

# Environmental Performance Measures for State Departments of Transportation

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**B**uilding and operating transportation systems has indisputable impacts on the air, the water, and the ecosystems that make up the natural environment. A state department of transportation (DOT) looking to address environmental concerns effectively while fulfilling its core mission therefore must include environmentally focused performance measures in its transportation planning.

Performance management has emerged as a mainstream business practice among state DOTs. Although agencies are increasingly harmonized in their approaches to performance measurement in infrastructure preservation, safety, and congestion management, the strategies for measuring environmental performance vary, and guidance on the use and usefulness of measures had been scant.

National Cooperative Highway Research Program (NCHRP) Report 809, *Environmental Performance Measures for State Departments of Transportation (I)*, provides a first step toward guidance, by establishing and demonstrating the practicality of a suite of core environmental measures. The findings provide a framework for a nationwide conversation among transportation practitioners and their stakeholders about the kind of environmental performance measures that could lead to advances in environmental stewardship.

## Performance Measure Principles

The environment is a multifaceted subject, and environmental issues are often partly or completely outside of a state DOT's control; as a result, outcomes



PHOTO: MISSOURI DEPARTMENT OF TRANSPORTATION, FLORENCE

Construction progresses on the Daniel Boone Bridge over the Missouri River between St. Louis and St. Charles counties in Missouri. Bridge construction raises a host of environmental concerns.

may not be greatly influenced by a state DOT's actions. A state DOT therefore should ensure that environmental measures are used with the proper goal in mind and in the most relevant mission area.

**Function of Measures**

Performance measures mostly serve one or more of three broad functions in a state DOT:

- ◆ Building external accountability and enhancing the agency's credibility,
- ◆ Supporting analytic tools and internal decision making, and
- ◆ Serving as management tools that indicate a focus for staff efforts.

Applying a measure in accordance with the function it serves will increase the measure's usefulness to the organization and ensure success in implementation.

**Applicability to Core Mission**

A state DOT's mission begins with strategic planning and extends to long-range plan development, to short-range programming, project planning, design, construction, and finally system operations and maintenance. Environmental measures have varying degrees of relevance to each of these elements, and this should be considered before putting a measure into effect.

**Target Setting**

Target setting is generally crucial to performance management but under some circumstances may not be practical or desirable—for example, a focus on numbers can draw staff attention from other issues or can cause stakeholder confusion. Other pitfalls in target setting include the following:

- ◆ Measures that track issues outside a state DOT's control—although these may indicate a commitment to improvement, the agency has limited power to achieve the formal target; and
- ◆ Newly created measures—because these lack historical precedent, the targets are subject to revision when greater clarity emerges about performance trends.

**Focus Areas**

The environment may be thought of as a single strategic priority but is a complex and multifaceted topic. Performance therefore cannot be captured easily by a single metric. For this reason, the proposed measures span five major focus areas:

PHOTO: OREGON DEPARTMENT OF TRANSPORTATION, FLICKR



An elk traverses a highway undercrossing in Oregon.

- ◆ Air quality,
- ◆ Energy and climate,
- ◆ Materials use,
- ◆ Stormwater, and
- ◆ Wildlife and ecosystems.

These five focus areas are susceptible to adverse impacts from transportation. Together, the five areas comprise a comprehensive and broadly shared set of environment-related interests in most state DOTs, providing a credible foundation for creating strong measures.

**Selecting Measures**

The project team selected one or two performance measures for each focus area (see Table 1, below). The measures come closest to meeting desired

**TABLE 1 Suggested Environmental Performance Measures**

<i>Focus Area</i>	<i>Measure</i>	<i>Description</i>
<b>Air Quality</b>	Motor vehicle emissions	Change in statewide motor vehicle emissions for oxides of nitrogen (NO <sub>x</sub> ), volatile organic compounds, and fine particulate matter (PM <sub>2.5</sub> )
<b>Energy and Climate</b>	Gasoline consumption	Statewide on-road gasoline consumption per capita
	State DOT alternative fuel use	State DOT fleet use of alternative fuel as percent of total fleet fuel use (by volume)
<b>Materials Recycling</b>	Reclaimed asphalt pavement (RAP) usage	Annual percent by mass of all roadway asphalt pavement materials composed of RAP used by state DOT
<b>Stormwater</b>	Stormwater treatment	Percent of state DOT-owned impervious surface for which stormwater treatment is provided
<b>Wildlife and Ecosystems</b>	Self-administered Ecosystems Self-Assessment Tool (ESAT)	41 questions that evaluate performance across all aspects of state DOT programs relevant to wildlife and ecosystems



NCHRP Report 809, *Environmental Performance Measures for State Departments of Transportation*, is available from the TRB online bookstore, <https://www.mytrb.org/Store/Product.aspx?ID=7859>; to view the book online, go to [www.trb.org/Publications/Blurbs/173012.aspx](http://www.trb.org/Publications/Blurbs/173012.aspx).

criteria in the context of today's environmental and technological know-how and political constraints. None of the measures, however, is perfect, but each provides state DOTs with a practical and improvable gauge.

The project compiled nearly 200 environmentally focused performance measures currently in use or identified in the transportation literature. To choose the most promising measures from the list, the team developed screening criteria—the ideal environmental measures should satisfy all or most of the following conditions:

- ◆ Address an issue of significance,
- ◆ Link directly to an environmental outcome,
- ◆ Be within a state DOT's power and influence to achieve,
- ◆ Yield results valuable to decision makers, and
- ◆ Prove meaningful and understandable to the public.

These criteria winnowed the list down to the most promising measures for proof-of-concept validation. No environmental performance measure fully met all of the criteria; the selected measures, however, were found to come as close as possible to the ideals.

## Individual Measures

### *Air Quality: Vehicle Emissions*

Change in statewide motor vehicle emissions can measure the direct link between vehicle emissions and air quality outcomes. Although state DOTs do not have direct control over microlevel factors that drive most of the year-to-year changes in emissions—such as driving habits or vehicle makeup—the agencies play an important role in the longer-term outcomes.



An Oregon DOT fleet car recharges. Alternative fuel use by a state DOT's fleet demonstrates commitment to the reduction of harmful emissions.

For example, state DOTs can affect motor vehicle emissions by planning and building multimodal transportation systems that offer low-emission travel choices and that reduce the recurring and nonrecurring congestion producing higher emissions. The measure therefore strikes a good balance between a state DOT's level of control and the desired outcome.

### *Energy and Climate: Alternative Fuels and Gasoline*

The two measures in the energy and climate focus area address the balance between state DOT control and impact on environmental outcomes. Alternative fuel use by a state DOT's fleet measures the agency's own reduction in fossil fuel use.

Because the state DOT directly controls this metric, the data tracking is relatively easy to implement. Admittedly, a DOT fleet consumes only a small fraction of all fuel and does not have a significant impact on total energy use or on climate effects; the second measure, however, addresses this.



Vehicles undergo emissions tests in Washington State. State agencies play an important role in the longer-term outcomes of motor vehicle emission reduction.

Highway gasoline consumption per capita is a clear measure of energy use and has climate effects. The measure also relates to such public-sector goals as reducing emissions, improving fleet fuel efficiency, limiting dependency on petroleum fuels, and managing growth in vehicle miles traveled. Each state already tracks gasoline consumption for other purposes—the data gathering is easy, and the metric is understandable to the general public.

### **Materials Recycling: RAP**

Reclaimed asphalt pavement (RAP) reuses materials containing asphalt and aggregates removed from old roads for reconstruction or resurfacing—essentially road recycling. Using RAP instead of new asphalt conserves energy, reduces landfill waste, conserves natural resources, and reduces agency and contractor costs.

Asphalt and aggregate represent two of the most frequently used materials in a state DOT's operation, and RAP has become the most common recycling practice among state DOTs. This measure therefore has an impact on the environment and is familiar to state DOTs. Accounting for RAP usage is straightforward and may require input from the state DOT's road contractors.

### **Stormwater: Impervious Surfaces**

Stormwater runoff is a universally significant issue for any local government or agency responsible for large areas of impervious surfaces, such as roads, sidewalks, and parking lots. As the owners of much of each state's public road system, state DOTs are important players in stormwater treatment.

The measure relies on structural best management practices (BMPs), which are designed or engineered physical installations near roads to manage the flow of stormwater runoff, often by filtering or otherwise treating the runoff to improve water quality.

Using BMPs for the measure has advantages. First, BMPs are in common use by state DOTs, and the extent of implementation can be documented. BMPs contribute directly to environmental improvement by actively managing water quantity or quality; moreover, their use is completely within a state DOT's control.

### **Wildlife and Ecosystems: Self-Assessment Tool**

A state DOT's mission includes ongoing construction on a statewide scale, which can greatly affect natural ecosystems and the wildlife that depends on them. Natural habitats vary widely from state to state, and each state's resource agencies and DOT may emphasize different natural resource issues.



PHOTO: NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, FLICKR

Finding a universally relevant measure for ecosystems therefore is a challenge.

The research team finally settled on the Ecosystems Self-Assessment Tool (ESAT), composed of 41 questions that evaluate performance across all aspects of state DOT programs related to wildlife and ecosystems. The ESAT takes into account and gives credit for almost any action that a transportation organization uses to reduce its impact on wildlife and ecosystems. This allows consistency in measuring outcomes across states with different wildlife and ecosystems.

### **Testing the Measures**

Each measure addresses an environmental issue of significance, focuses on desired outcomes within a state DOT's control, and yields information to decision makers and clarity to the public. Without good data, however, none of these measures is usable.

A milling machine removes asphalt from Interstate 85 in North Carolina; recycled asphalt pavement conserves energy while reducing landfill waste and contractor costs.

Oregon's animal undercrossings accommodate a variety of wildlife, including coyotes.



PHOTO: OREGON DEPARTMENT OF TRANSPORTATION, FLICKR

Proof-of-concept testing therefore applied data from 27 state DOTs to demonstrate the validity of the proposed measures in terms of three quantitative criteria:

- ◆ States can apply the measure consistently,
- ◆ The necessary data are available or can be generated easily, and
- ◆ The data quality is credible and defensible.

Table 2 (below) shows the states that participated in the testing for each measure. The results reflect the variety of environmental performance measurement among state DOTs (see Table 3, page 33)—no state could provide data for every measure.

Nonetheless, the proof-of-concept testing demonstrated the viability of the measures within a subset of states.

## Findings

Each measure fell into one of three categories: suitable for use in the near term, suitable for use in the long term, or not suitable for use.

- ◆ *Suitable for use in the near term*—The proof-of-concept testing generally validated the measures of on-road emissions, gasoline consumption, alternative fuel use by the agency, and RAP usage for adoption in the near term. The availability and com-

**TABLE 2 Summary of Participating Pilot States**

State	Comprehensive Statewide Data Obtained				Experimental Data Obtained	
	Air: Statewide Vehicle Emissions	Energy–Climate Change:		Recycling: RAP as Percentage of Total Pavement	Stormwater: Percentage of Roads Treated	Wildlife and Ecosystems: ESAT
		Gasoline Consumption per Capita	State DOT Fleet Alternative Fuels Use			
California	x	x	x			
Colorado	x	x		x		
Delaware	x	x		x	x	
Florida	x	x		x		
Georgia		x				x
Illinois	x	x		x		x
Iowa		x	x			
Maine		x	x			
Maryland	x	x	x		x	x
Minnesota		x	x		x	x
Missouri	x	x	x	x		
Nebraska		x	x			
New Jersey	x	x		x		
New Mexico		x	x			
North Carolina	x	x	x	x	x	
North Dakota	x	x		x		
Ohio		x			x	x
Oregon		x				x
Pennsylvania	x	x	x	x		
South Carolina		x	x			
South Dakota	x	x		x		
Texas		x				x
Utah		x		x		
Vermont	x	x	x			
Virginia	x	x				
Washington	x	x	x			
Wyoming	x	x	x			
<b>Total</b>	<b>16</b>	<b>27</b>	<b>14</b>	<b>11</b>	<b>5</b>	<b>7</b>

prehensiveness of the data and the viability of the methods to calculate the measures presented few barriers to implementation by state DOTs.

◆ *Suitable for use in the long term*—The stormwater and final wildlife and ecosystems core measures are clearly experimental, and only a handful of state DOTs had capabilities in these two areas—sometimes only nascently or in pilot testing. Although the stormwater treatment and ESAT measures may not be ready for immediate implementation, the testing suggested strong promise, and continued efforts to expand the measures are encouraged, with a goal of phased adoption.

◆ *Not suitable for use*—The initially proposed wildlife and ecosystem measure, “Share of mitigation obligations with on-time regulatory approval,” proved unsuccessful at two of the three pilot DOTs. Further research showed that the extensive use of mitigation banking to fulfill obligations was a widespread practice at many state DOTs, making this measure less effective.

## Next Steps

Performance measurement is a continual journey. None of the 27 states involved in the proof-of-concept testing could easily provide data for all measures. Clearly, all 50 states are not ready to implement a complete set of environmental measures immediately. But the testing suggests that the measures are within reach and point to several logical next steps:

◆ **Conduct an environmental performance measures workshop for state DOTs.** A workshop could convene state DOT representatives to discuss environmental performance research findings and to encourage uniform adoption of the measures by the states.

◆ **Collect full-scale or partial data.** All or some states could be encouraged to collect and report data for all or some of the measures. This could be a goal of the workshop and may involve a regular meeting of states to share lessons learned as the data are collected.

PHOTO: VIRGINIA DEPARTMENT OF TRANSPORTATION, FLICKR



◆ **Explore trends and map target-setting opportunities.** Examining trends and concerns as the data are collected will assist in developing robust approaches to target setting.

◆ **Launch a website for reporting performance.** The NCHRP Report 809 findings provide a foundation for a website that could allow centralized tracking and reporting of state DOT performance on each of the core environmental performance measures.

◆ **Enhance the performance measure methodologies.** The essential ideas of the performance measures can develop further, through improvements in the methodologies or by making the calculations more precise.

The search for ideal environmental performance measures often changes direction with shifts in industry practices, technology, or politics. Nonetheless, the measures proposed in NCHRP Report 809 present a practical map for the path ahead in developing more robust environmental performance measures for state DOTs

## Reference

1. Crossett, J., J. Ang-Olson, and J. Frantz. *NCHRP Report 809: Environmental Performance Measures for State Departments of Transportation*. Transportation Research Board, Washington, D.C., 2015. [www.trb.org/Publications/Blurbs/173012.aspx](http://www.trb.org/Publications/Blurbs/173012.aspx).

More than 8,000 pollinator-friendly plants are planted at a highway rest area in Dale City, Virginia, part of the Virginia DOT’s Pollinator Habitat Program to protect Monarch butterflies.

**TABLE 3 Summary of Results from Proof-of-Concept Testing**

Measure	Supports Consistent Application from State to State?	Data Are Available or Easy to Generate?	Data Quality Is Credible and Defensible?	State DOT Readiness for Implementation
Vehicle emissions	Fully	Somewhat	Mostly	Ready for use
Alternative fuel use	Mostly	Mostly	Fully	Ready for use
Gasoline consumption	Fully	Fully	Fully	Ready for use
RAP usage	Fully	Somewhat	Mostly	Ready for use
Stormwater treatment	Somewhat	Lacking	Lacking	Suitable for future use
ESAT	Somewhat	Fully	Somewhat	Suitable for future use