegas, 10.8 percent in Reno-Sparks, and 11.0 percent in Nevada. While these carpooling rates are higher than the national average of 9.7 percent, transit travel in Las Vegas (4.8 percent), Reno-Sparks (2.9 percent), and Nevada (3.3 percent) is below the national average of 4.9 percent, which virtually necessitates the expansion of highway infrastructure to meet demand. However, outside limitations (e.g., continued congestion, the federal Clean Air Act requirement limitations on traditional roadway expansion, and federal funding provisions) often restrict the ability to expand infrastructure to accommodate current and ever-increasing roadway demand. To better position NDOT to receive federal

approval and funding of its projects, managed lanes, ramp metering and other congestion management and operational approaches must be considered as means to ensure that new, large-scale transportation projects maximize mobility benefits and minimize negative impacts.

Both managed lanes and ramp meters are widely implemented, cost-effective solutions that improve safety and mobility on freeways. Managed lanes promote time savings to users by offering a way of bypassing congestion. Ramp meters accomplish these objectives by smoothing the flow of traffic that enters a freeway facility by holding traffic to the ramp, and slowly releasing vehicles in a controlled manner so ramp-based traffic can safely merge with traffic on the freeway.

Since the 1960s, many metropolitan areas within the United States have successfully applied managed lane and ramp metering facilities to promote person movement and corridor mobility along congested routes. The Research and Innovative Technology Administration (RITA) recently conducted a national survey to identify the level of implementation. In all, 29 metropolitan areas in the United States reported using ramp meters, with a total of 2,901 ramp meters in operation throughout the United States. The survey respondents also reported 2,026 centerline miles of managed lanes in current operation, which included about 1,017 centerline miles of high-occupancy vehicle (HOV) lanes that provided mobility options to transit and rideshare commuters.

2.1. Legislative Background and Project Application

In February 2005, the Nevada State Legislative Committee on Transportation passed Assembly Bill 82 to amend Chapter 484 of the NRS. This action provided NDOT with the authority to designate a lane on a highway for HOV use in certain circumstances in order to provide additional mobility options to commuters and highway users. The amended Chapter 484 of the NRS further requires NDOT to establish the conditions for the use of any such designated lane, including vehicle occupant requirements and daily hour restrictions for the designated lane. Chapter 484 of NRS prescribes the unlawful use of a designated lane as a misdemeanor that is punishable by a fine of \$250.

Furthermore, Chapter 484 of NRS authorizes NDOT discretion when establishing a range of managed lane facility policies. The law also allows NDOT the flexibility to utilize related mobility management tools, such as ramp metering and other types of designated or managed lanes to address growing travel demand.

The first HOV lanes were opened in Nevada as part of the 2006 reconstruction and widening of US Route 95 (US 95) north of Interstate 15 (I-15) in Las Vegas. In 2010, express lanes along I-15 within the Las Vegas' Resort Corridor were opened. Additional managed lane facilities are being planned on several freeways within Las Vegas and Reno-Sparks.

In 2005, ramp meters were installed and activated at three freeway entrance ramps in Las Vegas along US 95. These three facilities were the first cases that exposed the public to ramp metering in Nevada. As of 2013, there are over 70 ramp metering facilities in Southern Nevada. As for Northern Nevada, a number of ramp meters have been implemented in Reno-Sparks, with several more planned to be added soon.

3.0. DEFINITIONS

3.1. Managed Lanes

A managed lane is a lane or set of lanes within a highway facility where operational strategies are proactively implemented and managed in response to changing conditions. Managed lanes have the following common elements, as described by the Federal Highway Administration (FHWA):

- ▶ The managed lane concept is typically a “freeway-within-a-freeway” where a set of lanes within the freeway cross-section is separated from the general-purpose lanes.
- ▶ The facility incorporates a high degree of operational flexibility so that over time, operations can be actively managed to respond to growth and changing needs.
- ▶ The operation and demand on the facility is managed using a combination of tools and techniques in order to continuously achieve an optimal condition, such as free-flow speeds.

The principal management strategies are pricing, eligibility, and access control:

- ▶ **Pricing:** Applied to toll lanes, using different strategies, in order to manage demand.
- ▶ **Eligibility:** The lanes are managed by allowing certain vehicles or restricting others. Minimum occupancy (2+, 3+, etc.) and/or vehicle type (bus, motorcycle, truck, etc.) are common eligibility strategies.
- ▶ **Access:** Restricting access is a means of regulating entry and exit movements and can be applied to many types of managed lanes.

The term “priced managed lanes” refers to lanes that employ some type of pricing as a management strategy. As per the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, priced managed lanes are to be designated as ‘Express Lanes’.

Types of managed lanes include:

- ▶ **HOV lanes:** HOV lanes are dedicated to the exclusive use of HOVs, including buses, carpools, vanpools, or a combination thereof, for at least a portion of the day.
- ▶ **High-Occupancy Toll (HOT) Lanes:** HOT lanes are priced managed lanes that use both pricing and eligibility strategies, where HOVs are given free or discounted use while other vehicles are tolled.
- ▶ **Express Toll Lanes (ETL):** ETLs are priced managed lanes where all vehicles pay a toll to use them. Unlike HOT lanes, ETLs charge all vehicles except for some cases where buses and vanpools may be toll-exempt.
- ▶ **Express Lanes without Toll:** All vehicles are allowed but access is limited during long stretches of the facility, minimizing turbulence in the flow of vehicles.
- ▶ **Bus Toll Lanes (BTL) and Truck-Only Toll (TOT) lanes:** BTLs and TOT lanes are priced managed lanes that use the eligibility strategy. These are not explicitly addressed in this Manual.

The term “managed” is sometimes understood to refer to variable pricing and/or variable occupancy type of strategies that are more “actively” applied in “real-time”. This Manual uses the term “managed lanes” to refer to all managed lanes including HOV lanes. Where a specific type of managed lane is to be addressed, the specific term is used (such as HOV, HOT, ETL, etc.).

By offering dedicated lanes for HOVs, HOV lanes, the most common type of managed lanes, emphasize person movement rather than traditional vehicle movement, which in turn improves the highway’s ability to move more people in fewer vehicles (Figure 3-1). This approach only works when an assured level of service in the lane is preserved and time savings that encourage mode shifts to transit, vanpooling, and carpooling are realized. To provide this benefit, the dedicated lanes are managed at a flow rate that is below traditionally defined lane capacity. When operated and managed at a high level of service, HOV lanes save peak-period travel time over the adjacent general-purpose lanes and can move substantially more commuters than general-purpose lanes during peak demand periods when priority must be assigned to the highest and best use. During these periods, HOV lanes provide significant benefits to those choosing to ride a bus or participate in a vanpool or carpool.

Figure 3-1: I-405 HOV Lanes in Irvine, California



This Manual addresses only managed lanes on controlled-access roadways. Managed lanes on arterials are not in the scope of this Manual.

3.2. Ramp Metering

Ramp metering is defined by FHWA as the use of traffic signals at freeway on-ramps to control the flow of traffic entering a freeway (Figure 3-2). By controlling the rate at which vehicles are allowed to enter a freeway, the flow of traffic onto the freeway facility becomes more consistent, smoothing the flow of traffic on the mainline and allowing more efficient use of existing freeway capacity. Ramp metering can be an effective tool to address congestion and safety issues that occur at a specific point or along a portion of a freeway.

Figure 3-2: Ramp Meter on I-15 in Las Vegas (Tropicana Road NB On-Ramp)



4.0. THE PRIMARY AGENCY PARTNERS

The primary partners in managed lane and ramp metering projects include NDOT, local agencies, and federal agencies. These agencies include metropolitan planning organizations (MPOs), transit providers, local roadway implementing agencies, enforcement agencies (state/city/county), and federal agencies, such as FHWA and the Federal Transit Administration (FTA). The role each agency serves within Nevada, Las Vegas, or Reno-Sparks is generally distinct and related to the specific implementation, operation, enforcement, and monitoring of activities for individual projects and the regional system as a whole.

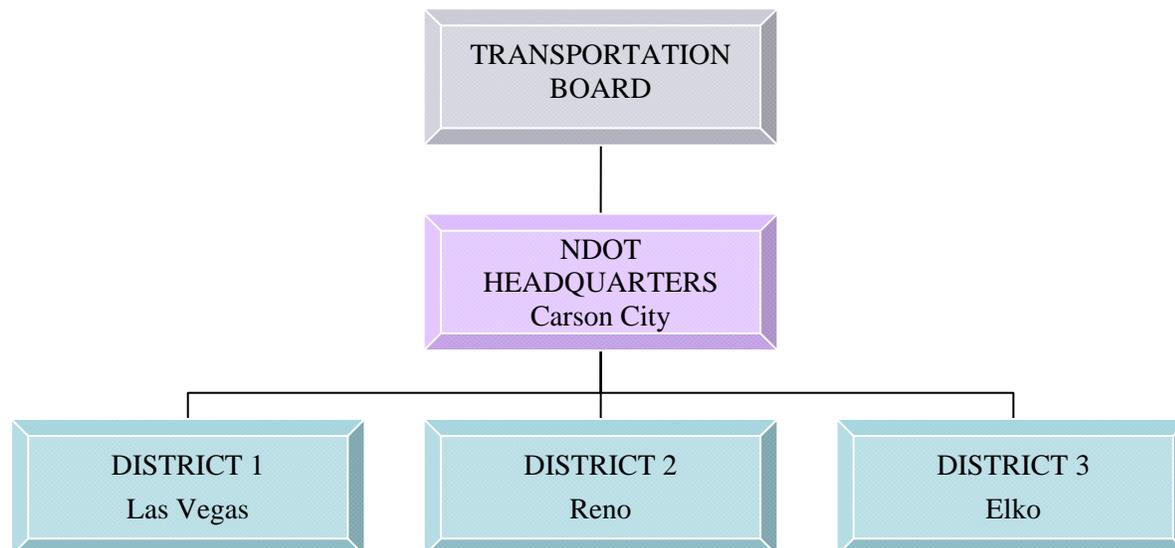
The following sections define the roles and responsibilities of the primary agencies in southern and northern Nevada.

4.1. Nevada Department of Transportation (NDOT)

NDOT has lead responsibility for the planning, design, construction, operation, and maintenance of Nevada’s highway system, which consists of approximately 5,400 miles of highway and nearly 1,000 bridges. NDOT is divided into three districts, with a district engineer and two assistant district engineers assigned to each district. The districts are responsible for supervising all transportation activities within their local areas. NDOT’s headquarters is located in Carson City, with the three district offices located in Las Vegas (District 1), Reno (District 2), and Elko (District 3).

A seven-member Board of Directors, which includes Nevada’s Governor, Lieutenant Governor, Attorney General, and State Controller, oversees NDOT. Three additional directors, one representing each of the three NDOT districts, comprise the remaining membership. Figure 4-1 depicts a simplified version of NDOT’s organizational structure.

Figure 4-1: NDOT Organization Chart



4.2. MPOs and Transit Providers

Transit providers and MPOs are partners with NDOT that assist in implementing managed lane and ramp metering facility planning, education, and outreach initiatives. Because MPOs are the “local planning voice” in a specific area, the success of these initiatives would be reduced

significantly without their support, and additional programs that support managed lanes and ramp metering (e.g., park-and-ride lots, commute trip reduction programs) may not be prioritized.

In northern Nevada, the Regional Transportation Commission (RTC) of Washoe County serves Reno-Sparks along with the unincorporated areas of Washoe County. The agency is responsible for regional public transportation and the transportation network within the County. In an effort to consolidate the Regional Street and Highway Commission, the Regional Transit Commission, and the Washoe County Area Transportation Study Policy Committee, the Nevada Legislature formed the RTC of Washoe County in July 1979. The agency is supervised by an executive director and directed by a regional board comprised of five representatives appointed from three government jurisdictions. Two representatives are from the Reno City Council; one is from the Sparks City Council; and two are from the Washoe County Board of Commissioners.

In southern Nevada, the RTC of Southern Nevada serves Las Vegas and other Southern Nevada communities. Formed in 1965, the agency oversees and performs a number of transportation activities described below. In 1981, the agency was named the MPO for Las Vegas and is responsible for maintaining a continuous, cooperative, and comprehensive transportation planning process.

Other responsibilities of the RTC of Southern Nevada include the following functions:

- ▶ Overseeing the federally-mandated transportation planning process for the Southern Nevada region;
- ▶ Directing the expenditure of funds generated from the FTA, the Federal Highway Trust Fund, the County Option Motor Vehicle Fuel Tax for regional street and highway construction, and the county sales tax designated for transportation;
- ▶ Ensuring that transportation plans and programs conform to approved air quality standards;
- ▶ Providing public mass transportation within southern Nevada; and
- ▶ Administering the region's trip reduction program (the Club Ride Commuter Services).

The RTC of Southern Nevada is directed by an executive director and overseen by a Board of Commissioners. Board membership is set by Nevada statute and consists of two members from the Board of Clark County Commissioners, two members from the city council of the largest incorporated city, and one member from the city council of every other incorporated city in Clark County. Additionally, the NDOT Director serves as an ex-officio member.

4.3. Organizational Structure: Roles and Responsibilities

Coordination is an essential aspect of any successful transportation program. It is anticipated that NDOT will coordinate all managed lane and ramp metering efforts with the appropriate agencies throughout the planning, design, construction, and operation phases. These agencies could include the following:

- ▶ Regional and local transportation implementing agencies,
- ▶ Public transit and private transportation service providers,
- ▶ Law enforcement,

- ▶ Upper management and government officials and decision makers, and
- ▶ Municipal/county jurisdictions.

Intermodal considerations and coordination is to take place throughout the planning and development process. When operational changes to the managed lane and ramp metering facilities are required, it will be the responsibility of NDOT (as the authorized agency that regulates managed lanes per NRS Chapter 484) to coordinate changes with the agencies and jurisdictions specifically affected by the change.

The following lists the lead roles and responsibilities by agency for the statewide development of the managed lane and ramp metering facilities.

Planning

- ▶ System planning, corridor screening, and concept development: NDOT
- ▶ Regional traffic forecasting and programming: RTC and NDOT
- ▶ Partnering agencies: FHWA, city, county, and RTC

Project Development

- ▶ Environmental approval, design, and construction: NDOT, FHWA, RTC, or local implementing agency
- ▶ Partnering agencies: FHWA, RTC, city, county, and affected enforcement agencies

Operation

- ▶ Operation policy and regulations: NDOT
- ▶ Enforcement: Local police and Nevada Highway Patrol (NHP)
- ▶ Transit service: RTC and other local transit providers
- ▶ Partnering agencies: FHWA, city, county, and RTC

Marketing

- ▶ Outreach: NDOT, city, county, and RTC
- ▶ Communication: NDOT, city, county, and RTC
- ▶ Partnering agencies: City, county, and other local agencies, as appropriate

Performance Monitoring

- ▶ Data collection: NDOT, RTC, city, county, and affected law enforcement agencies
- ▶ Documentation and dissemination: NDOT

The functional roles outlined above serve as a means of establishing working relationships on projects or regional system task forces. Specific roles may be assigned on a project-by-project basis. In each case, the lead agency is responsible for coordination and communication with each partnering agency, in addition to addressing issues of common interest and concern.

5.0. POLICY GUIDANCE FOR MANAGED LANE FACILITIES

The following section provides overall policy guidance regarding implementation, operation, enforcement, performance, public involvement, and funding for managed lane facilities throughout Nevada. Appropriate goals have been established to guide NDOT and related agencies on how to manage the managed lane facilities.

5.1. Program and Policy Understanding

Policies are needed to ensure that managed lane facilities obtain the necessary resources for successful system implementation, operation, and maintenance. The policies outlined in this section help identify when managed lane facilities are to be used, as well as how they are to be operated to maintain a consistent approach statewide.

5.1.1. Elements

A system of managed lane facilities is comprised of dedicated lanes and various supporting facility improvements, such as access treatments, park-and-ride lots, and bus transit terminals and programs (e.g., rideshare and marketing programs), that are intended to provide and promote mobility options to freeway users as well as encourage and sustain transit and carpool/vanpool ridership.

5.1.2. Need

Based on a defined vision, goals, and objectives, policies can provide direction for determining when managed lane facilities should be considered; and may establish guidelines and thresholds for use when determining the need for a managed lane facility. Thresholds (also called justifications or warrants) typically include the presence and duration of traffic congestion, managed lane demand, potential for travel benefits, transit service levels, and commuter market characteristics and travel patterns associated with the subject region or corridor market area. As funding constraints intensify, the ability to generate revenue through pricing may become an additional threshold for justifying need, where revenue may be required to support implementation and operation of new lanes.

In addition to implementation thresholds, policies relating to operational thresholds may be appropriate for triggering a revision of the managed lane operating policy. A managed lane facility's level of demand and utilization may require policy modifications that relate to eligibility (minimum occupancy, vehicle types, tolling), access (ingress and egress or direct access), and hours of operation.

5.1.3. Vision Statement

At the onset of the Managed Lanes and Ramp Metering Statewide Study in 2005, a working group comprised of state, federal, and local agency representatives was convened in Las Vegas. The group included agencies and divisions of NDOT involved in planning, implementing, operating, and maintaining transportation improvements. Specific external agency representation included the RTC of Washoe County, the RTC of Southern Nevada, and FHWA. Based on several workshops, the following vision statement was developed and adopted to be applied to all managed lane facilities in Nevada.

It is the vision of NDOT to help move more people within existing and planned transportation corridors by providing a broader range of options for travelers in Nevada. By planning, developing and operating a comprehensive system of managed lane facilities, travel time savings can be used as an incentive to encourage people to use transit or to carpool, thereby maximizing investments in transportation infrastructure by moving more people, particularly where options to expand roadway capacity and protect future mobility are limited.

In all, it is the vision of NDOT to develop a system of managed lane facilities that would serve major metropolitan area freeways, extend to major urban and suburban arterial streets, and incorporate essential support facilities. The development of an encompassing system of managed lane facilities would protect transportation corridors for future use by higher-capacity modes. As travel demand increases over time, managed lane facilities can evolve to accommodate bus rapid transit and to complement other fixed guideway transit investments designed to move more people.

5.1.4. Goals and Objectives

Building upon the vision statement and considering previously established goals and objectives from other states, Nevada has defined a series of goals to guide and manage the implementation, operations, performance, public involvement, and funding for managed lane facilities.

Goals and objectives often establish the parameters by which subsequent policy elements can be defined and how the performance of managed lane facilities can ultimately be evaluated. In all, the goals of a managed lane facility is to be consistent with regional and statewide guidance related to the broader planning processes and is to represent one component of a larger congestion management effort. However, the goals and objectives also need to be unique and specific to local needs. Drawing on this guidance and based on the visioning workshops, the following points offer methodological guidance that was applied to creating and defining the subsequent goals.

- ▶ The goals and objectives need to be regional in nature and should not be project specific.
- ▶ Both for NDOT and FHWA, the traditional planning goal of meeting acceptable peak hour levels of service for future demand may not always be achievable. The reality is that projects are now being developed in constrained settings that provide mobility options and improve overall transportation performance and efficiency. This is in contrast to singularly attempting to eliminate congestion by striving to achieve an acceptable level of service for all users.
- ▶ In constrained settings, it will be appropriate to look at specific user groups and to try to serve these groups through managed lanes. Operational policies may create different eligibility requirements by time of day (e.g., HOV during commute, goods movement during off-peak) to serve specific user groups.
- ▶ Goals need to be discussed in the context of a Monitoring Plan, Operations Plan, Enforcement Plan, and Marketing Plan that supports the policies.
- ▶ Primary measures that address goals include vehicles per hour, occupancy of vehicles, transit travel, time savings, and travel speeds.
- ▶ NDOT and each respective RTC must monitor the system in order to establish a baseline condition to better assess the impact of managed lane facilities as they are implemented.

The goals for managed lane facilities are as follows.

Goal #1: Optimize the movement of people

- ▶ The primary regional goal is to move more people, which can increase the low overall vehicle occupancy rate currently present in Las Vegas and Reno-Sparks.
- ▶ Everyone needs to realize that it takes considerable time to alter commuter travel behavior. For this reason, the benefits of a managed lane facility may be realized slowly over a long period of time.
- ▶ This goal is best measured by reviewing change in average vehicle occupancy over time.

Goal #2: Provide incentives to share the ride

- ▶ Time savings and trip reliability are the motivating factors to use a Managed lane facility. For these reasons, these factors must be preserved for the facilities to be successful.

Goal #3: Increase bus transit efficiency

- ▶ RTC will define how they want transit efficiency to be measured. Various other locales monitor transit on-time performance as a measure for this goal.

Goal #4: Not unduly impact existing traffic operations

- ▶ This goal specifically discourages using lane conversions in an attempt to implement the Managed lane facility, particularly where implementation adversely affects existing traffic demand and travel patterns.
- ▶ This goal also ensures that the operation of Managed lane facilities (e.g., traffic weaving at access points) does not excessively impact other traffic using the freeway or arterial street system.

Goal #5: Secure public support

- ▶ Managed lane facilities need to have public support. The role of monitoring public support for Managed lane facilities will likely be shared in partnership between NDOT and local agencies, such as the RTC.
- ▶ In assessing overall support for Managed lane facilities, it is important to specifically ask people how they feel about them. This question should be asked of users and non-users of the facilities.
- ▶ Marketing and outreach can only be effective if the concept and its application are sound. Managed lane facilities are a transportation product. Good planning, effective design, and efficient operation of these facilities are necessary to ensure the public understands and supports these facilities.

Goal #6: Consider congestion pricing as a means to optimize system performance

- ▶ Congestion pricing will be primarily considered as a traffic management tool, not to generate revenues from managed lanes.
- ▶ Managed lane facilities are to be available for use by all income groups through pricing preference (free or discounted use) to carpool, vanpool, and transit users. Priced lanes must be equitable for all users.

Goal #7: Promote goods movement by trucking if possible

- ▶ *Trucking promotes regional economic development. Major highway routes are of strategic significance to Nevada and its respective cities. Improved mobility for person movement and trucking is a statewide objective.*
- ▶ *Preferential treatment is to be offered to trucks where safe, practicable, and beneficial, without compromising the overarching goal of promoting greater person movement in congested corridors.*

5.2. Program Policies

This section outlines policies that addresses managed lane facility goals as outlined above. Program policies help provide the framework for managed lane facility technical guidance found in Part 2: Implementation Plan and Part 3: Design Manual. These policies are to be routinely revisited as projects are implemented and operated.

NDOT retains control of policy, implementation, and overall management of the managed lane facilities. While management may be carried out through association with other regional agencies, NDOT is ultimately responsible.

5.2.1. Implementation

Implementation policies are needed to ensure that a managed lane facility is implemented in a manner that is beneficial, meets achievable and practical standards, and is cost-effective. The following policies serve as a starting point or minimum set of recommended actions that must be completed to ensure successful implementation of managed lane facilities.

Corridor and System Justification

- ▶ A system level assessment is to be made of any metropolitan area experiencing congestion. This assessment determines the feasibility of managed lane facilities on the transportation system (as a whole) or on portions of the transportation system. Assessment criteria are based on the list of goals provided above and regional and corridor evaluation measures provided in Part 2: Implementation Plan. Reassessments are periodically needed as the system or individual corridors are expanded.
- ▶ Consideration of a managed lane facility is to be made for any portion of the region's highway system that is programmed for construction or reconstruction based on findings from the system level assessment.
- ▶ Identifying logical termini (interim and ultimate) is primarily determined by facility demand and not interchange location, since this approach is the best way to verify that benefits can be maximized. When part of a larger, more comprehensive project, the limits for a managed lane facility may be different from the limits of the larger, more comprehensive project.
- ▶ Primary justification is based on opportunities to promote travel time benefits and trip reliability above minimum threshold levels established in Part 2: Implementation Plan. The presence of congestion for current and/or forecast years is a prerequisite condition for consideration.

Project Justification

- ▶ The basis for specific project justification involves criteria locally adopted at the region and corridor-specific level. Specific criteria are included in Part 2: Implementation Plan.

Demand Thresholds

- ▶ The initial demand threshold to justify a managed lane facility varies by the type of facility (refer to Part 2: Implementation Plan).
- ▶ Various operational steps are to be identified to justify how demand is managed when the demand threshold is reached.

Selecting Types of Lane Treatments

- ▶ While NDOT determines the specific type of lane treatment, it involves all of the affected partnering agencies in this decision. Determination involves considering traffic needs and impacts, physical and environmental constraints, cost, funding, and public input.
- ▶ Specific guidance for selecting design treatments is based on Part 2: Implementation Plan and Part 3: Design Manual.
- ▶ To the extent possible, a common design approach is to be applied to all managed lane facilities throughout a specific region (e.g., Las Vegas or Reno-Sparks). A common design approach helps promote driver awareness and safety based on establishing similar driver expectations in that region.

Funding

- ▶ NDOT is the primary designated agency to develop a funding plan for the regional system of managed lane facilities and for individual projects.
- ▶ Funding managed lane facilities often involves federal funding from both FHWA and FTA. Securing funding for specific projects is the responsibility of all affected local agencies in each urban area. Local, state, and federal funding all play a role in making a managed lane project feasible. The local transit provider in cooperation with NDOT has the responsibility for FTA funding.
- ▶ Local and state agencies are to promote public awareness of how funding is secured and applied for developing and implementing managed lane facilities. This approach aids in developing overall public support.
- ▶ Capital and operation/maintenance funding is not to rely on revenue generation as a primary means of project justification and delivery.

Cost Effectiveness

- ▶ Benefits and costs for a corridor project are to be considered for a managed lane project as a whole (e.g., dedicated lanes, access features, transit improvements). Individual components are not to be evaluated for benefits and costs even if they are implemented through different projects.

Transit

- ▶ The transit agencies are to be engaged as a project partner for any managed lane project being considered and evaluated. Efforts to make the project “transit friendly” are to be

explored to support current and proposed transit routings and in analyzing the potential for addressing new transit markets with managed lanes and/or express bus services.

Rideshare Facilities and Provisions

- ▶ NDOT and transit agencies are committed to supporting rideshare promotion by providing rideshare staging facilities along any planned or operating managed lane corridor. Where possible, such facilities are to be located on available right-of-way and designed such that access does not adversely affect interchange design or operation and access management policy.
- ▶ Rideshare facilities, which are endorsed as part of any managed lane facility, is to include parking areas and provisions for extra spaces within transit park-and-ride lots for rideshare parking.

Access and Termini Impacts

- ▶ Access treatments (e.g., designated intermediate access zones, direct access ramps, and project termini) are to be designed and evaluated to both prioritize travel benefits (minimize travel delay time associated with queuing and merging) and to minimize adverse impacts on adjacent travel lanes.

Adjacent Traffic Impacts

- ▶ When planning projects, the impact to adjacent traffic is to be minimized and balanced between the managed lane facility and adjacent roadway system to the greatest extent possible.
- ▶ Traffic diversion from the freeway system and onto adjacent streets caused by a proposed managed lane facility is not to represent a noticeable adverse impact.

Implementation Phasing

- ▶ Phasing of a managed lane project in a region must attempt to maximize benefits and minimize impacts in the initial phase to the greatest extent possible, since this is often the basis for how future phases are perceived.
- ▶ Future phasing must attempt to minimize lost benefits due to temporary or permanent termini treatments.
- ▶ Project improvements in a corridor or system can be discontinuous and still be effective. Separate ramp meter bypasses and mainline treatments are considered independently in justification and implementation.
- ▶ Direct-access ramps may be considered as stand-alone enhancements to a managed lane, particularly for projects implemented independently (or not as a part of another larger project).

5.2.2. Operations

NDOT has responsibility for setting operation policy. NDOT may consult with and/or lead a managed lane committee (composed of affected local agencies) for establishing the operation policy.

Eligibility Hierarchy

- ▶ The primary users for HOV lane facilities are buses, vanpools, and carpools. Eligibility requirements for other users (trucks, motorcycles, etc.) are defined in Part 2: Implementation Plan.
- ▶ The default occupancy eligibility assigned to any HOV lane facility is two or more persons per vehicle.
- ▶ Management actions, including raising occupancy requirements, are to be periodically considered in response to congestion and/or (lack of) travel time benefits experienced by users.

Hours of Operation

- ▶ The hours of operation for a managed lane facility are typically either all day (full-time) or during peak periods only. Hours of operation may be different for each project or region. Regional consistency is desired for each area where multiple managed lane facilities are planned.
- ▶ Operating periods must be clearly delineated at regular intervals for all managed lane facilities. The interval is to be determined based on partnering with respective law enforcement agencies.
- ▶ Operation periods may be modified as conditions warrant.

Pricing

- ▶ Pricing may be considered for a managed lane facility.
- ▶ Pricing may be considered as a means of promoting more efficient traffic management and, accordingly, may be considered for selected hours and selected projects.
- ▶ Toll based lane management is to be implemented through electronic toll collection (ETC) technology. Vehicles/owners are to be registered in advance and managed through off-line accounting. No toll booths are to be implemented on any managed lane facility.
- ▶ If implemented, pricing is designed to manage traffic in real time (dynamically) by setting a price that either encourages or discourages use in an attempt to manage flow at an operational threshold.
- ▶ Determination of pricing programs needs to consider the following:
 - Evaluation of demand, impacts, and benefits;
 - Evaluation of technology, enforcement, and institutional arrangements;
 - Public support through outreach; and/or
 - Environmental justice impacts.
- ▶ The pricing plan needs to include a policy level determination to address any net excess revenue.
- ▶ Adverse impacts to the formation and promotion of transit and ridesharing is to be avoided.

- ▶ In the interest of uniformity to facilitate driver acceptance, consistency across multiple facilities in terms of pricing policy, administration, and technology must be achieved.

Overutilization

- ▶ A project is considered overutilized when its volume exceeds maximum thresholds defined in Part 2: Implementation Plan. In partnership with affected local agencies, NDOT will address various management measures to restore acceptable level of service.
- ▶ Options to address overutilization may include raising occupancy requirements for the affected hours, raising pricing for lower occupancy vehicles, and/or altering access.

Underutilization

- ▶ A project will be considered underutilized if it does not reach the minimum threshold volumes defined in Part 2: Implementation Plan within the first two years of opening, and the adjacent general-purpose lane LOS during this same comparable period is better than LOS D.
- ▶ Options to address underutilization may include adding other user groups, opening the lanes to priced SOVs (HOT lane operation [see pricing policy]), increasing access, increasing transit and rideshare promotion, and/or expanding the project limits to generate greater demand.
- ▶ A progressive operational phasing plan of a managed lane facility is to be defined prior to project implementation. This operational phasing plan needs to include and define performance metrics and continuous monitoring provisions to evaluate performance.

5.2.3. Enforcement

Enforcement policies are needed to enforce managed lane facility operations.

Fines and Statutes

- ▶ State statutes relating to managed lane facilities may be modified over time. Statutes are to be routinely reviewed prior to and following each operational policy change that is implemented.
- ▶ NDOT and the Nevada Highway Patrol (NHP) may propose changes to State statutes. Partnering agencies are encouraged to participate with NDOT and NHP in addressing legislative changes as needed.

Enforcement Compliance

- ▶ The compliance goal for managed lane facilities is 95 percent. If pricing is employed, a higher compliance goal may be considered.

Staffing: Initial Facility Opening

- ▶ Increased law enforcement is to be recommended during the initial months when opening a new facility. Dedicated enforcement personnel during this period is a goal for any new project.

Staffing: Routine Facility Monitoring

- ▶ After a defined initial opening period, managed lane facility enforcement is routine and similar to other traffic and incident management duties. However, in the case of a priced

managed lane facility, revenue from the facility may be used to support the provision of dedicated enforcement.

Funding

- ▶ Extraordinary enforcement funding (overtime pay or contracted support) for managed lane facility enforcement is to be considered as part of each new managed lane facility, up to a period of six months after opening.
- ▶ In the case of a priced managed lane facility, revenue from the facility may be used to fund routine dedicated enforcement.

Outreach

- ▶ Outreach to NHP is required at key milestones in the managed lane project development phase. These milestones include design, operational planning, opening, and performance monitoring.
- ▶ Outreach includes:
 - Affected law enforcement agencies and assigned enforcement staff,
 - The district attorney’s office,
 - Traffic court judges, and
 - The media.

5.2.4. Performance Measurement

Performance measurement policies are needed to monitor, evaluate, and report the performance of managed lane facilities. Performance measurement conveys the benefits of these facilities to decision makers. Performance measurement policies serve as a means to improve operations and to allocate resources to programs that are most effective in satisfying the stated goals.

Purpose

- ▶ The purpose of monitoring and reporting managed lane facility performance is to provide validation that project and system benefits are being met, to communicate these benefits with the public, and to provide guidance for changes in operation policy and project implementation.

Performance Measures

- ▶ Performance measures are to address the regional and project-specific goals and objectives for the managed lane facility. Specific performance measures for consideration are included in Part 2: Implementation Plan.

Baseline Conditions

- ▶ Each project is to be “baselined” by collecting data on the “before” traffic and operation conditions for each of the performance measures being monitored. This is done so that a comparison and evaluation can be done on whether the adopted goals and objectives are being met. Baseline conditions are to be developed prior to construction activities.

Data Collection

- ▶ To the extent possible, data is to be collected through agencies and NDOT divisions already involved in the specific data needed. Data needs are coordinated with and sought from sources that may already have this data available (e.g., RTCs for transit data and NHP enforcement for violations).

Reporting

- ▶ Each time a managed lane project is implemented in a new corridor, operational performance must be documented through a six-month, and first year performance report. After the first year of operations, an annual report for the region is the routine reporting frequency. More frequent (up to monthly) reporting may be required of some projects.
- ▶ An annual inventory of projects is to be maintained and updated for performance data. A regional or statewide cycle for reporting may also be established.

5.2.5. Public Information and Outreach

Public information and outreach policies are needed to ensure that information regarding managed lane facilities is being communicated to all relevant agencies, groups, and individuals.

- ▶ The benefits of managed lane facilities and the reasoning for their implementation is to be conveyed to upper management, traffic managers, traffic engineering departments, law enforcement agencies, transit agencies, the media, or any other stakeholder, individual, or agency affected by managed lane facility implementation and operation (see Part 5: Public Outreach Primer).

5.2.6. Funding (Operations & Maintenance)

Funding is the backbone for any project. It is necessary to identify funding sources well in advance of when a managed lane facility is proposed to be installed. Funding foresight helps to assure that managed lane facilities are operated and maintained correctly, consistently, and routinely.

- ▶ NDOT has the responsibility for identifying funding for managed lane facility operations and maintenance on State freeway facilities. RTC may support NDOT in identifying funding opportunities and in accelerating the implementation of projects through various financing strategies.
- ▶ The primary funding for transit service and enforcement comes from the respective regional/local agency vested with this role.

6.0. POLICY GUIDANCE FOR RAMP METERING

The following section provides overall policy guidance regarding implementation, operations, enforcement, performance monitoring, public involvement, funding, staffing, and system requirements for ramp metering. This section also includes ramp metering goals and objectives.

6.1. Program and Policy Understanding

Policies are needed to ensure that ramp metering programs are consistently implemented, operated, and maintained. The policies outlined in this section help identify when ramp meters are to be used, as well as how they are to be operated to maintain a consistent statewide approach.

6.1.1. Need

Based on defined goals and objectives, policies can provide direction for determining when ramp metering is to be considered. Policies may also establish guidelines and thresholds for identifying the need for ramp metering. Justifications (or warrants) typically include the presence and duration of traffic congestion, ramp and mainline demands above specified thresholds, freeway speeds below a threshold, history of accidents, and the potential for travel benefits.

6.1.2. Goals

The goals related to ramp metering are as follows.

Goal #1: Improve overall safety and decrease crashes

- ▶ The primary intent of this goal is to decrease collisions in the vicinity of the freeway on-ramp. This includes merge and weave areas and upstream freeway sections.
- ▶ This goal seeks to improve freeway flow by reducing conflicts to make the merge operation smoother and safer.

Goal #2: Improve overall travel speeds

- ▶ The primary intent of this goal is to increase vehicle speeds on the freeway to levels that are considered desirable by the traveling public.
- ▶ This goal seeks to prevent (or delay) the onset of freeway flow breakdowns that result in reduced speeds.

Goal #3: Increase freeway throughput

- ▶ The primary intent of this goal is to reduce congestion and improve overall freeway level of service.
- ▶ This goal seeks to prevent (or delay) the onset of freeway flow breakdowns that results in reduced freeway capacity.

Goal #4: Manage ramp delay and avoid excessive queuing

- ▶ The primary intent of this goal is to manage delay to ramp vehicles and keep such delay to acceptable levels.
- ▶ This goal also ensures that vehicle queues that form at the ramp meter do not spill back onto and/or excessively impact operations on adjacent arterials.

Goal #5: Avoid cut through traffic in neighborhoods

- ▶ The primary intent of this goal is to prevent diverted traffic from using local neighborhood streets.

Goal #6: Support Regional Air Quality

- ▶ The primary intent of this goal is to reduce overall (corridor-wide) vehicle delay through the use of ramp meters, and thereby reduce the amount of emissions released into the environment.

Goal #7: Promote bus and carpool benefits at ramp meter sites

- ▶ The primary intent of this goal is to promote the use of transit/carpooling/vanpooling by providing HOV queue bypass lanes on metered ramps where it is possible to do so.

6.2. Program Policies

This section outlines policies that address ramp metering goals as outlined above. Program policies provide the framework for ramp metering technical guidance found in Part 2: Implementation Plan, Part 3: Design Manual, and Part 4: Ramp Metering Performance Measurement Plan. These policies are to be routinely revisited as projects are implemented and operated.

NDOT retains control of policy, implementation, and overall management of the ramp metering program and specific ramp meters. While management is done in association with RTC, NDOT is responsible for final decisions.

6.2.1. Implementation

Implementation policies are needed to ensure that ramp metering is implemented in a manner that is beneficial, meets achievable and practical standards, and is cost-effective. The following policies serve as a starting point or minimum set of recommended actions that must be completed to ensure successful implementation of the ramp metering program.

Justification for Ramp Meter Deployment

- ▶ A system level assessment is to be conducted for any area considering ramp metering per Part 2: Implementation Plan. This assessment determines the need for and impacts of ramp meters.
- ▶ Corridors with routine congestion or flow breakdown near on-ramps are to be considered for ramp metering.
- ▶ Ramp meters are considered for deployment on ramps where a safety problem exists either on the ramp or at a location on the freeway facility at or near the ramp/freeway merge point or in the vicinity of the on-ramp.

Justification of Geographic Extent

- ▶ Ramp meters are considered for deployment on a system-wide basis if ramp-related problems are observed at multiple locations on multiple segments of a freeway within a given region.

- ▶ Ramp meters are considered for deployment on a corridor basis if ramp-related problems are observed at multiple locations on a specific corridor, and similar problems are not observed at multiple locations on any other corridor.
- ▶ Ramp meters may be considered for deployment at a specific location if a ramp-related problem is observed, so long as similar problems are not observed at ramps immediately upstream or downstream of the ramp being considered for ramp meter deployment.

Safety Considerations

- ▶ Ramp metering is considered only if sufficient (acceleration) distance can be provided for vehicles stopped at the ramp meter to accelerate and attain safe merge speeds.
- ▶ Sufficient stopping sight distance is to be provided for vehicles joining ramp queue during metering operations.
- ▶ Advance warning is to be provided to ramp vehicles during ramp metering operations.

Demand Thresholds

- ▶ Pre-metering demand on the ramp is used to determine the appropriate ramp metering flow control (see Part 2: Implementation Plan).

Adjacent Facility Operations

- ▶ When planning ramp metering projects, the impacts to adjacent arterial traffic must be considered.
- ▶ Ramp meters are considered for deployment only if there is sufficient storage room on the ramp to hold vehicles that must wait at the ramp meter. If existing storage room is deemed inadequate for times when the ramp metering is operational, ramp meter implementation may be allowable if sufficient, additional storage can be created by widening the ramp or by other means (e.g., re-striping lanes).

High-Occupancy Vehicles

- ▶ An HOV bypass lane is to be provided at every urban ramp where ramp metering is installed (see Part 2: Implementation Plan for exceptions).

Implementation Phasing

- ▶ During the introductory phases of ramp metering implementation, media campaigns are to be conducted to inform drivers about the objectives and operations of the ramp meters.
- ▶ Ramp meters are to be installed and operational at least one week before they are turned on for public use for the first time. This allows sufficient time to fully test the operation of each ramp meter.
- ▶ Ramp meters are to be phased in a logical sequence with communications provided to the Traffic Management Center (TMC) prior to deployment.

6.2.2. Operations

Operations policies are needed to ensure that ramp metering is operated in a consistent manner in a region. NDOT has the primary responsibility for ramp metering operations. The operation of ramp meters may be delegated to RTC or other local agency through an agreement.

Hours of Operation

- ▶ Ramp meters are turned on/off at the same time everyday during the initial period of operation, unless otherwise indicated by the supervisor in charge of ramp metering operations. The initial period depends on several factors, including the degree to which motorists have adjusted to the ramp meter.
- ▶ Ramp meters are operated only during the peak-periods during the initial period of operation to reduce probability of motorists' confusion and to make the system more predictable.
- ▶ Ramp meters are to be operated when emergencies occur or in unique situations where their use would benefit existing conditions.
- ▶ Ramp meters are to be turned on/off outside normal hours of operation only by trained operators that are familiar with typical traffic patterns and problems.

Day-to-Day Activities

- ▶ Ramp meters are to operate on a consistent basis for the entire region.
- ▶ If closed circuit television (CCTV) is present near metered ramps, ramp meters are individually monitored on a periodic basis to confirm that each is working correctly. This is in addition to adjusting parameters when appropriate.
- ▶ If CCTV is not present near metered ramps, operators are to schedule routine field visits to observe if meters are working correctly. This is in addition to adjusting parameters when appropriate.

6.2.3. Maintenance

Maintenance policies are needed to ensure reliable use and effectiveness of ramp metering equipment. Policies in this section allow the verification that equipment is being maintained on a routine and as-needed basis. NDOT has the primary responsibility for ramp meter maintenance. The maintenance of ramp meters may be delegated to RTC or other local agency through an agreement.

Day-to-Day Activities

- ▶ Ramp metering equipment is maintained according to vendor requirements.
- ▶ Operators are to develop and update a checklist of activities for maintaining ramp metering equipment.
- ▶ Operators are to develop and update an inventory of ramp metering hardware, software, and other equipment that detail:
 - The date the equipment was installed;
 - Location of equipment;
 - The equipment vendor;
 - Equipment vendor contact information; and
 - Equipment model/version and serial numbers.

Responsive Maintenance

- ▶ Ramp metering equipment is maintained promptly when system malfunctions occur.
- ▶ Responsive maintenance needs have a higher priority than preventative maintenance needs when sufficient staff is not immediately available to address every maintenance need.

Preventative Maintenance

- ▶ Ramp metering equipment is maintained on a regular/scheduled basis in accordance with vendor recommendations.

6.2.4. Enforcement

Enforcement policies are needed to enforce ramp metering operations. Enforcement is by NHP and other law enforcement.

Outreach

- ▶ NDOT is responsible for coordinating with local, regional, and state law enforcement agencies to maximize public compliance.

Initial Operations

- ▶ Ramp meters are actively enforced during the initial month of operation.
- ▶ After the initial month of operation, ramp meters are enforced on a routine, spot-check basis.
- ▶ Operators are to report specific ramp meters that have high violation rates to enforcement agencies.
- ▶ Ramp metering locations are to generally include enforcement areas that provide a safe observation point for officers and an area to pull violators off the traveled lane so that enforcement actions have minimal impact on traffic conditions.

6.2.5. Performance Measurement

Performance measurement policies are needed to monitor, evaluate, and report the performance of ramp metering. Performance measurement conveys the benefits of ramp meters to decision makers and creates the foundation from which the ramp metering program can be a routine tool for use on urban freeways.

Monitoring

- ▶ Ramp meters are monitored on an on-going basis throughout the respective ramp meter's entire life-cycle.
- ▶ Ramp meters are monitored either remotely (using CCTV) or manually in the field to determine their impacts and effectiveness in accomplishing stated goals and objectives.

Evaluation

- ▶ Ramp meters are evaluated on a routine basis to assess whether or not anticipated outcomes are being produced and if improvements need to be made.
- ▶ Measures of effectiveness for ramp metering evaluation are to reflect the overall transportation system's goals and objectives.

- ▶ Ramp meters are to be evaluated three months after initial operations and annually thereafter.

Reporting

- ▶ Ramp metering effectiveness is monitored and reported to upper management, staff, outside agencies, the media, and the public in a manner that each of these groups can easily understand.
- ▶ Operators are to record and compare the results of ramp meter evaluations with the results of past and future evaluations so conclusions regarding ramp metering effectiveness can be made.

6.2.6. Public Information and Outreach

Public information and outreach policies are needed to ensure that information regarding ramp metering is being communicated to all relevant agencies, groups, and individuals.

- ▶ The benefits of ramp metering and the reasoning for implementation are to be conveyed to upper management, traffic managers, traffic engineering departments, law enforcement agencies, transit agencies, the media, or any other individual or agency affected by ramp meter implementation and operation (see Part 5: Public Outreach Primer).

6.2.7. Funding (Operations and Maintenance)

As noted, funding is the backbone for any project. It is necessary to identify funding sources well in advance of when ramp meters are proposed to be installed. Funding foresight allows the ramp meters to be implemented in a timely and effective fashion. This also helps to assure that ramp meters are operated and maintained correctly, consistently, and routinely. Since NDOT is leading the effort to deploy ramp meters, funding is the responsibility of NDOT.

Funding

- ▶ Ramp meters are considered for deployment only if funding is available to support their operation and maintenance throughout their designed operational life-cycles.
- ▶ Funding sources are to be identified well in advance of when ramp meters are planned to be deployed.
- ▶ Funding is secured for the entire life-cycle of a specific ramp meter, which includes funding needed for planning, design, implementation, operation, maintenance, and performance evaluation.
- ▶ Resources are to be secured to properly train staff.
- ▶ Resources are to be secured to allow staff to do their jobs effectively.
- ▶ New and innovative ways to fund ramp meter life-cycle activities are to be investigated, including possibilities to “piggyback” with other projects.

6.2.8. Staffing (Operations and Maintenance)

Staff is needed to operate and maintain ramp metering equipment. Ramp meters are not to be implemented if staff is not available to operate and maintain the ramp metering system. In addition, a ramp meter is not to be installed if staff has not been trained on its proper operation.

Staff Skills

- ▶ The skills of the staff responsible for ramp metering operations and maintenance are evaluated before ramp metering equipment is installed, and additional training is provided as necessary.
- ▶ Ramp metering equipment is not to be installed until NDOT and RTCs (as applicable) agree that staff skills are adequate.

Staff Training

- ▶ The training needs of staff that operate or maintain ramp metering equipment are evaluated during the planning phase and before ramp meters are deployed.
- ▶ Staff that operate ramp meters are to be trained on the policies and procedures for effective ramp meter operation.
- ▶ Staff training is conducted on an on-going basis to keep staff up-to-date and to train new staff members.
- ▶ Staff that operate or maintain ramp metering equipment are trained on how to perform operation and maintenance activities correctly and in a timely fashion before ramp meters are initially operated.
- ▶ Staff training is to include technical and operational components.
- ▶ Staff that operate or maintain ramp metering equipment are each given a training manual or made aware of the location where a manual is kept.
- ▶ Training manuals are to include, at a minimum, the types of information outlined in the Training Section of Part 2: Implementation Plan.

6.2.9. Equipment and Hardware

- ▶ Ramp metering equipment and hardware is upgraded periodically in order to assure that they can be maintained. As a minimum, equipment is to be upgraded before spare parts and vendor support are no longer available.
- ▶ Ramp metering equipment and hardware is to be inventoried.
- ▶ Ramp metering equipment and hardware inventories are updated every time equipment or hardware is added, removed, or modified.

6.2.10. Software

- ▶ Ramp metering software is upgraded periodically. A software and system upgrade plan is to be developed to provide a plan for updating software that indicates when the entire computer system (including software) is recommended to be replaced.
- ▶ Ramp metering software is to be inventoried.

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APPENDIX

Terminology

The most common terminology found in this Manual includes the following:

<i>Term</i>	<i>Condition</i>	<i>Requirement for Disregarding</i>
Required	Mandatory	Written justification and approval from NDOT
Must	Mandatory	Written justification and approval from NDOT
Needed	Mandatory	Written justification and approval from NDOT
Desirable	Desirable	Engineering judgment
May	Optional	Engineering judgment
Might	Optional	Engineering judgment
Can/Could	Optional	Engineering judgment
Optional	Optional	Engineering judgment
Minimum	Mandatory	Written justification and approval from NDOT
Maximum	Mandatory	Written justification and approval from NDOT

Abbreviations

The following is a list of the abbreviations that are used throughout the Manual.

AASHTO:	American Association of State Highway and Transportation Officials
AET:	All Electronic Tolling
ALPR:	Automated License Plate Recognition
AQD:	Advance Queue Detector
AVC:	Automatic Vehicle Classification
AVD:	Average Vehicle Delay
AVI:	Automatic Vehicle Identification
BI:	Buffer Index
BRT:	Bus Rapid Transit
BTL:	Bus Toll Lane
CAAA:	Clean Air Act Amendments
CBD:	Central Business District
CCTV:	Closed Circuit Television
CFR:	Code of Federal Regulations
DMS:	Dynamic Message Sign
DOT:	Department of Transportation

DV:	Delay Volume
EMS:	Emergency Medical Services
ETC:	Electronic Toll Collection
ETL:	Express Toll Lanes
FAST:	Freeway and Arterial System of Transportation
FHWA:	Federal Highway Administration
FMS:	Freeway Management System
FTA:	Federal Transit Administration
GIS:	Geographic Information System
GPS:	Global Positioning System
HCM:	Highway Capacity Manual
HOT	High-Occupancy Toll
HOV:	High-Occupancy Vehicle
ID:	Identification
IDAS:	ITS Deployment Analysis System
ILEV:	Inherently Low Emission Vehicle
ITE:	Institute of Transportation Engineers
ITS:	Intelligent Transportation Systems
KSAs:	Knowledge, Skills and Abilities
LED:	Light Emitting Diode
LEV:	Low-Emission Vehicle
LOS:	Level of Service
MAP-21:	Moving Ahead for Progress in the 21 st Century Act
MOE:	Measure of Effectiveness
MPH:	Miles per Hour
MPO:	Metropolitan Planning Organization
MUTCD:	Manual on Uniform Traffic Control Devices
NCHRP:	National Cooperative Highway Research Program
NHI:	National Highway Institute
NHP:	Nevada Highway Patrol
NRS:	Nevada Revised Statutes
NDOT:	Nevada Department of Transportation
OEM:	Original Equipment Manufacturer

PTI:	Planning Time Index
RF:	Radio Frequency
RFID:	Radio Frequency Identification
RTC:	Regional Transportation Commission
SOV:	Single-Occupant Vehicle
TDM:	Transportation Demand Management
TMC:	Traffic Management Center
TOT:	Truck-only Toll
TRB:	Transportation Research Board
TTI:	Travel Time Index
TTI:	Texas Transportation Institute
USC:	United States Code
VHD:	Vehicle Hours of Delay
VMT:	Vehicle-Miles of Travel
VPH:	Vehicles per hour
VPHPL:	Vehicles per hour per lane
V/C:	Volume to Capacity Ratio

Glossary

The following terms have been borrowed from various local and national guideline documents. They represent the most current definitions for terms likely to be encountered in the development of ramp metering treatments and managed lane facilities.

ACCESS — The ability to enter or approach a facility or to make use of a facility. In the context of managed lanes, access generally refers to the location(s) where eligible vehicles are permitted to enter or exit the facility.

ACCESSIBILITY — Measure of the ability or ease of individuals to travel among all origins and destinations in an area.

ACCELERATION LENGTH — The distance needed for vehicles to accelerate to freeway speeds. For ramp metering this distance is usually measured from the ramp meter stop bar to the end of the ramp/freeway convergence point.

ADD-A-LANE — Term used to describe when a managed lane facility is created by adding roadway capacity. The additional capacity may be accomplished by widening a freeway or arterial street, modifying a median or a shoulder, or by adding a new facility on a separate right-of-way.

ADVANCE WARNING SIGN — A sign posted on a ramp (upstream of a ramp meter) or along an adjacent arterial that gives advance warning to motorists of the presence of ramp meters on a ramp or the operational status of ramp meters.

ALL ELECTRONIC TOLLING (AET) — The standard electronic toll collection practice for priced managed lanes where all users are registered with the tolling system.

ALTERNATIVE FUEL VEHICLE— A vehicle that is so defined in USC166 (f) (1).

ARTICULATED BUS — An extra-long, high-capacity bus that has the rear body section or sections flexible but permanently connected to the forward section. The arrangement allows the vehicle to bend in curves and yet have no interior barrier to movement between the two parts. Typically, an articulated bus is 50-to-60 ft long and has a passenger seating capacity of 60 to 80 people.

AT-GRADE ACCESS — Ingress/egress between two facilities (such as a managed lane facility and the adjacent general-purpose lanes) that occurs with a direct merging maneuver at the same level/elevation.

AUTOMATIC LICENSE PLATE RECOGNITION (ALPR) — Term to describe optical character recognition technology used for electronic toll collection and/or automated enforcement functions on managed lane facilities.

AUTOMATIC VEHICLE IDENTIFICATION (AVI) — Use of overhead or roadside detectors to read and identify vehicles equipped with a transponder or a similar device. Used for electronic toll collection and management.

AUTOMATIC VEHICLE CLASSIFICATION (AVC) — Verification of the vehicle classification using sensors, typically based on the vehicle's profile and number of axles, so that the proper toll can be charged.

AUTOMATIC VEHICLE LOCATION (AVL) — The use of advanced technologies to monitor the location and movement of vehicles.

AUXILIARY LANE — The portion of the roadway adjoining the traveled way for parking, speed change, or other purposes supplementary to through traffic movements. In the context of freeways, auxiliary lane generally refers to an additional lane to connect an on-ramp and an off-ramp.

AVERAGE DAILY TRAFFIC (ADT) — The average 24-hour volume, being the total volume during a stated period divided by the number of days in that period. The term is commonly abbreviated as ADT. If the period is a year, it is called Annual Average Daily Traffic (AADT).

AVERAGE OVERALL TRAVEL SPEED — For all traffic or component thereof, the summation of distances divided by the summation of overall travel time.

AVERAGE VEHICLE OCCUPANCY (AVO) — The total number of persons in all vehicles divided by the number of vehicles traveling past a selected point during a predetermined time period. AVO is usually expressed to two or three significant decimal places, such as 1.2 or 1.26.

AVERAGE VEHICLE RIDERSHIP (AVR) — The number of employees who report to a work site divided by the number of vehicles driven by these employees to arrive at that work site, calculated for an established time period. This calculation recognizes vehicle trip reductions from telecommuting, compressed work weeks, and non-motorized transportation.

BARRIER-SEPARATED LANE— A preferential lane or other special purpose lane that is separated from the adjacent general-purpose lane(s) by a physical barrier.

BUFFER — Designated pavement width separating a managed lane from adjacent general-purpose lanes.

BUFFER-SEPARATED LANE — A managed lane that is separated from the adjacent mixed-flow freeway lanes by a designated buffer.

BUS BAY — A designated area at a bus stop or transit station for buses to pull into to pick up and drop off passengers.

BUS TOLL LANE — A priced managed lane for buses only.

BUSPOOL — A form of bus service set up to serve one large employer or group of employers with limited origin and destination points. Buspools are often subsidized by the employer they serve, provide guaranteed seats for passengers, and have limited service.

BUS PRIORITY SYSTEMS — Techniques and strategies to improve the movement of buses in heavily traveled corridors, usually on arterial streets, which may include priority at traffic signals, phasing and coordinating traffic signals, and other treatments.

BUSWAY — A preferential roadway designed exclusively for use by buses. Busways are usually constructed in separate rights-of-way, but may be located within a freeway or roadway right-of-way.

BYPASS LANE — A separate lane that circumvents a traffic queue, typically a queue of entering vehicles at a ramp meter.

CARPOOL OR CARPOOLING — Any automobile or private vehicle containing two or more occupants including the driver.

CARPOOL LANE — Another term used to describe an HOV lane, especially in areas with lower levels of bus service and high numbers of carpools.

CHANGE OF MODE — The transfer from one type of transportation vehicle to another. For example, changing from driving alone to taking a bus at a park and ride lot represents a change of mode.

COMMUTE TRIPS — Trips that are made on a daily or regular basis between home and a fixed location (e.g., work), including those with intermediate stops to and from a work site.

COMMUTE ALTERNATIVES — Alternatives to driving alone such as carpooling, vanpooling, transit, bicycling, and walking; or alternative work schedules that shift the commute trip to less congested periods, or remove work trips from the system altogether.

COMMUTE ASSISTANCE PROGRAMS — Programs which provide services to help commuters identify and use alternative modes, such as ridesharing and transit, and provide support facilities and services.

CONCURRENT-FLOW LANE — A managed lane that operates in the same direction as the adjacent general-purpose (or mixed-flow) lanes, and is designed for use by eligible vehicles during all or a portion of the day. The lane is separated from the adjacent general-purpose freeway lanes by a standard lane stripe, buffer or barrier.

CONGESTION PRICING (PRIORITY PRICING, VALUE PRICING OR VARIABLE PRICING) — The practice of charging a toll or fee for the use of a transportation facility, such

as a roadway, based on severity of congestion. The greater the congestion, which usually occurs during the morning and afternoon peak-periods, the higher the cost to use the facility.

CONTIGUOUS LANE — A lane, preferential or otherwise, that is separated from the adjacent lane(s) only by a normal or wide lane line marking.

CONTRAFLOW LANE — A lane operating in a direction opposite to the normal flow of traffic designated for peak direction of travel during at least a portion of the day. Contraflow lanes are usually separated from the off-peak direction lanes by tubular markers or other flexible channelizing devices, temporary lane separators, or movable or permanent barrier.

CORRIDOR — A strip of land between two termini within which traffic, topography, environment and other characteristics are evaluated for transportation purposes. It may contain a number of streets and highways and many transit lines and multimodal routes.

CRITERIA — Documentation used as the basis of a design.

CYCLE LENGTH — The total time for a traffic control signal to complete a complete sequence of signal indications.

DEADHEAD — Non-revenue bus travel time: (1) Bus travel to or from the garage and a terminus point where revenue service begins or ends; (2) A bus's travel between the ends of service on one route to the beginning of another; synonyms: non-revenue time.

DEGRADED FACILITY— As per 23 USC 166, a facility is considered degraded if vehicles operating on the facility are failing to maintain a minimum average operating speed 90 percent of the time over a consecutive 180-day period during morning or evening weekday peak hour periods or both. The term minimum average operating speed means: (1) 45 miles per hour, in the case of a HOV facility with a speed limit of 50 miles per hour or greater; and (2) not more than 10 miles per hour below the speed limit, in the case of a HOV facility with a speed limit of less than 50 miles per hour.

DESIGN ALTERNATIVE — One design from among those that are proposed for a particular transportation system improvement. A proposal to “do nothing” is a design alternative.

DESIGN CAPACITY — The maximum number of vehicles that a facility is designed to accommodate over a given period of time without operating conditions falling below a pre-selected threshold.

DESIGN HOURLY VOLUME — The traffic volumes on which the functional design of a highway is based. The design hourly volume normally represents the 30th highest hourly volume 20 years from the anticipated year of construction. The term is commonly abbreviated as DHV.

DESIGN VEHICLE — A selected motor vehicle of which the weight, dimensions, and operating characteristics are used to establish highway design controls that will accommodate a range of vehicle types. Design vehicles are distinguished as either physical or operational depending on what features of the facility they apply to. The movements of a physical design vehicle are not prohibited by restrictive infrastructure such as signal poles, but traffic control measures such as striping and channeling islands may be contravened during some maneuvers. The movements of an operational design vehicle can occur within the limits established by the traffic control measures such as striping and channeling islands.

DESIGN YEAR — The year for which the roadway is designed. This is usually 20 years from the opening year (i.e., the year the roadway is placed in service) but may be any time within a range of years from the present (for restoration type projects) to 20 or more years in the future (for new construction type projects).

DESIRABLE — A condition or standard that is deemed to provide the best benefit for the associated cost under normal and reasonable circumstances. Desirable standards and conditions should be used or achieved.

DETECTORS — A device that detects a vehicle's presence and/or other characteristics. The most common detectors are inductive loop detectors located in the pavement and overhead presence detectors located on traffic signal masts.

DIAMOND LANE — A term sometimes used to refer to an HOV lane due to the diamond symbol on signing and pavement markings.

DIAMOND SYMBOL — The diamond symbol is commonly used on signing and pavement markings to designate an HOV lane or other restricted lane.

DIRECTIONAL SPLIT — The distribution of traffic flows on a two-way facility, usually expressed as a percentage of the total two-way traffic.

DIRECT CONNECTION — A directional ramp providing an unimpeded link between two intersecting roadways.

DIRECTIONAL INTERCHANGE — An interchange, generally having more than one highway grade separation, with direct connections for the major turning movements.

DOWNSTREAM — A term that refers to a location that is encountered by traffic subsequent to an upstream location as it flows in an “upstream to downstream” direction.

DRIVER BEHAVIOR — The range of human responses to various stimuli that may be encountered while driving. Often reduced to a typical range of responses, or classified by various driver traits such as age or ability.

DRIVER EXPECTANCY — The assumptions that form the reasonable driver's anticipation for the impending sequence of events based on past driving experience and training.

DRIVER PERFORMANCE — The interaction of drivers with the highway and its information system.

EGRESS — The provision of a location to leave or exit a managed lane, freeway, or roadway. The action of coming out of a managed lane, freeway, or roadway. Providing access into the lanes is ingress.

ELECTRONIC TOLL COLLECTION (ETC) — A system for automated collection of tolls from moving or stopped vehicles through wireless technologies such as radio-frequency communication or optical scanning. ETC systems are classified as one of the following: (1) systems that require users to have registered toll accounts, with the use of equipment inside or on the exterior of vehicles, such as a transponder or barcode decal, that communicates with or is detected by roadside or overhead receiving equipment, or with the use of license plate optical scanning, to automatically deduct the toll from the registered user account, or (2) systems that do not require users to have registered toll accounts because vehicle license plates are optically

scanned and invoices for the toll amount are sent through postal mail to the address of the vehicle owner.

ELECTRONIC TOLL COLLECTION (ETC) ACCOUNT-ONLY LANE: A non-attended toll lane that is restricted to use only by vehicles with a registered toll payment account.

EMERGENCY VEHICLE — Any vehicle used to respond to an incident or accident. Examples include police cars, fire engines, ambulances, tow trucks, and maintenance vehicles.

ENFORCEMENT — The function of ensuring that the rules and regulations relating to the use of a managed lane facility, such as vehicle occupancy levels, are abided by. The NHP, transit police, or local police are usually responsible for enforcement activities.

ENFORCEMENT AREA — An area for enforcement vehicles and personnel to monitor the managed lane and to stop vehicles to issue citations. Enforcement areas may be delineated within an available shoulder or provided at specific locations such as entrances and exits.

ENTRANCE RAMP — A short roadway that allows traffic to enter a freeway.

EQUITY — A normative measure of fairness of a transportation project (or strategy) among all users.

EXIT RAMP — A short roadway for traffic to leave a freeway.

EXPRESS BUS SERVICE — Bus service with a limited number of stops, either originating and traveling non-stop from a specific location or serving a limited number of stops along a route to a destination.

EXPRESS TOLL LANE — A priced managed lane where all vehicles pay a toll.

FREEWAY — A divided highway with full control of access.

FREEWAY-TO-FREEWAY RAMP METERING — The metering of ramps that connect one freeway to another.

FRONTAGE ROAD — A public street or road auxiliary to and normally located alongside and parallel to a freeway or expressway for purposes of maintaining local road continuity and for control of access.

GENERAL-PURPOSE LANES (MIXED-FLOW LANES) — The travel lanes on a freeway or roadway that are open to all motor vehicles.

GORE — The area immediately beyond the divergence of two roadways, bounded by the edges of those roadways. Similarly, it is also the point where two roads meet.

HIGH-OCCUPANCY TOLL (HOT) LANE — A priced managed lane that use both pricing and eligibility strategies, where HOVs are given free or discounted use while other vehicles are tolled.

HIGH-OCCUPANCY VEHICLE (HOV) — A motor vehicle carrying at least two or more persons, including carpools, vanpools, and buses.

HIGH-OCCUPANCY VEHICLE LANE — A lane designated for exclusive use by high-occupancy vehicles (HOVs) for all or part of a day. An HOV lane may be on a freeway, roadway, arterial street, or in a separate right-of-way.

HYBRID — Vehicle that uses two or more power sources to move the vehicle. The term commonly refers to a vehicle that uses a conventional and alternative energy source, such as an on-board rechargeable battery powering one or more electric motors, to provide more efficient operation.

INCIDENT MANAGEMENT — The development, oversight and implementation of procedures for efficiently and effectively minimizing the negative impacts that traffic incidents have on the flow of traffic.

INHERENTLY LOW EMISSION VEHICLE (ILEV) — Any kind of vehicle that, because of inherent properties of the fuel system design, will not have significant evaporative emissions, even if its evaporative emission control system has failed.

INTELLIGENT TRANSPORTATION SYSTEMS (ITS) — The application of a wide range of advanced technologies to enhance the operation and management of the surface transportation system.

INTERIM YEAR — Interim year can be any year between the opening year and the design year of a project. It is usually 10 years into the future from the opening year of a project and 10 years prior to the design year of the project.

LANE CONVERSION — Term used to refer to the implementation of a managed lane created by converting a general-purpose lane on a freeway or arterial street.

LINE-HAUL — That portion of a commute trip that is express or nonstop between two points. The term is usually used to define the trunk portion of a transit trip, as distinguished from local distribution.

LOCAL STREET — A street or road primarily for access to residence, business, or other abutting property.

LONGITUDINAL TRAFFIC BARRIER — A generic term for highway features intended to prevent vehicles from traveling off the road into the adjacent roadside.

LOOP RAMP — A one-way turning roadway that curves about 270 degrees to the right to accommodate a left-turning movement. It may include provision for left turns at a terminal to accommodate another turning movement.

LOOP DETECTOR — A type of detector that is embedded in the pavement to serve the purpose of detecting the presence of vehicles.

LOW EMISSION AND ENERGY EFFICIENT VEHICLES — A vehicle that is so defined in USC 166 (f) (3).

MANAGED LANE(S) — A lane or set of lanes within a highway facility where operational strategies are proactively implemented and managed to achieve predefined performance objectives.

MAXIMUM — The upper limit allowable for a standard or condition where the quality of the design diminishes with increasing values of the standard.

MEASURES OF EFFECTIVENESS (MOEs) — Criteria or measures that identify progress toward predefined objectives (typically from a user perspective). MOEs identify the threshold

level of change or benefits anticipated from a transportation improvement or project towards achievement of desired results.

MERGING — The converging of separate streams of traffic into a single stream.

MINIMUM — The lower limit allowable for a standard or condition where the quality of the design diminishes with decreasing values of the standard.

MINIMUM TURNING RADIUS — The radius of the path of the outer front wheel of a vehicle making its sharpest turn.

MODE — A particular form of travel (e.g., buses, automobiles, carpools, vanpools, single occupant vehicles, walking, bicycling, rail, air, and water-borne vessels).

MODE SHIFT — The act of changing from one travel mode, such as driving alone, to another mode, such as taking the bus.

MODE SPLIT — The proportion of people that use each of the various modes of travel.

MOTOR VEHICLE CRASH — Any event that results in unintended injury or property damage attributable directly or indirectly to the motion of a motor vehicle or its load.

OFF-LINE STATION — A mode transfer facility located off of a managed lane, or other fixed guideway system, either adjacent to the facility or a short distance away.

OFF-PEAK DIRECTION OF TRAVEL — The direction of travel in a corridor experiencing lower demand during a peak commuting period. In a radial corridor, the off-peak direction has traditionally been away from the central business district in the morning and toward the central business district in the evening.

OFF-PEAK PERIOD — The period of time outside the peak commuting periods, usually the midday, evening, night, and early morning.

ON-LINE STATION — A mode transfer facility located along a managed lane or a fixed guideway system.

ON-TIME PERFORMANCE — The measure, usually a percentage, of times that a transit vehicle meets the published schedule arrival time within a policy window.

OPEN-ROAD ETC LANE — A non-attended lane that is designed to allow toll payments to be electronically collected from vehicles traveling at normal highway speeds. Open Road ETC lanes are typically physically separated from the toll plaza, often following the alignment of the mainline lanes, with toll plaza lanes for cash toll payments being on a different alignment after diverging from the mainline lanes or a subset thereof.

OPEN-ROAD TOLLING — A system designed to allow electronic toll collection (ETC) from vehicles traveling at normal highway speeds. Open-Road Tolling might be used on toll roads or toll facilities in conjunction with toll plazas. Open-Road Tolling is also typically used on managed lanes and on toll facilities that only accept payment by ETC.

OPEN-ROAD TOLLING POINT — The location along an Open-Road ETC lane at which roadside or overhead detection and receiving equipment are placed and vehicles are electronically assessed a toll.

OPERATIONAL DELAY — Delay caused by interference between components of traffic.

OVERPASS — A grade separation structure where the subject highway passes over an intersecting highway or railroad, also called Over-crossing.

PARK-AND-POOL LOT — A facility where individuals can park their private vehicle and join a carpool or vanpool. The facility is not normally served by public transportation.

PARK-AND-RIDE LOT — A facility where individuals can park their private vehicle for the day and access public transportation or rideshare for the major portion of their trip.

PEAK DIRECTION AND PEAK DIRECTION OF TRAVEL — The direction of higher travel demand during a peak commuting period. In a radial corridor, the peak direction has traditionally been toward the central business district in the morning and away from the central business district in the evening.

PEAK HOUR — The hour in the morning and in the afternoon when the maximum demand occurs on a given transportation facility or corridor.

PEAK PERIOD — The time period in the morning and in the afternoon when the heaviest demand occurs on a given transportation facility or corridor. Usually two or more hours.

PERSON THROUGHPUT — Term used to describe the number of persons, not vehicles, being carried on a facility. Usually measured at a specific point on the roadway facility for a predetermined period of time.

PREFERENTIAL LANE — A highway lane reserved for the exclusive use of one or more specific types of vehicles or vehicles with at least a specific number of occupants.

PREFERENTIAL PARKING — Parking lots, spaces, or other areas reserved for carpools and vanpools. Preferential parking is usually located closer to the destination, in a parking garage, or in some other desirable area.

PREFERENTIAL TREATMENT — Providing special privileges to a specific mode or modes of transportation, such as bus lanes or signal priority for buses at intersections.

PREVENTATIVE MAINTENANCE — The systematic inspection, detection and correction of equipment that is in satisfactory working condition to prevent failures, either before they occur, or before they develop into major defects.

PRICED MANAGED LANE — Type of managed lane that employs some type of pricing as a management strategy.

PUBLIC TRANSIT AND PUBLIC TRANSPORTATION — The services provided for the public on a regular basis by vehicles such as bus or rail vehicle on public ways, using specific routes and schedules, usually on a fare-paying basis. Also includes non-scheduled, on-demand transit services, such as paratransit or dial-a-ride.

QUEUE — A line of vehicles or persons.

RAMP METER — A traffic signal that controls the entry of vehicles from a ramp onto a limited access roadway. The signal allows one or two vehicles to enter on each green indication.

RAMP TERMINAL — A junction of a ramp with a surface street serving vehicles entering or exiting a freeway.

RAMP/FREEWAY CONVERGENCE POINT — The point where the right edge of the ramp traveled way is 12 feet from the right edge of the rightmost through lane of the freeway mainline.

RESPONSIVE MAINTENANCE — Maintenance that is unplanned and is done when systems or equipment break down or require unexpected repair.

REVERSIBLE LANE — A managed lane in which the direction of traffic flow can be changed at different times of day to match the peak direction of travel during periods of peak demand.

SIGHT DISTANCE — The distance a person can see along an unobstructed line of sight.

SLIP LANE (SLIP RAMP) — A type of at-grade access that can be used at the beginning or end of a managed lane facility that provides acceleration/deceleration taper.

STATION — A major facility servicing one or more transit mode.

STREET, HIGHWAY OR ROAD — A general term denoting a public way for purposes of public transportation, including the entire area within the right-of-way. (Recommended usage: in urban areas use highway or street; in rural areas use highway or road.)

SUPPORT FACILITY — A physical improvement that enhances managed lane operations, including park-and-ride lots, park-and-pool lots, transit centers, and associated elements.

SUPPORT PROGRAM — Policies, programs, and services that enhance the public acceptance or usage of a managed lane facility, including ridesharing programs, employer-sponsored incentives, public information, and marketing activities.

TOLL LANE — An individual lane located within a toll plaza in which a toll payment is collected or, for toll-ticket systems, a toll ticket is issued

TRAFFIC MARKINGS — All lines, patterns, words, colors, or other devices, except signs, set into the surface of, applied upon, or attached to the pavement or curbing or to objects within or adjacent to the roadway, officially placed for the purpose of regulating, warning, or guiding traffic.

TRAFFIC RESPONSIVE — A traffic signal timing approach which can be implemented in response to the direction and volume of traffic flow.

TRAFFIC SIGN — A device mounted on a fixed or portable support whereby a specific message is conveyed by means of words or symbols, officially erected for the purpose of regulating, warning, or guiding traffic.

TRANSFER — The act of changing from one vehicle or route to another. Also, the paper provided to a passenger by a transit operator upon paying a fare that allows the individual to board the second vehicle without paying another fare.

TRANSIT CENTER OR TRANSIT STATION — A facility where transit vehicles converge, enabling passengers to transfer among routes and services. Transit centers are generally located off the street and provide passengers with a shaded or enclosed waiting area, seats, drinking fountains, and transit information.

TRANSITWAY — Term used to describe an HOV lane or facility. In some cases, it refers to bus-only facilities, but in other cases, it may be used on a facility open to all HOVs.

TRANSPONDER — An electronic tag mounted on a license plate, built into a vehicle, or placed on the dashboard. The tag is read electronically by an electronic tolling device that automatically assesses the amount of the user fee.

TRANSPORTATION CONTROL MEASURE (TCM) — Under the Transportation Conformity Rule, Transportation Control Measures (TCMs) are strategies that: 1) are specifically identified and committed to in State Implementation Plans (SIPs); and 2) are either listed in Section 108 of the Clean Air Act (CAA) or will reduce transportation-related emissions by reducing vehicle use or improving traffic flow.

TRANSPORTATION PLAN — A program of action to provide effectively for present and future demands for movement of people and goods. This program must necessarily include consideration of the various modes of travel.

TRAVEL TIME — The average time spent by vehicles traversing a highway segment, including control delay, in seconds per vehicle or minutes per vehicle.

TRAVEL TIME RELIABILITY — Term referring to the lack of variability in travel time that can be expected using different facilities.

TRAVEL TIME SAVINGS — The time saved by use of a managed lane facility. Calculated by the difference in travel times between two points using the managed lane facility and the general-purpose lane.

TRUCK-ONLY TOLL LANE — A priced managed lane for use of trucks only.

TURNING MOVEMENT — The traffic making a designated turn at an intersection.

TURNING PATH — The path of a designated point on a vehicle making a specified turn.

TWO-WAY RAMP — A ramp for travel in two directions. At a cloverleaf it serves as both an outer connection and a loop.

UNDERPASS — A grade separation where the subject highway passes under an intersecting highway or railroad; also called under-crossing.

UPSTREAM — The opposite direction to which traffic is moving.

VANPOOL — An organized ridesharing arrangement in which a number of people travel together on a regular basis in a van. The van may be company owned, individually owned, leased, or owned by a third party. Expenses are shared, and there is usually a regular volunteer driver.

VEHICLE HOURS OF TRAVEL (VHT) — A statistic describing the amount of vehicular travel time in a given area. It is calculated by multiplying the total number of vehicles with the total number of hours that vehicles travel. The VHT is most commonly used to compare alternative transportation systems in a planning context.

VEHICLE MILES OF TRAVEL (VMT) — A statistic describing the amount of vehicular travel in a given area. It is calculated by multiplying the total number of vehicles with the total number of miles that are traversed by those vehicles.

VEHICLE OCCUPANCY — The number of people in a car, truck, bus, or other vehicle.

MANAGED LANE VIOLATION RATE — The number of vehicles in a managed lane that do not meet the minimum requirements to use that managed lane facility. Usually expressed as a percentage of the total vehicles using the lane during a predetermined time period.

VOLUME TO CAPACITY RATIO (V/C) — Either the ratio of demand volume to capacity or the ratio of service flow rate to capacity for a system element, depending on the particular situation.

WEAVE ZONE — An area where vehicles cross to enter or exit a highway or managed lane. Areas along a managed lane facility designated for both ingress and egress with appropriate signing and markings.

WEAVE LANE — In the context of managed lanes, a lane designated for both ingress and egress to the managed lane. The inclusion of a weave lane minimizes the potential for unstable flow along the weave zone due to the speed differential between the managed lane and general-purpose lanes.

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