Economic Benefits of the Michigan Department of Transportation's 2009–2013 Highway Program

FINAL REPORT

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Prepared by

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and

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The statements, findings, and conclusions herein are those of the authors and do not necessarily reflect the views of the project sponsor.

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1. Introduction

The purpose of this study is to conduct an economic benefit analysis of the Michigan Department of Transportation's current Five-Year Highway Program. Through this program, MDOT makes substantial investments in the highway system throughout the state of Michigan, serving as custodian for the preservation, maintenance, and enhancement of the state's road and bridge system. In the study we will analyze two scenarios, the first being the full investment level program that was initially proposed, and the second being a reduced investment level program that would reflect less-than-anticipated revenues due to the decline in gas tax receipts. Under the latter scenario, spending would average $0.9 billion annually, compared with $1.2 billion per year for the full program.

A well-maintained and efficient transportation system provides the backbone for all economic activity within Michigan. Investment in transportation thus results in economic benefits for Michigan overall as well as for its industry sectors individually. Included in our assessment is the estimation of the transportation-related benefits of the program: time-savings for households and businesses, and investment in construction and engineering. The resulting value to Michigan's macroeconomy is then derived. These results are shown in comparison with a base case, that is, allowing the state's road and bridge infrastructure to wear down as a consequence of not funding MDOT activities.

The economic impact is assessed both for Michigan's overall economy and for its major industry sectors. Included are two sectors that MDOT has earmarked for particular attention: manufacturing and tourism (and by extension, the balance of the total economy, consisting of the nonmanufacturing sector excluding tourism). The aggregate economic impacts are measured as follows: (1) in terms of various labor market indicators such as changes in employment, labor force, and unemployment; (2) with monetary variables such as changes in compensation and personal income; and (3) by the most comprehensive measure of output, Gross State Product (a state measure comparable to Gross Domestic Product for the nation). The industry sector impacts are measured in terms of jobs. As indicated below, the economic effects of the program will include estimates of its spin-off benefits, as generated by the REMI (Regional Economic Models, Inc.) model of the Michigan economy.

REMI is probably the most widely applied regional economic forecasting and policy analysis tool in the nation. The methodology was first initiated in the mid-1970s by G. I. Treyz, A. F. Friedlander, and B. H. Stevens, all of whom were affiliated with the Economics Department at the University of Massachusetts. A core version of the model was then developed for the National Academy of Sciences. REMI was subsequently established in 1980, and since then has been developing models that answer "what if" questions about the effect of policy initiatives on the economy of local regions. The model has been generalized for all counties and states in the United States, and it can be applied to any combination of counties and states. The University of Michigan has been using various versions of the REMI model since 1983 to assess projects for several state government agencies in Michigan. The model is based on past and current research and development, which is subject to peer review and published in academic journals.

The model is currently used by hundreds of governmental agencies, universities, utilities, and private consulting firms for forecasting and policy analysis in areas including:

- Transportation infrastructure investments
- Forecasting and planning
- Regional economic development programs
- Environmental improvement projects
- Energy and natural resource conservation programs
- State and local taxation, budget, and welfare policy changes

The model is constructed to respond in a logical way to changes in any of these areas.

REMI is especially well-suited for assessing initiatives such as MDOT's Highway Program because: (1) the model is structured to compare the consequences of policy initiatives with a base case absent these changes; (2) the model is very detailed, able to capture the complexities of interactions among economic sectors in response to a policy change; and (3) the model has a regional focus, for instance, taking account of the "leakage" outside of the state of a portion of the economic activity stimulated by a local policy change. Central to the current MDOT study is the estimation of the spin-off benefits to the Michigan economy of the Highway Program in addition to its direct benefits. The REMI model is designed to generate such estimates. Spin-off effects

come from two sources: indirect effects, or purchases from local suppliers (e.g., steel, concrete, professional services); and expenditure-induced effects, or spending by people who receive income attributable to transportation-policy-related activity (e.g., spending by realtors of income received from selling homes to construction workers). It is the sum of the direct and spin-off activities that determines the total effect of MDOT's investments on the Michigan economy. More detail on the model and procedures is provided in section 2.3.

MDOT provided much of the initial input data. The Economic Development Research Group (an independent consulting firm located in Boston, Massachusetts) took primary responsibility for estimating the time and cost savings that result from the program, and apportioning program-related spending in Michigan in such a way that the economic model could interpret it. The University of Michigan's Institute for Research on Labor, Employment, and the Economy (formerly the Institute of Labor and Industrial Relations) took primary responsibility for generating the estimates of the economic benefits of the program that derive from the inputs. The two units did work as a team, though, each contributing to both phases of the project.

The following sections summarize the inputs into the economic model, including cost savings and transportation investments; the modeling methodology; and the results of processing the inputs through the economic model. This is the fourth such economic impact study commissioned by MDOT, using the most complete information available as well as state-of-the-art research tools. The present study is an update of a similar study carried out two years ago for one investment scenario by the same team of researchers. As always, the results of the current study are not strictly comparable with those of the previous study because of ongoing improvements in methodology, including capturing travel-time savings related to the capital preventive maintenance (CPM) activities.

2. Methodology

The general approach to determine the benefit of pursuing trunkline road and bridge system improvement was to take annual state-level program data provided by MDOT, and in combination with information and parameters considered as standard for this type of analysis, generate: (1) mappings of program expenditures into the appropriate policy levers for the REMI economic model; (2) estimates of annual travel-time savings for households and businesses (valued for each specific trip class) in terms of vehicle-hours of travel; and (3) the economic benefits accruing to the Michigan economy and its major industry sectors from these program expenditures and travel-time savings. The procedures underlying each of these stages are summarized briefly in the following three subsections.

2.1 Mapping MDOT Five-Year Program Expenditures

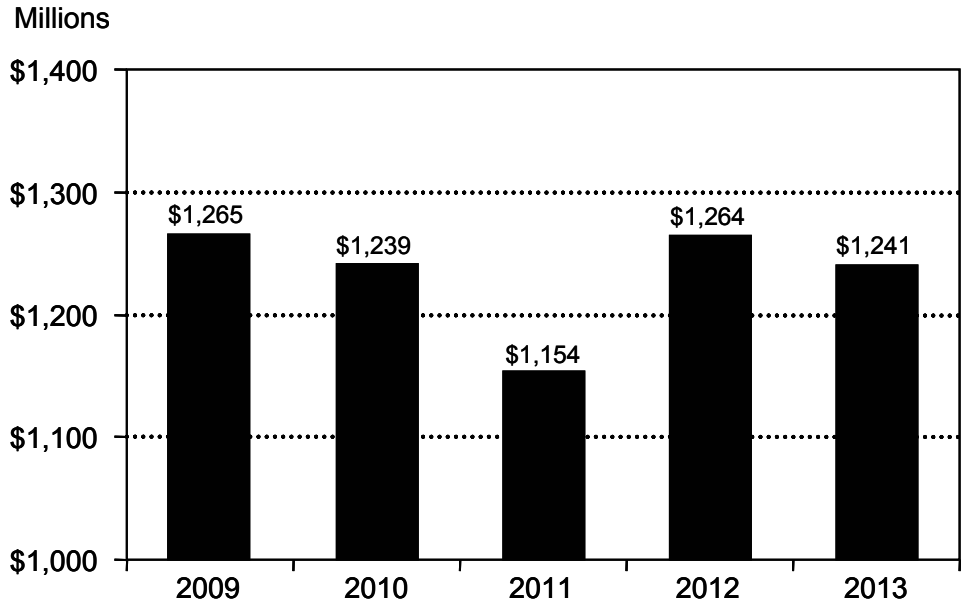
MDOT provided annual state-level highway program investment data (on a current-year dollar basis) for the interval 2009 through 2013 for both investment program scenarios. The annual investment levels for the full program are shown in figure 1F, and for the reduced program in figure 1R.

More detail on each program is provided in tables 1F and 1R, which show both the annual average and the five-year total investment of the scenarios distributed among major program subcategories. For the full program, the annual average investment for fiscal years 2009 to 2013 is $1.233 billion, for a five-year total of $6.163 billion. Overall investment levels for the reduced program are about 70 percent of the full program, averaging $0.892 billion per year and totaling $4.459 billion over the period.

The federal aid revenue estimate used to develop the 2009−2013 Five-Year Highway Program is based on the federal reauthorization bill known as SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, enacted August 10, 2005, as Public Law 109–59).

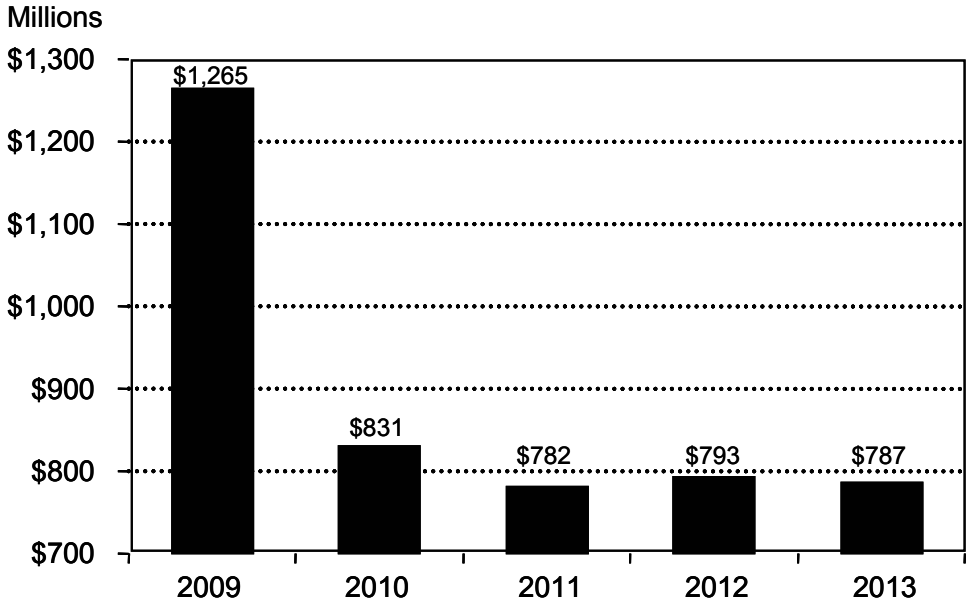
The state aid revenue estimate used to develop the 2009–2013 Highway Program is based on MDOT's share of the fiscal-year 2009 and 2010 Michigan Transportation Fund (MTF) as estimated by the Michigan Department of Treasury, Economic and Revenue Forecasting Division. Future-year state revenue is forecast using a long-range

Figure 1F (Full Program)
MDOT Five-Year Highway Program[1]
FY 2009 to FY 2013 Investment Levels



[1]MDOT Highway Capital Program investment includes routine maintenance.

Figure 1R (Reduced Program)
MDOT Five-Year Highway Program[1]
FY 2009 to FY 2013 Investment Levels



[1]MDOT Highway Capital Program investment includes routine maintenance.

Table 1F (Full Program)
MDOT Five-Year Highway Program
FY 2009 to FY 2013 Investment Levels

Repair and maintain roads and bridges	Annual Average ($ millions)	Five-Year Total ($ millions)
Repair and rebuild roads and CPM	**733**	**3,665**
Repair and rebuild roads	338	1,691
Capital preventive maintenance	93	463
Routine maintenance	302	1,512
Rehabilitate, replace, and rebuild bridges	**208**	**1,308**
Capacity improvements[1] and new roads	**58**	**292**
Capacity improvements[2]	27	136
New road construction[2]	31	156
Safety program[3]	**66**	**328**
Congestion mitigation and air quality	**42**	**209**
Intelligent transportation system	**14**	**68**
Other programs	**113**	**563**
Total five-year trunkline program	**1,233**	**6,163**

Source: Estimated capital outlay program template
1. A substantial portion of capacity improvement projects includes the preservation of the existing road.
2. Projects list included in the Five-Year Transportation Program document.
3. Additional safety funds are utilized in other programs such as road rehabilitation and reconstruction, bridges, capacity improvements, and new roads.

Table 1R (Reduced Program)
MDOT Five-Year Highway Program
FY 2009 to FY 2013 Investment Levels

Repair and maintain roads and bridges	Annual Average ($ millions)	Five-Year Total ($ millions)
Repair and rebuild roads and CPM	**583**	**2,917**
Repair and rebuild roads	206	1,031
Capital preventive maintenance	93	463
Routine maintenance	285	1,424
Rehabilitate, replace, and rebuild bridges	**144**	**722**
Capacity improvements[1] and new roads	**31**	**156**
Capacity improvements[2]	20	101
New road construction[2]	11	55
Safety program[3]	**42**	**210**
Congestion mitigation and air quality	**24**	**120**
Intelligent transportation system	**9**	**47**
Other programs	**57**	**286**
Total five-year trunkline program	**892**	**4,459**

Source: Estimated capital outlay program template
1. A substantial portion of capacity improvement projects includes the preservation of the existing road.
2. Projects list included in the Five-Year Transportation Program document.
3. Additional safety funds are utilized in other programs such as road rehabilitation and reconstruction, bridges, capacity improvements, and new roads.

forecasting model developed by MDOT, Statewide Transportation Planning Division. The Five-Year Highway Program includes revenues available from the state trunkline fund (STF) as well as bond revenue.

Annual detail on these investment data pertains to the following funding categories: repair and rebuild of existing roads, capital preventative maintenance, bridges, capacity improvements and new roads, safety programs, congestion mitigation and air quality, intelligent transportation systems, other programs, and routine maintenance. On a percentage basis, the funding categories that would absorb the largest cutbacks under the reduced program would be (in order): new road construction, congestion mitigation and air quality, repair and rebuild of existing roads, and intelligent transportation systems.

MDOT also provided guidance on the apportioning of program-related spending. For all categories except routine maintenance, MDOT assumed that 20 percent of the budgeted amounts would be spent on planning and engineering. The balance would be spent on construction activities. Routine maintenance involves no planning and engineering component. For both the planning and engineering component and the construction component, we also have information from MDOT regarding the extent that contractors perform category-specific projects versus work performed by MDOT employees. These allocations for each relevant funding category, shown in table 2, were time-invariant and investment-program-invariant.

Table 2 (Full or Reduced Program)
Apportioning Program-Related Spending

	P/E Component of Annual Cost	% of P/E $ to		% of Construction $ to	
		Contractors	MDOT Staff	Contractors	MDOT Staff
Repair and rebuild roads	20%	55%	45%	100%	0%
Maintenance	20%	20%	80%	50%	50%
Bridges	20%	60%	40%	100%	0%
Capacity improvements and new roads	20%	70%	30%	100%	0%
Safety program	20%	60%	40%	95%	5%
Other programs	20%	60%	40%	90%	10%
Routine maintenance	0%	na	na	0%	100%

Another important piece of information provided by MDOT concerns the prevalence of Michigan contractors engaged in MDOT programs. For planning and engineering, 95 percent of the contractors are Michigan-based, and for construction, 87 percent. Contractors from outside Michigan would fulfill the balance of the contracted activities, as shown in table 3. These distributions hold for both the full and the reduced programs.

Table 3 (Full or Reduced Program)
Summary of MDOT FY 2008 Construction Contracts
% of Work Performed by Michigan Contractors

	2008 FY Total	% of Total Contracts
Michigan contractors	$1,158,747,074	87
Out-of-state contractors	$174,470,066	13
Total	$1,333,217,140	100

We combine the information on what types of activities are performed and what sectors perform them with the information on how much is directly awarded to businesses in Michigan. We do this to calibrate the program-related expenditures to the values that serve as inputs into the REMI economic model. These inputs are specified as REMI policy variables, and they form the policy-initiated changes that are processed through the model to simulate the effects of the program-related expenditures on the Michigan economy and its major sectors.

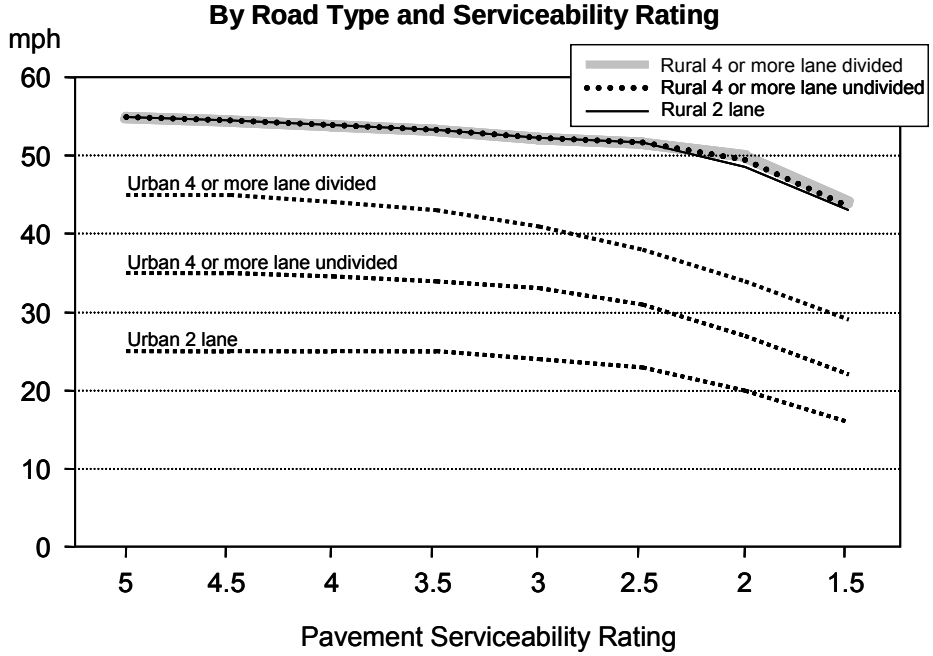
2.2 Travel-Time Savings Related to Program Improvements

A key assumption used in the assessment of travel-time savings was the correlation of pavement condition and vehicle speed. Limited research has shown that there is a correlation in real traffic performance with ride quality and pavement condition. Generally, past research has shown that free-flow speed falls as ride quality deteriorates (Zaniewski 1982). Very small speed reductions occur with slight worsening of ride quality, and speed begins to fall off noticeably as ride quality declines to the "poor" rating. For this study, MDOT estimated that speeds on free-access roads fell by 2½ m.p.h. on pavements with poor ride quality, and by 5 m.p.h. on limited-access freeways with poor ride quality. Severe reductions of 10 m.p.h. or more may be

observed on very poor pavements, but these are unlikely to occur on the state trunkline system.[1]

The relationship between the change in vehicle speed and the change in pavement quality, for specific road types, is shown in figure 2. The change in VHT associated with the MDOT program is estimated based on this relationship.

Figure 2 (Full or Reduced Program)
Average Vehicle Speeds
By Road Type and Serviceability Rating



Source: "Life-cycle Analysis for Pavement Management Decision-making Methodology Development" by Texas Research and Development Foundation, September 1985
Adapted from McFarland and Zaniewski

As part of this study, MDOT isolated the implied changes in vehicle hours traveled (VHT), by MDOT region, associated with making the improvements proposed in both scenarios of the Five-Year Program. These changes (annual increments, not cumulative) are shown in table 4F for the full program and table 4R for the reduced program, and are contrasted against each region's VHT estimates under the existing road conditions (and the implied future deterioration). The daily VHT savings expected from improved pavement conditions under the reduced program are considerably less than the savings anticipated from the full program.

[1]FHWA guidelines for assessing pavement quality are from their published recommendations (U.S. Department of Transportation, Federal Highway Administration 2004).

Table 4F (Full Program)
Daily Vehicle Hours Traveled (VHT) Savings Expected from Improved Pavement Conditions
(From projects within MDOT's 2009–2013 Highway Program)

Region	Year	Daily VHT (Representative of conditions following pavement reconstruction) For 2009–13 Project Segments Only	Daily VHT (Representative of existing conditions) For 2009–13 Project Segments Only)	Expected Daily VHT Savings as a Result of Improved Pavement Conditions For 2009–13 Project Segments Only
Bay	2009	5,390.23	5,797.69	407.46
Bay	2010	2,325.92	2,504.84	178.92
Bay	2011	3,379.66	3,607.16	227.50
Bay	2012	4,713.14	5,046.88	333.74
Bay	2013	4,498.87	4,853.86	354.99
			Bay Region 2009–2013 Cumulative Savings:	**1,502.59**
Grand	2009	2,186.16	2,299.93	113.76
Grand	2010	3,650.11	3,956.82	306.72
Grand	2011	4,183.54	4,415.64	232.10
Grand	2012*	2,417.24	2,585.87	743.63*
Grand	2013*	2,887.75	3,050.97	439.23*
			Grand Region 2009–2013 Cumulative Savings:	**1,835.44**
Metro	2009	18,462.46	19,884.77	1,422.31
Metro	2010	25,621.87	27,407.29	1,785.43
Metro	2011	10,918.94	11,658.20	739.26
Metro	2012	13,394.16	14,300.64	906.48
Metro	2013	24,084.06	25,752.27	1,668.21
			Metro Region 2009–2013 Cumulative Savings:	**6,521.68**
North	2009	2,888.73	3,069.38	180.65
North	2010	889.05	935.56	46.51
North	2011	2,915.16	3,084.29	169.13
North	2012	1,828.52	1,928.05	99.53
North	2013	2,523.86	2,711.81	187.95
			North Region 2009–2013 Cumulative Savings:	**683.78**
Southwest	2009	2,464.42	2,632.62	168.20
Southwest	2010	2,285.14	2,460.92	175.78
Southwest	2011	5,177.77	5,477.67	299.90
Southwest	2012*	4,034.68	4,326.37	817.69*
Southwest	2013	3,467.05	3,675.84	208.79
			Southwest Region 2009–2013 Cumulative Savings:	**1,670.36**
Superior	2009	812.60	867.88	55.28
Superior	2010	1,899.80	2,014.51	114.72
Superior	2011	1,603.50	1,680.61	77.11
Superior	2012	1,944.83	2,057.07	112.23
Superior	2013	1,051.54	1,109.80	58.27
			Superior Region 2009–2013 Cumulative Savings:	**417.61**
University	2009	7,258.33	7,764.66	506.33
University	2010*	8,868.80	9,551.02	827.22*
University	2011	3,370.68	3,581.27	210.59
University	2012	11,797.35	12,681.80	884.45
University	2013	7,518.21	8,054.96	536.75
			University Region 2009–2013 Cumulative Savings:	**2,965.34**
			Plus: All Regions CPM 2009-2013 Cumulative Saved:	**44,331**
			Total All Region Savings:	**59,928**

*Capacity improvements included, with the result that column (5) values exceed values for column (4) minus column (3).

Sources: MDOT Statewide Model and MDOT MAPSCORE Database

Table 4R (Reduced Program)
Daily Vehicle Hours Traveled (VHT) Savings Expected from Improved Pavement Conditions
(From projects within MDOT's 2009–2013 Highway Program)

Region	Year	Daily VHT (Representative of conditions following pavement reconstruction) For 2009–13 Project Segments Only	Daily VHT (Representative of existing conditions) For 2009–13 Project Segments Only	Expected Daily VHT Savings as a Result of Improved Pavement Conditions For 2009–13 Project Segments Only
Bay	2009	5,390.23	5,797.69	407.46
Bay	2010	1,464.13	1,576.76	112.63
Bay	2011	863.18	929.58	66.40
Bay	2012	3,729.91	4,016.82	286.92
Bay	2013	4,853.86	4,853.86	0.00
			Bay Region 2009–2013 Cumulative Savings:	**873.40**
Grand	2009	2,186.16	2,299.93	113.76
Grand	2010	1,680.84	1,772.58	91.74
Grand	2011	2,925.29	3,083.28	157.98
Grand	2012	2,610.59	2,858.62	248.03
Grand	2013	2,103.49	2,269.91	166.42
			Grand Region 2009–2013 Cumulative Savings:	**777.93**
Metro	2009	18,462.46	19,884.77	1,422.31
Metro	2010	18,357.41	19,659.79	1,302.38
Metro	2011	9,415.38	10,088.73	673.35
Metro	2012	4,271.87	4,524.83	252.96
Metro	2013	11,092.73	11,785.89	693.16
			Metro Region 2009–2013 Cumulative Savings:	**4,344.16**
North	2009	2,888.73	3,069.38	180.65
North	2010	358.31	375.38	17.06
North	2011	1,825.71	1,942.97	117.25
North	2012	1,250.45	1,314.93	64.48
North	2013	1,745.88	1,875.25	129.38
			North Region 2009–2013 Cumulative Savings:	**508.83**
Southwest	2009	2,464.42	2,632.62	168.20
Southwest	2010	2,460.92	2,460.92	0.00
Southwest	2011	2,293.62	2,470.05	176.43
Southwest	2012	3,378.21	3,631.54	253.32
Southwest	2013	1,812.95	1,942.31	129.37
			Southwest Region 2009–2013 Cumulative Savings:	**727.32**
Superior	2009	812.60	867.88	55.28
Superior	2010	823.55	873.42	49.87
Superior	2011	1,209.61	1,280.82	71.21
Superior	2012	1,940.24	2,044.59	104.35
Superior	2013	793.70	839.15	45.46
			Superior Region 2009–2013 Cumulative Savings:	**326.17**
University	2009	7,258.33	7,764.66	506.33
University	2010*	4,543.42	4,892.91	494.49*
University	2011	4,985.48	5,350.10	364.62
University	2012	1,324.92	1,425.01	100.09
University	2013	7,134.05	7,669.96	535.91
			University Region 2009–2013 Cumulative Savings:	**2,001.44**
			Plus: All Regions CPM 2009-2013 Cumulative Saved:	**44,331**
			Total All Region Savings:	**53,890**

*Capacity improvements included, with the result that column (5) values exceed values for column (4) minus column (3).

Sources: MDOT Statewide Model and MDOT MAPSCORE Database

MDOT provided a region-specific traffic composition table for 2007 (see table 5), which describes the percentage of annual VHT in a region by commercial vehicles, and applies to both the full and reduced programs. Combining the region-specific traffic composition with the information in tables 4F and 4R, summing over all MDOT regions, we were able to estimate VHT saved for both commercial and auto categories. Tables 5A.F (full program) and 5A.R (reduced program) show how these VHT savings accumulate over time for each program.

This annual series of VHT saved must be allocated appropriately (and valued) before measuring the added economic benefit to Michigan businesses and households. Table 5B presents the projected 2010 trip table for Michigan. The origin-destination composition of trips on the state's roads affects how much of annual VHT saved is awarded to the Michigan business or household sectors. These are discussed in section 3.1.

In addition, for autos, table 5B also shows trip-purpose breakout. With this trip profile, auto VHT savings can be allocated among households (for personal and commuting) and businesses (for on-the-clock[2] and a portion of their employees' commuting). The implications of this are also presented in section 3.1.

The value of travel-time savings for business is mapped into the appropriate policy variables in the REMI model after adjusting for the local (Michigan) benefit. The data are entered into the policy variables by industry, and REMI treats the business savings as reductions in production costs for those industries. The changes in these policy variables (known as COSPOLs[3]) are processed through the model to simulate the effect on the Michigan economy of travel-time savings for business.

Several sets of COSPOL variables are introduced into the REMI model to represent reduced cost of doing business among several categories of industry travel-time savings, including: (1) an industry's savings related to truck-transported freight

[2]On-the-clock travel refers to trips made by workers during their work day as part of the job. The cost of this excess travel-time is borne by business and is valued at the worker's wage plus fringe/overhead costs.

[3]COSPOL is shorthand for production cost policy variables in the REMI model. Values of these policy variables can be altered to change the production costs of particular industries. They are used when a specific policy will affect the cost of doing business in a region without directly changing the relative costs of factor inputs (i.e., labor, capital, or fuel).

Table 5 (Full or Reduced Program)

Traffic / Vehicle / Trip Composition

Region	Annual VMT 2007	Annual Commercial VMT	% VMT As Commercial
Bay	6,484,391,011	478,104,541	7.4%
Grand	6,005,175,061	471,543,673	7.9%
Metro	18,194,901,086	1,132,226,994	6.2%
North	3,865,783,049	279,978,004	7.2%
Southwest	5,580,535,385	926,097,735	16.6%
Superior	2,011,750,864	165,668,392	8.2%
University	9,407,859,398	1,094,180,932	11.6%

Table 5A (Full and Reduced Programs)

Cumulative Annual VHT Savings, 2009–13

	5A.F (Full Program)		**5A.R (Reduced Program)**	
Year	Commercial	Auto	Commercial	Auto
2009	–357,394	–4,040,666	–357,394	–4,040,666
2010	–745,403	–8,036,971	–649,252	–7,717,699
2011	–1,117,890	–11,592,286	–1,069,180	–11,105,728
2012	–1,714,382	–15,702,431	–1,470,889	–14,466,182
2013	–1,805,606	–19,984,572	–1,743,913	–17,921,292

Table 5B (Full or Reduced Program)

Annual Trips in Michigan, 2010

	Commercial	Auto
Total number of trips	37,125,052	9,705,051,910
Origin-destination		
Michigan to Michigan	50.2%	98.6%
Michigan to/from other states	41.8%	1.4%
Thru-trips	7.9%	0.0%

Auto Trip—Purpose

Commute	Non-home-based to work	Personal
25.2%	4.3%	70.5%

(sensitive to the origin-destination aspects with respect to Michigan's borders), and (2) an industry's savings when its employees' on-the-clock times improve, and when its employees have shorter commute times. For the latter, it is recognized in the economics of labor markets that employers share a portion of their workers' commuting costs as capitalized in the wages they must offer to attract the necessary labor, as longer and more difficult commutes translate into wage premiums.[4]

The industries encompassed in category (1) above are those captured by MDOT's projected 2010 Commodity Flow Summary compiled from the Transearch Database provided by Global Insight, Inc. (July 2006 update). For the same origin-destination pairings, Transearch data describe, for the year 2006 and a projection for 2010, the number of trucks and tons by commodity type, classified by Standard Transportation Commodity Code (STCC). STCC groupings are readily mapped into North American Industrial Classification System (NAICS) industry categories. For each industry implicitly represented in the Michigan Transearch data, the truck share projected for 2010 is used to allocate Michigan commercial vehicle savings for each year.

The industries encompassed in category (2) above involve services with on-the-clock requirements. All private-sector industries are included with respect to workers' commute time savings. Allocation of the annual savings due to on-the-clock travel is based on the service industry's employment share of total service sector employment in Michigan.[5] The allocation of commute-related savings is based on an industry's employment share of total private-sector employment in Michigan.

Finally, the travel-time savings to households (including savings related to personal trips and one-half of commute trip savings) is modeled at 50 percent of the savings, using the REMI model's quality of life (non-monetary amenity) policy variable.

2.3 REMI Economic/Demographic Model and General Procedures

As indicated in section 1, to estimate the effect of MDOT's Five-Year Highway Program on the Michigan economy, we use an economic/demographic model constructed by Regional Economic Models, Inc. (REMI) of Amherst, Massachusetts, and adapted by

[4]Retail, construction, and nonprofits were judged to be industries that do not have to pay a wage premium to attract workers who have difficult commutes within the state.
[5]For this calculation, the insurance industry is included in services.

the research team at the University of Michigan for the purposes of this study. The REMI model has been fully documented and peer-reviewed in the professional literature (Treyz 1993, Treyz et. al 1992). The REMI model has been designed particularly for carrying out simulations of the type generated for this study, and has been used nationwide for such studies for almost three decades.

The industry interactions associated with the presence or absence of an activity are captured by input-output methods, which identify the buying and selling relationships among a fairly detailed breakout of industries. The REMI model is much more complex than its input-output component, though, having a very detailed calibration of the workings of the macroeconomy.

The general procedure in estimating the economic effect of the MDOT Highway Program is to adjust the model so as to add the specific MDOT capital improvement program and then to have the model generate the economywide impact, including the spin-off effects. As stated earlier, it is the sum of the direct and spin-off activities that determines the total effect of MDOT's investments on the Michigan economy.

For the purpose of the current analysis, the base-case forecast for Michigan allows the state's road and bridge infrastructure to wear down during the period 2009–2013 as a consequence of not funding MDOT activities. The underlying projection of state government employment represents a slower growth in staffing than would be needed when developing and implementing the Five-Year Program. We then add the program to the baseline, to determine hypothetically how different the economies would be.

The details underlying the general modeling methodology are more complex. To the extent possible, the model inputs were tailored to the specific program components, rather than being generic representations of the components. Adjustments were made to avoid double-counting activities. Care was taken to distinguish those activities that bring in funding from outside of the state from those that involve spending redirected within Michigan. A case in point is tourism. We recalibrated some of the industry results in the model to isolate the impacts on out-of-state tourism, a sector not explicitly broken out in the REMI model. We were able to take tourist-related industries, and for each of those industries, separate out the portion that was related to out-of-state tourism by using current information in the REMI model.

3. Results

3.1 Travel-time Savings Related to Program Improvements

Implementation of the projects within MDOT's Highway Program—for each of the full and reduced investment scenarios— is estimated to provide Michigan with the following travel-time savings over the period 2009–2013. ***All values are stated in inflation-adjusted 2009 dollars.***

(1) Automobiles realize the greatest amount of VHT savings; 98.6 percent are trips fully contained within Michigan. The balance of trips have either an origin or destination in Michigan. About 25 percent of these VHT savings are related to trips between home and work. Another 4.3 percent are non-home-based work-related trips (we call these on-the-clock or OTC). The balance of the automobile trips are non-work-related (or personal).

(2) Under the full program, Michigan households realize annual travel-time savings of $32.9 million (2009) to $163 million (2013) per year, using the standard[6] of valuing an hour of an individual's time at one-half the wage of $20.35, or $10.17.[7] Under the reduced program, the equivalent savings would be $32.9 million (2009) to $146.2 million (2013) per year.

(3) Michigan businesses share part of the savings associated with employees' commute times, and the full amount of the OTC. Under the full program, these are worth between $8.4 million (2009) and $41.4 million (2013) per year. The equivalent savings under the reduced program would be $8.4 million (2009) and $37.1 million (2013) per year

(4) Michigan businesses reap savings related to their commercial VHT savings. The standard used here is $59.40 per hour in driver wages, freight logistics cost, and vehicle operating costs.[8] Under the full program, these savings would be between $14.7 million (2009) and $74.1 million (2013) per year. Under the reduced program,

[6]Victoria Transportation Policy Institute's On-line TDM (Transportation Demand Management) Encyclopedia.
[7]Since the data provided were for annual increments, the inputs are cumulative, with the larger amounts in each range pertaining to the last year analyzed.
[8]TREDIS (transportation economic development impact system) model and EDR Group research.

the equivalent savings would be between $14.7 million (2009) and $71.6 million (2013) per year

(5) Combining (3) and (4), Michigan businesses are set to save between $23.1 million (2009) and $115.5 million (2013) per year under the full program, and between $23.1 million (2009) and $108.7 million (2013) per year under the reduced program.

3.2 Economic Effect on Michigan of MDOT's Program

The tables and figures in this section show our estimates of the economic effect on Michigan of MDOT's Five-Year Highway Program, compared with the scenario of allowing the state's road and bridge infrastructure to wear down during 2009–2013 as a consequence of not funding the activities. The tables and figures are presented for both of the investment scenarios, one with full funding and the other with reduced funding. The results reflect the total effect of the program, including the spin-off effects from program activity. The aggregate economic effects are represented in tables 6F and 6R by employment, population, number of unemployed, labor force, value of shipments (sales), Gross State Product, and categories of personal income.[9] The industry effects presented in tables 7F and 7R focus on employment. The results are shown annually for the duration of the program. The differences between the two sets of results represent the difference in economic gain between the two programs.

Under the full-funding scenario, MDOT plans to spend $1,265 million in 2009, as shown previously in figure 1F. MDOT's planned expenditures under this scenario are expected to decrease in 2010 and 2011, then increase in 2012. In 2013, planned expenditures slip again so that even under the full-funding scenario, spending by MDOT in 2013 is about 2 percent below 2009 levels. Adjusted for inflation, expenditures in 2013 decrease even further, to only $1,113 million (2009 dollars).

Under the reduced-funding scenario, spending in 2009 remains the same as in the full-funding scenario, but spending then falls dramatically in 2010. By 2013, spending by

[9]Employment represents the total number of private and public sector jobs, including the self-employed. Population includes all residents, civilian and military. Labor force consists of the employed and unemployed, where the unemployed are actively seeking work. Gross State Product is a state measure comparable to Gross Domestic Product for the nation. Personal income is the income of Michigan residents from all sources, after deduction of contributions to social insurance programs but before deductions of income tax and other personal taxes.

MDOT would be 62 percent of 2009 levels. Adjusted for inflation, the amount would be 56 percent of what MDOT anticipates spending in 2009.

As shown in figure 3F, the full-funding program is forecast to generate 16,108 jobs in Michigan in 2009. The effect on employment is muted in 2010 and 2011, reflecting lower spending levels. The effect is greater in 2012 but softens again in 2013, when it generates 14,546 jobs.[10] Expenditures per job in 2009 amount to $78,500, falling to $76,500 (2009 dollars) by 2013 because the benefits of better roads cumulate over time. Indeed, the benefits that accrue to the state from the Five-Year Highway Program would extend beyond 2013, outside of our period of analysis.

Under the reduced-funding program, employment benefits are the same as for the full-funding program in 2009, as shown in figure 3R. The reduced-funding employment effects then fall off dramatically in 2010. By 2013, the program generates only 9,818 jobs in the state. This means that the reduction in MDOT funding costs the state 4,728 jobs by 2013 compared with the full-funding scenario.

Several other metrics gauging the economic benefits of MDOT's expenditures are shown in tables 6F and 6R. During 2009–2013, under the base case, Michigan is forecast to see a continued outmigration of residents. MDOT's full-funding expenditures program is projected to reduce the number of residents leaving the state by 3,452 in 2009 and 2,061 in 2013 compared with the situation without the program, reflecting a stronger economy and a positive amenity effect (i.e., Michigan as a more attractive place to live). The slower rate of outmigration contributes to a higher population than predicted by the baseline forecast, 3,489 higher in 2009 and 13,746 higher by 2013.

Under the reduced-funding program, the outmigration of Michigan residents is also reduced compared with what would happen if there was no spending at all, but the reduction in the rate of population loss is less than under the full-funding scenario. Under the reduced-funding program Michigan's population in 2013 is only 10,676 higher than it otherwise would be.

[10]Note that the job gains are not cumulative; that is, the job gains in 2009 and 2010 are not added to the gains in 2011 to determine the total job gain in 2011. The only cumulative results shown are the monetary values reported in the final columns of tables 6F and 6R, and in figures 4F, 4R, 5F, and 5R.

Figure 3F (Full Program)
Effect on Employment of MDOT's Five-Year Highway Program
2009–2013

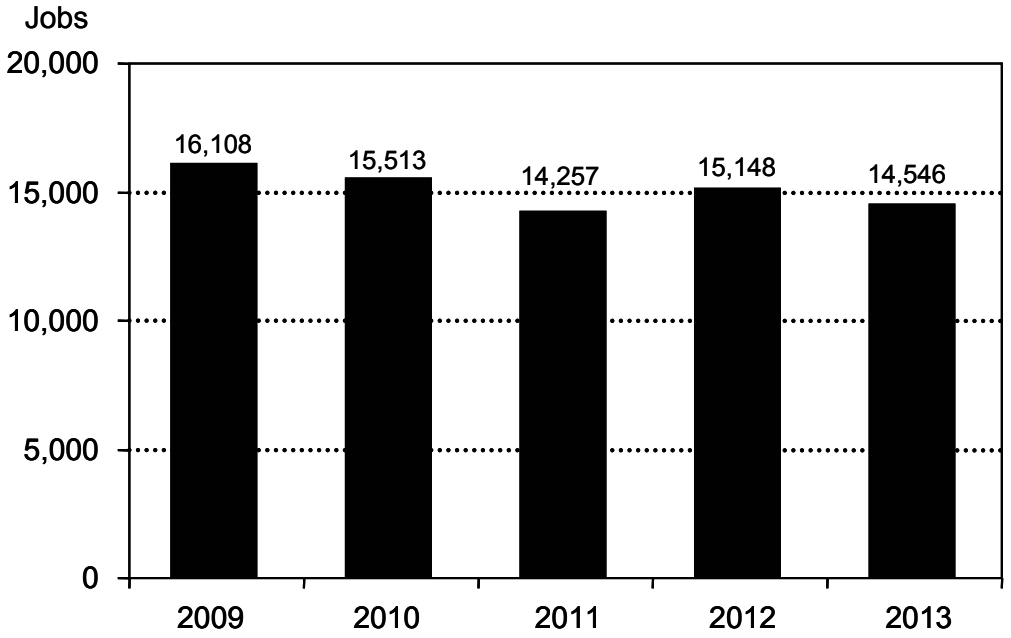


Figure 3R (Reduced Program)
Effect on Employment of MDOT's Five-Year Highway Program
2009–2013

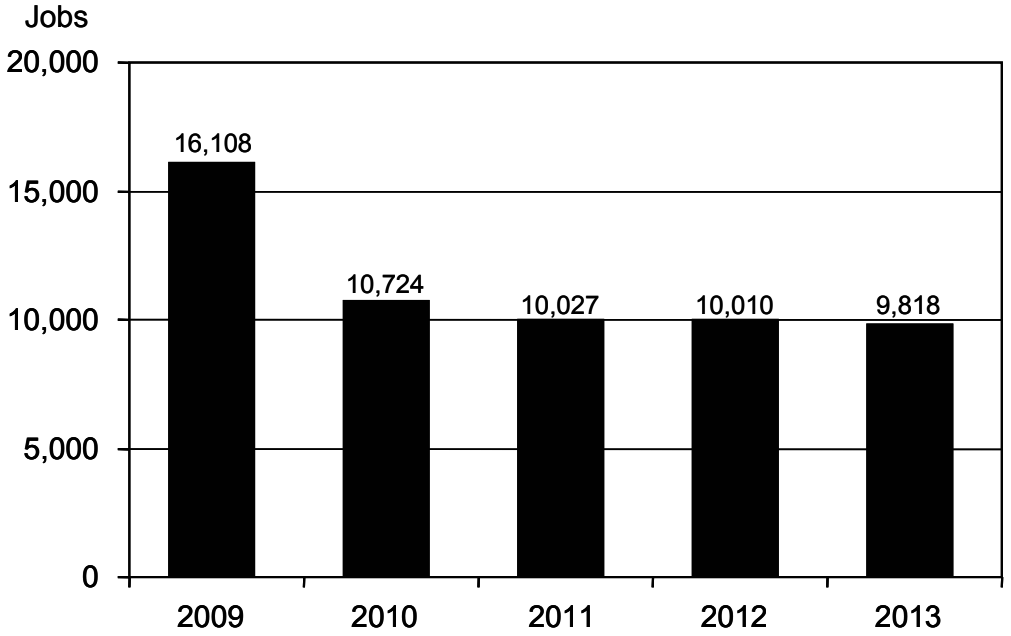


Table 6F (Full Program)
Economic Benefits of MDOT's Five-Year Highway Program
2009–2013
(Changes compared with baseline forecast)

	2009	2010	2011	2012	2013	Total 2009–13
Total employment	16,108	15,513	14,257	15,148	14,546	–
Population	3,489	6,412	8,869	11,425	13,746	–
Reduction in outmigration	3,452	2,817	2,296	2,343	2,061	–
Reduction in number of unemployed	12,613	9,792	7,061	6,507	4,825	–
Labor force	3,496	5,721	7,197	8,641	9,722	–
Value of shipments (millions '09 $)	1,815	1,781	1,670	1,809	1,776	8,851
Gross State Product (millions '09 $)	1,072	1,075	1,029	1,138	1,131	5,445
Real personal income (millions '09 $)	713	728	713	796	801	3,751
Labor & proprietors' income (millions $)	883	913	881	974	965	4,616
Less: Social insurance taxes (millions $)	89	93	91	101	101	475
Plus: Non-labor income (millions $)	–81	–55	–24	–6	24	–142
Equals: Total personal income (millions $)	713	765	766	867	888	3,999

Source: REMI model; includes amenity effect, household time savings valued at $10.17 (approximately ½ the hourly wage rate).

Table 6R (Reduced Program)
Economic Benefits of MDOT's Five-Year Highway Program
2009–2013
(Changes compared with baseline forecast)

	2009	2010	2011	2012	2013	Total 2009-13
Total employment	16,108	10,724	10,027	10,010	9,818	–
Population	3,489	5,453	7,243	8,997	10,676	–
Reduction in outmigration	3,452	1,868	1,658	1,584	1,477	–
Reduction in number of unemployed	12,613	5,993	4,336	3,473	2,562	–
Labor force	3,496	4,730	5,690	6,537	7,256	–
Value of shipments (millions '09 $)	1,815	1,244	1,187	1,210	1,215	6,671
Gross State Product (millions '09 $)	1,072	741	726	758	776	4,073
Real personal income (millions '09 $)	713	504	508	535	552	2,812
Labor & proprietors' income (millions $)	883	621	606	625	630	3,365
Less: Social insurance taxes (millions $)	89	63	62	65	66	345
Plus: Non-labor income (millions $)	–81	–29	–7	11	31	–75
Equals: Total personal income (millions $)	713	529	537	571	595	2,945

Source: REMI model; includes amenity effect, household time savings valued at $10.17 (approximately ½ the hourly wage rate).

The impact of the full-funding program is to reduce the number of unemployed workers by 12,613 in 2009 and by 4,825 in 2013 compared with the base case. The labor force is also greater and growing over time, mostly because of a decrease in outmigration of the working-age population. Under the reduced-funding scenario, the number of unemployed decreases by a smaller 2,562 in 2013.

Under the full-funding program, the total value of shipments is greater by $1.815 billion (2009 dollars) in 2009, while the real Gross State Product (GSP) is increased by $1.072 billion.[11] As shown in figure 4F, the real GSP benefits cumulate from 2009 to 2013, to $5.4 billion. Under the reduced-funding program, cumulative real GSP benefits are substantially reduced to only $4.1 billion, as shown in figure 4R, and this lower number includes the same expenditures in 2009 as the full-funding program. A portion of the value-added, or GSP, benefits becomes personal income tied to the additional jobs created.

As shown in table 6F, real personal income under the full-funding program is increased by $713 million in 2009, and by $801 million (2009 dollars) in 2013. The real personal income benefit, like the real GSP benefit, increases between 2009 and 2013 despite the slowing of real funding and employment. The increase in income and GSP results from several factors: (1) the economic benefits of a better transportation network cumulate over time, and, in fact, will extend beyond the time period examined in this report; (2) real wages increase over time due to economy-wide productivity growth; and (3) a decline in unemployment and welfare payments results in a negative contribution from non-labor income for 2009, but by 2013, this negative contribution is more than offset by an increase in dividend, interest, and rental income, resulting in a positive contribution from non-labor income. As shown in figure 5F, the real income benefits cumulate from 2009 to 2013, to $3.8 billion.

Under the reduced-funding scenario, the benefits to the state in terms of real shipments, real GSP, and real personal income are the same in 2009 as with full funding, but are markedly less in 2010 and remain at a much lower level through 2013. As shown in figure 5R, the real income benefits under the reduced-funding scenario cumulate to only $2.8 billion (and this is with same level of benefits in 2009 as under the full-funding program).

[11]Note that the value of shipments exceeds the GSP because the shipments measure includes the value of intermediate goods and services, while GSP includes only the value added by Michigan firms.

Figure 4F (Full Program)
Cumulative Effect on Real Gross State Product
of MDOT's Five-Year Highway Program, 2009–2013

Note: Values for each year are cumulative; that is, they include that year plus all previous years shown in the figure.

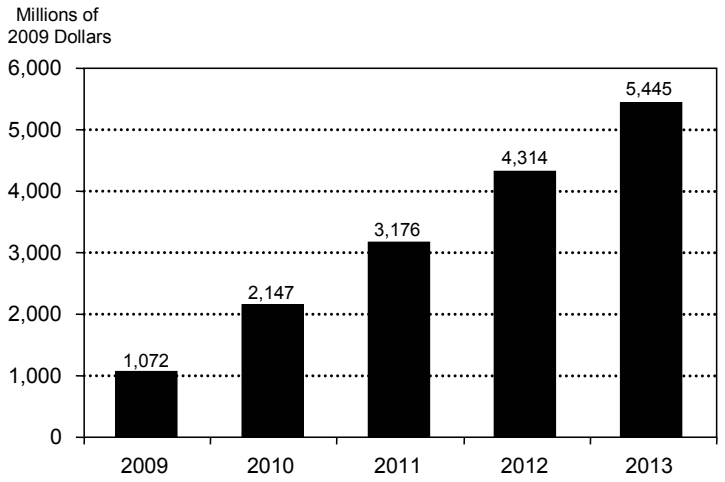


Figure 4R (Reduced Program)
Cumulative Effect on Real Gross State Product
of MDOT's Five-Year Highway Program, 2009–2013

Note: Values for each year are cumulative; that is, they include that year plus all previous years shown in the figure.

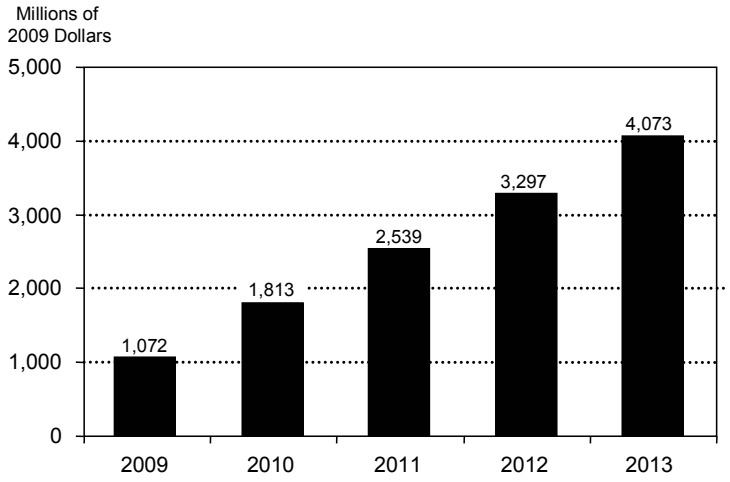


Figure 5F (Full Program)
Cumulative Effect on Real Income of MDOT's Five-Year Highway Program
2009–2013

Note: Values for each year are cumulative; that is, they include that year plus all previous years shown in the figure.

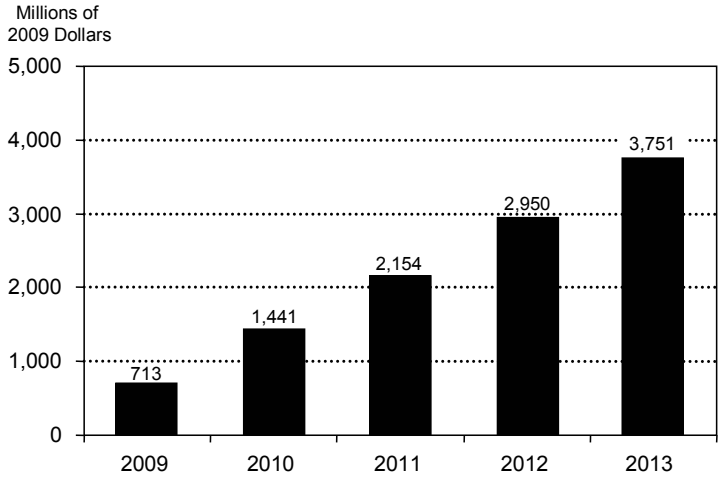
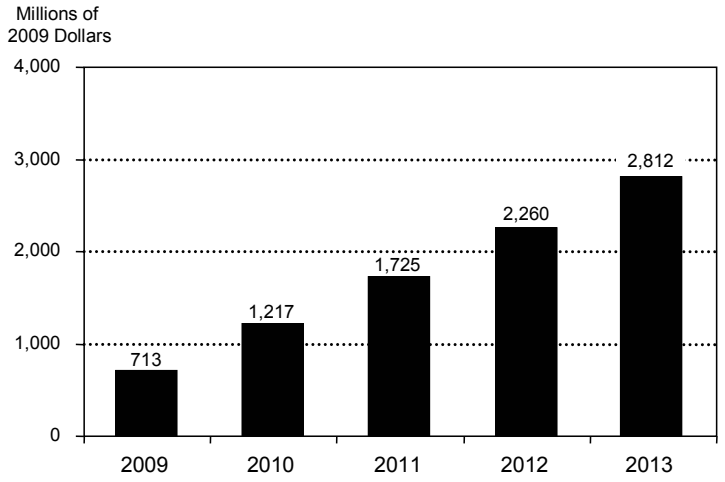


Figure 5R (Reduced Program)
Cumulative Effect on Real Income of MDOT's Five-Year Highway Program
2009–2013

Note: Values for each year are cumulative; that is, they include that year plus all previous years shown in the figure.



The employment benefits of MDOT's Five-Year Highway Program are shown by major industry division in tables 7F and 7R. The estimates represent direct and spin-off employment, and the totals for each year duplicate the total employment effect reported in tables 6F and 6R. As shown in the tables, the largest job gains are in construction, which includes the direct employment of highway construction workers, and in professional services, reflecting the employment of engineers and other professional workers.

Table 7F (Full Program)

Employment Benefits of MDOT's Five-Year Highway Program
By Industry, 2009–2013
(Changes compared with baseline forecast)

Industry	2009	2010	2011	2011	2013
Total employment	16,108	15,513	14,257	15,148	14,546
Manufacturing	275	247	218	240	238
Tourism (out-of-state visitors)	121	118	110	119	116
Nonmanufacturing except out-of-state tourism	15,712	15,148	13,929	14,789	14,193
Construction	7,858	7,434	6,680	6,863	6,407
Retail trade	1,390	1,372	1,290	1,393	1,352
Professional services	2,436	2,260	1,982	2,093	1,952
Accommodation & food services	735	701	640	688	657
Other	3,293	3,382	3,337	3,752	3,825

Note: Out-of-state tourism estimates are based on the share of output from tourist-related industries that are "shipped" out of state; data are from REMI.

Table 7R (Reduced Program)

Employment Benefits of MDOT's Five-Year Highway Program
By Industry, 2009–2013
(Changes compared with baseline forecast)

Industry	2009	2010	2011	2011	2013
Total employment	16,108	10,724	10,027	10,010	9,818
Manufacturing	275	170	160	172	187
Tourism (out-of-state visitors)	121	80	77	79	80
Nonmanufacturing except out-of-state tourism	15,712	10,474	9,790	9,758	9,552
Construction	7,858	5,273	4,757	4,551	4,272
Retail trade	1,390	954	917	930	923
Professional services	2,436	1,403	1,250	1,226	1,171
Accommodation & food services	735	465	439	442	437
Other	3,293	2,379	2,427	2,609	2,750

Note: Out-of-state tourism estimates are based on the share of output from tourist-related industries that are "shipped" out of state; data are from REMI.

MDOT's focus industries, the manufacturing and out-of-state tourism sectors, make up 14 percent of the jobs in Michigan's economy. In addition to contributing over 730,000 jobs in 2007, manufacturing and tourism are two of the state's leading export-base sectors, drawing in income from the rest of the country as well as from the rest of the world.[12] The Highway Program creates 275 jobs in manufacturing in 2009, and 121 jobs in out-of-state tourism.[13] By 2013, the full-funding program is supporting 238 jobs in manufacturing and 116 jobs in out-of-state tourism, whereas the reduced-funding program brings in a smaller number of jobs, as would be expected: 187 in manufacturing and 80 in out-of-state tourism

For context, the total number of jobs attributable to the programs in 2009 amounts to about 0.3 percent of total employment in the state. None of these estimates include the non-measurable effects and intangible advantages that would produce additional economic benefits for Michigan.

While the MDOT program activities have been presented in terms of their economic impact on Michigan, this does not represent the full value to the state's residents and businesses. The primary advantages are human and social. A well-maintained surface transportation system that operates efficiently can generate air quality benefits that improve health and quality of life. A safer surface system reduces the number of accidents for all users of Michigan's roads and bridges, residents and visitors alike. The prevention of auto-related injury and death is the most compelling reason for upkeep and improvement of infrastructure.

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[12]Note that we are not counting any in-state tourism impact, for example, the benefits from a resident of Oakland County vacationing in the Traverse City area. We only count people visiting Michigan from outside the state who would not travel here if the roads and highways were in worse condition.

[13]The "Other" designation in tables 7F and 7R includes the following major industry categories: (1) natural resources and mining; (2) wholesale trade, part of transportation, and utilities; (3) information; (4) financial activities except part of real estate; (5) private education and health services; (6) leisure and hospitality except accommodation and food services and part of arts, entertainment, and recreation; (7) other services except part of personal services; and (8) government.

4. Conclusion

MDOT makes substantial investments to maintain Michigan's complex infrastructure network, dedicating approximately $1.2 billion annually for the preservation, maintenance, and enhancement of the state's road and bridge system. These transportation investments result in economic benefits both for Michigan overall and for its industry sectors individually. In this study, we conduct an economic benefit analysis of MDOT's current Five-Year Highway Program, using the most complete information available as well as state-of-the-art research tools. We evaluate two scenarios, a full-investment program that was initially proposed and a reduced-investment program that is about 30 percent smaller, reflecting less-than-anticipated revenues due to the decline in state gas tax receipts. The present study is an update of a similar study carried out two years ago for one investment scenario by the same team of researchers. As always, the results of the current study are not strictly comparable with those of the previous study because of ongoing improvements in methodology, including capturing travel-time savings related to the capital preventive maintenance (CPM) activities.

Under the full program, we find that Michigan households realize travel-time savings worth $32.9 million to $163 million per year between 2009 and 2013, and Michigan businesses save between $23.1 million and $115.5 million per year (2009 dollars). With the reduced program, the equivalent savings would be between $32.9 million and $146.2 million per year for households, and between $23.1 million and $108.7 million per year for businesses.

These time savings, combined with program expenditures on construction and engineering projects, result in economic benefits accruing to Michigan. In 2009, there are 16,108 jobs created in Michigan due to the full program, almost $1.1 billion in Gross State Product (GSP) is generated, and about $700 million in personal income is produced. Over the duration of the program, from 2009 to 2013, the inflation-adjusted GSP benefits cumulate to $5.4 billion, and real personal income benefits sum to $3.8 billion (2009 dollars).

The reduced program has the same expenditure levels in 2009 as the full program. Over the duration of the reduced program, the inflation-adjusted GSP benefits cumulate to $4.1 billion, and real personal income benefits sum to $2.8 billion (2009 dollars).

These numbers make it clear that the economic benefits of MDOT's Five-Year Highway Program are considerably smaller under the reduced-funding scenario.

As important as the economic contributions are, the primary advantages of the program are human and social. Of these advantages, none is more significant than the enhancement of safety. Jobs are replaceable, lives and time are not. With MDOT's Highway Program, Michigan's economic health is improved along with the public's safety and quality of life.

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