M A S S

# INTERCHANGE

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# SAFETY

## at a crossroads

A lot of action occurs at an intersection. Cars and trucks speed in from all directions, stopping, turning, changing lanes. Introducing other variables--such as poor visibility, bad weather, inadequate signage, and human error--to these hubs of activity leads to a recipe for disaster.

According to the Federal Highway Administration, approximately 40% of all automotive collisions occur at intersections. Also, intersection crashes account for 50% of injury crashes and 21% of all roadway fatalities. In 2001, for example, there were nearly 3 million intersection-related crashes in the United States, causing 8,876 deaths.

Motivated by such tragic numbers and personal experience--one of his eight children died in a collision--one Congressman has called for a full disclosure of the nation's intersection crash statistics. Sen. Mike DeWine (R-Ohio) sponsored a number of provisions in the recently passed $300 billion highway bill designed to bring attention to several problem areas that befuddle transportation safety. His efforts include programs designed to raise awareness about vehicle and roadway safety, improve driver education and licensing, ban the sale of remote devices used to change traffic signals, and step up traffic safety law enforcement.

Among the causes championed by DeWine include the Safe Streets and Highways provision. Co-sponsored by Sen. Jay Rockefeller (D-W.Va.), the provision would fund a mandatory program requiring states to identify, rank according to severity, and publicly disclose a list of its most dangerous roads and intersections.


*Prior to improvements (top), the crash-prone intersection of 7 Mile Road and Dequindre Street in Detroit had small, 8-inch diameter signals, left turn prohibition, and no dedicated left turn lane. Based on recommendations by engineers from AAA, the city created a dedicated left-turn lane, added a protected left-turn arrow, and replaced the signal lenses with brighter 12-inch lenses (bottom). Photos: AAA Michigan*

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# CLEAR ROADS:

## Research for Winter Maintenance

Winter maintenance agencies are always on the lookout for new techniques and technologies. Although some evaluations of materials and equipment are underway, these testing activities for the most part are related to how the materials and equipment meet specifications or perform on standard lab tests. What is needed, in addition, is related field-testing and follow-up.

The Clear Roads program is intended to fill this gap with rigorous real-world testing of winter maintenance materials, equipment, and methods for use by highway maintenance crews. Launched in 2004 by seasoned winter maintenance engineers, Clear Roads is part of the Transportation Pooled Fund Program, and is sponsored by the FHWA, the Transportation Research Board, and AASHTO.

By conducting structured field-testing and evaluation across a range of winter conditions and highway maintenance organizational structures, Clear Roads projects will deliver useful data and recommendations on the effectiveness, ease of use, optimum application rates, durability, and more, of many advanced winter operations technologies.

### Clear Roads will:

- Work with the nation's top researchers
- Evaluate winter maintenance materials, equipment and methods under real-world conditions
- Develop specifications and recommendations
- Study and promote innovative techniques and technologies that will save state and local agencies money, improve safety, and increase efficiency
- Make results available to interested agencies

Work began in August 2005 on the first project approved by the Technical Advisory Committee (see sidebar) and is expected to be completed in 2-3 years. More information can be found at: www.clearroads.org and www.pooledfund.org/about.stm

**Clear Roads Project: Accuracy of ground-speed-control spreaders**

**Problem: Although ground-speed control has been used on snowplow and salt spreader trucks in place of manual spreaders since the mid-1990s, the accuracy of the equipment has never been determined.**

**Objective: Document controller settings, actual salt usage, and prewetting rate information from trucks with various types of controller units during winter storm events.**

**Expected Results: Guidelines to help snowplow operators establish and maintain accurate calibration of ground-speed controllers, resulting in reduced salt usage and improved efficiency.**

*Adapted and reprinted with permission of Minnesota LTAP*

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"The public has a right to know where dangerous roads and intersections are in their communities, and where these tragic deaths are occuring," said DeWine. "That way, residents can not only make sure improvements are being made, but they can make responsible decisions when driving or handing their keys to young drivers."

## SIGNALING A SOLUTION

For the past eight years, one innovative program has sought to improve safety at problem intersections. In the mid-1990s, the city of Detroit approached the Dearborn-based Michigan arm of the American Automobile Association (AAA) with concerns about problem areas within its boundaries, including intersections. The mayor and a team of AAA traffic safety engineers put their heads together to come up with a plan.

"AAA worked with the city to identify problem locations to conduct an initial assessment of the safety issues and what kind of analysis was needed," said Jeffrey Bagdade, a traffic engineer who previously worked with AAA. "The best source of data was the Michigan crash database from the State Police. Once we combed through that, we pulled individual collision reports to make sure we actually knew what was going on." Details from the crash data--including the position of the vehicle involved, the nature of damage sustained, and the severity of crashes--further informed the engineers.
After its initial assessment, the team zeroed in on specific intersections to target. They conducted a study of each site and performed a benefit/cost analysis to determine what improvements, if any, would be feasible and economical. AAA worked with the city of Detroit to identify potential funding sources for improvements. The city used existing federal safety funds; they also received money from the state earmarked for road upgrades.

*Traffic at the intersection of Obernefemann Road and State Street in O'Fallon,Ill--already busy thanks to motorists from a nearby interstate--will soon increase when the city's Sports Complex and community park open later this year.*

The project moved relatively fast; the assessments began in 1996 and improvements at the first three Detroit intersections were completed in 1997. Initial success motivated other agencies to join the program--the Michigan DOT, the city of Grand Rapids, and Wayne County (home to Detroit) jumped in.

According to Bagdade, the extent of enhancements varies from intersection to intersection. "Common improvements that we implemented included increasing the size of the signals," he said. "Most urban areas used smaller signal heads--8 inches in diameter, the minimum. We recommended upgrading to larger 12-inch heads, making sign improvements, adding left-turn green arrows, and placing extra signal heads at the far left of the intersection."

Other measures included adding or enhancing pavement markings, re-striping intersections, adding turn lanes, enlarging and illuminating signs, and installing "countdown" pedestrian signals. The cost for these upgrades varies. According to Bagdade, the average is $50,000 to $100,000 for an intersection undergoing signal improvements and pavement markings. Basic improvements--such as minor sign changes and simple markings--could total as little as $1,000; more ambitious

*A proposed roundabout designed by Horner & Shifrin Inc. would increase pedestrian safety, increase traffic flow, and reduce air/noise pollution. Photos: Horner & Shifrin*

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# WASHBOARDING

One of the most aggravating gravel maintenance problems plaguing grader operators, managers, and elected officials is corrugation. Often called "washboarding" -- because driving on corrugated gravel surfaces is much like driving over a giant washboard -- this nuisance elicits more complaints from the public than any other gravel maintenance problem. And, washboarding doesn't just make for an uncomfortable ride, it can be a safety problem: even moderated washboarding can reduce vehicle control.

## CAUSES & CURES

### Driving Habits

Hard acceleration and hard braking can lead to washboarding. When vehicle tires lose a firm grip on the road and spin or skid, a slight amount of gravel is displaced. With repetition, the gravel will align into a washboard pattern. Light vehicles with small wheels and light suspensions are a bigger culprit than heavy trucks, which tend to grip the road better. Washboarding usually appears where you would expect repeated hard acceleration or braking, at intersections, sharp curves, business entrances, and driveways. Don't expect the public to stop accelerating hard, driving fast or applying brakes firmly: driving habits are a cause over which we have no control.

### Lack of Moisture

Prolonged dry weather can cause washboarding, even with relatively low traffic. In high traffic areas, just a few days without rain can lead to washboarding. Hauling water is generally cost prohibitive and counter productive to water conservation efforts which leads to little control of moisture in the gravel.

### Poor Quality Gravel

Washboarding will almost certainly develop if the surface gravel has poor gradation, little or no binding characteristics, and a low percentage of fractured stone. Here, there is complete control through choice of new material with good gradation and adequate fines. Good gravel is the cure for washboarding.

*Example of washboarding*

## WHAT IS GOOD GRAVEL?

Surface gravel should be a blend of stone, sand and fines that will compact into a dense, tight mass with an almost impervious surface. Proper gradation is paramount. Gravel with too few stones will not have strength in wet weather. Gravel with excessive stones will be hard to compact, and the stones will "float" in dry weather, piling up between the wheel tracks and along the shoulders. Gravel with too few fines will not allow the gravel to form a crust. Gravel with excess fines will be slick in wet weather.

Generally, the maximum size stone should be 3/4". Crushed gravel with a higher percentage of fractured stones will have better "aggregate interlock" and will stay in place better than rock with a naturally rounded shape, reducing washboarding and yielding higher strength.

The proper percentage and quality of fine materials, those that pass the #200 sieve, will act as a binder, holding the larger aggregate in place and increasing the cohesiveness of the gravel. There are natural binders, such as clay, and commercial binders. When exposed to moisture these

materials will cling together tightly, helping the surface resist washboarding. Beware, some fines fall into the silt category and will not yield the cohesiveness needed. While you may be able to compact the material into a dense mass, it will loosen more quickly under traffic and will cause more dust in dry weather. The only way to determine which type of fines you have is by laboratory testing the Plasticity Index (PI) of the material.

While sampling and testing the gravel is the only sure way to determine the quality, you can perform some basic field tests. To test gravel with moisture for binding, squeeze material into your fist. The material should form a ball. To test for the presence of fines, pick up a hand full of gravel, then drop it. You should see fine material remaining on your hand.

## HOW TO OBTAIN GOOD GRAVEL

Obtaining good gravel in the field can be a real challenge, so start by establishing good specifications. Close control of materials used in the base, asphalt and concrete of our major construction projects is expected, however, little attention is normally given to surface material specifications for "plain old gravel roads." Increase your knowledge of materials, then specify exactly what you want. Even if your local pits and quarries do not have a good natural blend of materials, the blend can often be improved simply by working the pit differently or by hauling in and blending materials such as clay or stone at the plant. Communicate your needs with your suppliers.

Another option for improving the quality is to incorporate reclaimed asphalt. With a 50/50 blend of recycled asphalt and virgin gravel, the asphalt will act as a binder and the surface will resist washboarding. The asphalt/gravel blend can still be worked with a grader. For best results, this blend should be placed to a minimum compacted depth of three inches.

Do not overemphasize an inexpensive initial cost of material. You will spend more to maintain and replace it over the years and receive more complaints from the public. Quality material lasts longer, requires less maintenance, and generates fewer complaints. Keep in mind, transport is often a significant portion of the project's total cost. Spending more to increase the quality of the gravel may cost less than you think. If the cost of the highest quality material remains prohibitive, consider using the best material only on trouble spots and regular quality on the rest of the road.

## MAINTENANCE TECHNIQUES

Simply blading over washboards with a motorgrader is almost useless. The best way to eliminate washboarding is to cut all of the material loose to a depth of one inch or more below the bottom of the washboard area, then work the material to mix in the fines brought up from below, finally reworking the material back to the proper shape and crown.

Use of a commercially available attachment of rotating scarifying teeth attached to the mold board of the grader blade produces excellent results mixing the fines back into the surface gravel. A replacement bit-type cutting edge on a front-mounted dozer blade can also be used to cut material loose and mix it. Use of a conventional scarifier also works, but care must be taken to avoid digging too deep and dislodging dirt and large rocks from the subgrade.

In some locations, windrows will be made to create roadside dikes for the winter season. Be aware that the fine materials from the gravel will flow away with the water. Simply blading the windrows back into the roadway in the spring may not be sufficient.

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When placing new material on a washboarded area, always cut and rework the area before adding the new material. Otherwise, the washboard pattern in the original surface will reflect up to the new surface and the same problem will remain. Treating gravel with calcium or magnesium chloride is also an option. These commercially available products are not binders but aid in keeping gravel in place by drawing moisture from the air. The key to success with these products is using them on gravel that already has proper gradation and good natural binding characteristics. The chlorides will work to keep the surface slightly damp and the gravel tightly bound.

Blading should never be done without good moisture in the material: materials should be moist but not saturated. It may pay to attend to problem areas after a heavy rain, then resume normal blading. You may be able to reduce blading outlying, low volume roads to just twice a year: in spring after the last rain and in fall after the first rain.

Finally, a note to dispel a common myth: motorgraders do not cause washboarding. While it is true that graders can cut distortions into a gravel surface, this distortion will never look like washboarding. When an operator runs a grader too fast, the machine can begin to "lope" or bounce. The resulting humps and dips will be farther apart and cut at an angle across the roadway at the same angle as the moldboard during the blading. Motorgraders help to control washboarding, they don't cause it.

*Adapted from an article by Ken Skorseth and printed with permission from the South Dakota LTAP Center.*

## *Request a free publication*

**UNS-18 Field Guide for Unpaved Rural Roads**

**UNS-19 Gravel Roads – Maintenance & Design Manual**

**UNS-24 Guidelines for Geometric Design of Very Low-Volume Local Roads**

**Fax request to: 413-545-6471**

Congratulations to the newest Baystate Roads Scholars on their fine achievement. Keep saving those certificates and you, too, could be listed here.

## Baystate Roads Scholars!

**Russell Robinson**
**Acton DPW**

**James Zarozinski**
**Ashburnham DPW**

**Michael Mansir**
**Hopkinton DPW**

**Richard Waite**
**Acton DPW**

**Paul Camilli**
**Winthrop DPW**

## NEW PUBLICATIONS

**BRI-127** Covered Bridge Manual
FHWA

**COC-139** High-Performance Concrete Structural Designers' Guide
FHWA (LOAN ONLY)

**D&C-158** Endangered Species Act Build Smart
FHWA Office of Federal Lands Highway

**S&I-69** Anti-Icing and Road Weather Information System
AASHTO (CDROM)

**S&I-70** A Snowplow Operators' Guide to Snow and Ice Equipment
Idaho LTAP Center

**TRA-113** Portable Changeable Message Sign Handbook
FHWA

**TRA-114** Full Road Closure for Work Zone Operation: A Case Study
FHWA

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projects involving widening of turn lanes, alterations to medians, and other significant changes could cost up to $250,000.

A total of 400 Michigan sites have been targeted since the program's inception; to date, improvements have been completed at approximately 225 sites. In 2003, researchers from Wayne State University in Detroit evaluated 84 sites involved in the program. The study revealed that the improved sites saw a 25% reduction in crashes, and 40% reduction in injuries, compared to before the changes were implemented.

## ROUNDING ON A SOLUTION

Highway officials have identified the installation of roundabouts--circular intersections in which drivers enter and exit through right turns--as another way to improve traffic safety. According to Tom Mannino, project manager with St. Louis-based engineering firm Homer & Shifrin Inc., roundabouts offer a range of benefits.

"In a roundabout, cars are approaching at a slower speed; therefore, drivers have more time to react to pedestrians, and pedestrians also have more time to react to vehicles," said Mannino. Collisions at roundabouts typically are less severe and frequent than at traditional intersections. In a December 2002 report, the Maryland Highway Administration indicated that 15 single-lane roundabouts had significantly improved safety at those intersections; analysis showed a 100% decrease in fatal crashes, 82% decrease in injury crashes, and a 60% reduction in overall crashes.

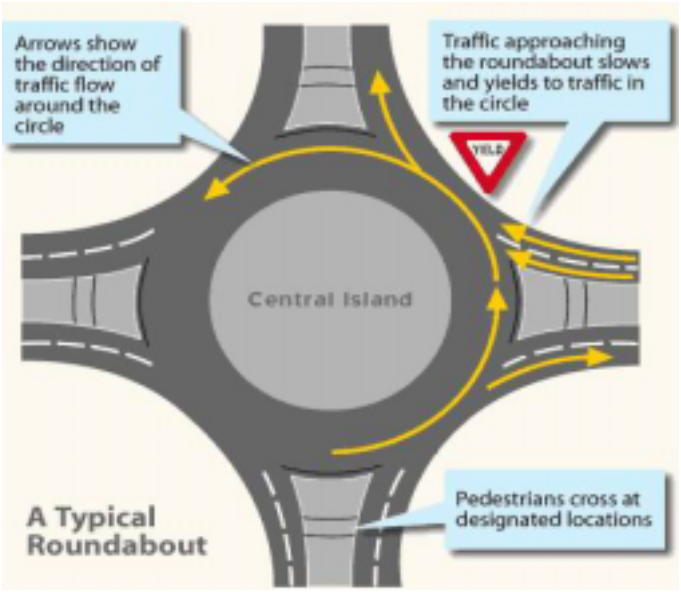
In O'Fallon, Ill., town officials harbored concerns about the intersection of State Street, an arterial roadway, and North Green Mount Road, a collector roadway.

"The location is problematic," said Dennis Sullivan, director of public works and engineering. "State Street, east and west, has cars traveling in a train-like pattern. As a result, motorists heeding the stop on the north-south road often become impatient and pull out in front of cars on State, causing accidents."

The city looked at a number of options, most of which were dismissed.

"A four-way stop would cause excessive stopping of traffic on State Street most hours of the day," said Sullivan. "A traffic light configuration would solve this problem, but is expensive to build and maintain, as well as coordinate with other signalized intersections nearby; it would also cause excessive delays in traffic most of the day based on the traffic distribution."

According to Mannino, a traffic study prepared by another engineering firm concluded that traffic signals should be installed with left turn lanes. The city council instead voted to pursue an overpass over the CSX railroad, but would need to defer the project until funding could be established. Engineers from Horner & Shifrin brought the idea using a roundabout as an interim improvement to officials, who gave the thumbs up. The roundabout best accommodates traffic for now and into the next 20 years, saving motorists time and minimizing pollution," said Sullivan.




Engineers performed a computer simulation that demonstrated installation of a roundabout at the location would lead to a marked reduction in air pollutants due to improved traffic flow and minimal traffic delay and congestion. Based on this recommendation, the city applied for and received a Congestion Management Air Quality (CMAQ) grant for $365,000 toward the projected total cost of $500,000. In addition, because the intersection averages more than one crash per month, many involving multiple vehicles, the city is applying for Highway Safety Improvement Program funds to supplement the CMAQ finding already received. This project is scheduled to begin construction this summer and wrap up by September. The city expects a 73% reduction in crashes and improved side street access.

# ROUNDABOUT RESOURCES

**Roundabouts: An Informational Guide**
FHWA-RD-00-67 June 2000 (BRP Library TRA-71)
Covers policy considerations and planning, evaluation procedures for assessing operational and safety performance, design guidelines, landscaping and system considerations.

**RoundaboutsUSA**
www.roundaboutsusa.com
Contains useful links to news items about roundabouts, background information, and resources for roundabouts.

**Crash Reductions Following Installation of Roundabouts in the US**
www.dot.state.ny.us/roundabouts/files/insurance_report.pdf
Insurance Institute for Highway Safety, March 2000, 15 pp
Presents a regression analysis of crash data noting that crash reductions are primarily attributable to reduced traffic speeds and elimination of specific types of conflicts occuring at angular intersections.

## in this issue



*Save the Date*

**MOVING TOGETHER 2006**
**Wednesday, October 18**
**Marriott Boston Courtyard Hotel**
**275 Tremont St., Boston, MA**

**When Roadway Design Options Are Wide Open, Why Not Build a Roundabout?**
www.iihs.org/sr/pdfs/sr4009.pdf
Status Report, Nov. 19, 2005. 1-4 pp
Communities are encouraged to construct roundabouts when an area is developed to reduce costs and avoid initial community opposition. They can improve traffic flow and reduce injury crashes by up to 75%.


The Baystate Roads Program, which publishes *Mass Interchange* each quarter, is a Technology Transfer (T2) Center created under the Federal Highway Administration's (FHWA) Local Technical Assistance Program (LTAP). This newsletter is prepared in cooperation with The Executive Office of Transportation (EOT) and the United States Department of Transportation Federal Highway Administration. FHWA is joined by EOT, UMass Transportation Center at the University of Massachusetts/ Amherst, and local public works departments in an effort to share and apply the best in transportation technologies.

In addition to publishing *Mass Interchange*, the Baystate Roads Program facilitates information exchange by conducting workshops, providing reports and publications and videotapes on request, and offering one-to-one technical assistance on specific roadway issues. Because the program relies on input from many sources, inquiries, articles, and ideas are encouraged.


## LTAP Local Technical Assistance Program

**To contact the Baystate Roads Program call (413) 545-2604 or FAX 413-545-6471.**

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