Economic Benefits of the Michigan Department of Transportation's 2005–2009 Highway Program

FINAL REPORT

Prepared for

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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 Five-Year Highway Program. Through this program, MDOT makes substantial investments in the highway system throughout the state of Michigan, spending approximately $1.2 billion annually on the preservation, maintenance, and enhancement of the state's road and bridge system.

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 (Economics Department, University of Massachusetts), and 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, or 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 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 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 first such economic impact study commissioned by MDOT, using the most complete information available as well as state-of-the-art research tools.

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.

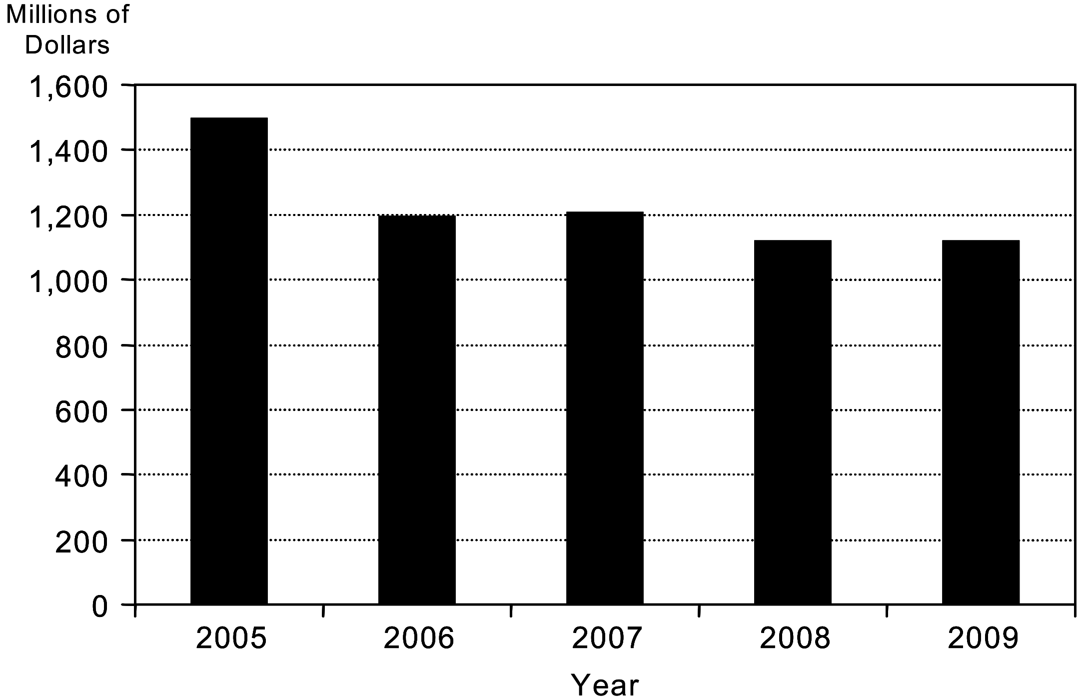
2.1 Mapping MDOT Five-Year Program Expenditures

MDOT provided annual state-level highway program investment data (on a current-year dollar basis) for the interval 2005 through 2009**,** as shown in figure 1. The federal aid revenue estimate used to develop the 2005−2009 Five-Year Highway Program is based on MDOT's share of the fiscal-year 2003 Federal Aid Highway Program, which was $31.6 billion nationally. Due to the lack of a new federal highway bill, MDOT has been working under a series of continuing resolutions to obtain federal funding for Michigan's Highway Program. For planning purposes, fiscal year 2003 is the last full year of federal apportionments available. MDOT has continued to assume a 3.2 percent increase compounded annually over the 2003 levels. Expected federal revenues for Michigan total $3.632 billion over the 2005−2009 Five-Year Highway Program time frame.

The state aid revenue estimate used to develop the program is based on MDOT's share of the fiscal-year 2004 and 2005 Michigan Transportation Fund as estimated by the Department of Treasury, Economic and Revenue Forecasting Division. Future-year state revenue is forecast using a long-range forecasting model.

Annual detail on these investment data pertains to the following funding categories: *repair and rebuild of existing roads, maintenance, bridges, capacity improvements and new roads, safety programs, other,* and *routine maintenance*. For all categories <u>except</u> *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.

Figure 1
MDOT 2005–2009
Highway Program Investment Levels



MDOT also provided guidance on *planning and engineering* activities. For each relevant category, they provided the allocation to planning versus engineering. For both the *planning and engineering* component and the *construction* component, we have information from MDOT regarding the extent that contractors perform category-specific projects versus work performed by MDOT employees. These allocations, shown in table 1, were time-invariant.

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 2.

Table 1
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%

Table 2
Summary of MDOT FY 2004 Construction Contracts
% of Work Performed by Michigan Contractors

	2004 FY Total	% of Total Contracts
Michigan contractors	$932,367,044.40	87
Out-of-state contractors	$133,647,530.68	13
Total	$1,066,014,575.08	100

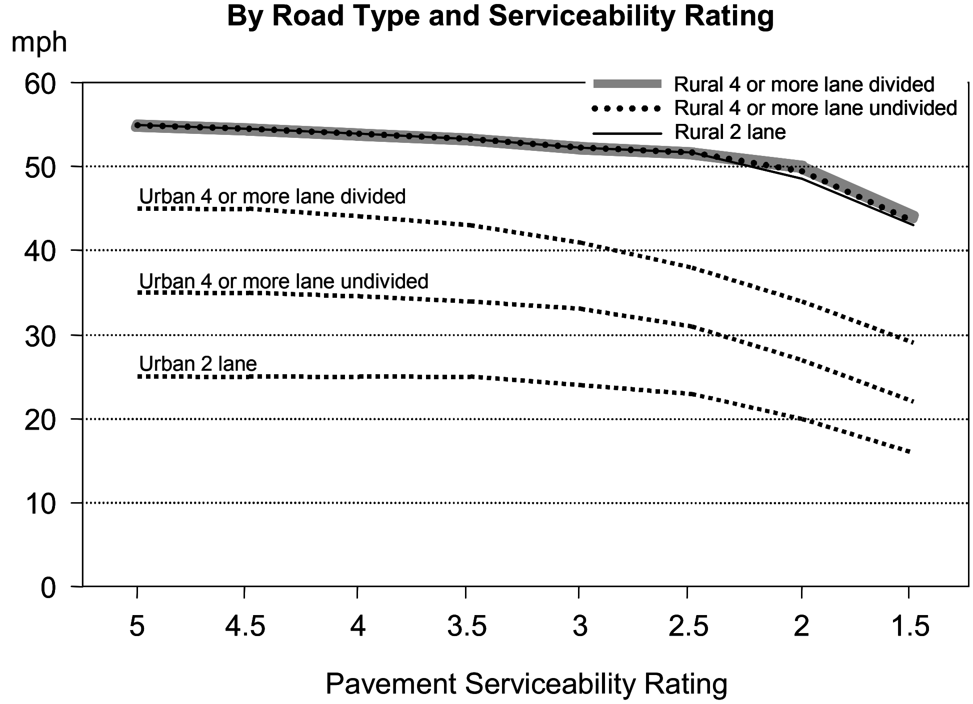
We combine the information on what types of activities are performed and what sectors perform them with the information on how much is directly awarded to businesses in Michigan. We do this to calibrate the program-related expenditures to the values that serve as inputs into the REMI economic model. 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. Very small speed reductions occur with slight worsening of ride-quality, and speed begins to fall off noticeably as ride-quality declines to “poor.” 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 or more m.p.h. may be observed on very poor pavements, but these are unlikely to occur on the state trunkline system.

The relationship between the change in road 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
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 the Five-Year Program. These changes (annual increments, not cumulative) are shown in table 3 and are contrasted against each region's VHT estimates under the existing road conditions (and the implied future deterioration). Details on these calculations are provided in the appendix.

Table 3
Daily Vehicle Hours Traveled (VHT) Savings Expected from Improved Pavement Conditions
(From Projects within MDOT's 2005–2009 Highway Program)

Region	Year	Daily VHT (Representative of existing conditions) For 2005-09 Project Segments Only	Daily VHT (Representative of conditions following pavement reconstruction)	Expected Daily VHT Savings as a Result of Improved Pavement Conditions For 2005-09 Project Segments Only
Bay	2005	10,628.40	9,952.89	675.51
Bay	2006	8,096.68	7,599.27	497.41
Bay	2007	7,880.50	7,326.65	553.85
Bay	2008	9,231.50	8,643.48	588.02
Bay	2009	10,421.48	9,683.26	738.22
			Bay Region 2005-2009 Cumulative Savings:	**3,053.01**
Grand	2005	6,800.41	6,246.74	553.67
Grand	2006	4,745.05	4,441.75	303.30
Grand	2007	7,297.82	6,775.80	522.02
Grand	2008	7,365.82	6,893.16	472.66
Grand	2009	5,998.33	5,553.02	445.31
			Grand Region 2005-2009 Cumulative Savings:	**2,296.96**
Metro	2005	26,495.46	24,389.25	2,106.21
Metro	2006	15,206.30	14,205.33	1,000.97
Metro	2007	24,775.52	23,146.01	1,629.51
Metro	2008	18,732.28	17,295.60	1,436.68
Metro	2009	21,150.49	19,579.23	1,571.26
			Metro Region 2005-2009 Cumulative Savings:	**7,744.63**
North	2005	4,395.43	4,157.57	237.86
North	2006	3,829.10	3,593.08	236.02
North	2007	6,424.06	6,060.42	363.64
North	2008	2,968.94	2,821.10	147.84
North	2009	2,924.86	2,765.20	159.66
			North Region 2005-2009 Cumulative Savings:	**1,145.02**
Southwest	2005	4,772.44	4,499.19	273.25
Southwest	2006	2,742.49	2,565.14	177.35
Southwest	2007	9,579.17	9,000.86	578.31
Southwest	2008	5,927.84	5,582.12	345.72
Southwest	2009	3,236.30	3,032.30	204.00
			Southwest Region 2005-2009 Cumulative Savings:	**1,578.63**
Superior	2005	4,284.87	4,059.70	225.17
Superior	2006	3,686.13	3,499.18	186.95
Superior	2007	5,607.98	5,307.10	300.88
Superior	2008	3,319.30	3,163.77	155.53
Superior	2009	6,573.93	6,249.37	324.56
			Superior Region 2005-2009 Cumulative Savings:	**1,193.09**
University	2005	10,514.43	9,967.69	546.74
University	2006	10,733.08	10,177.92	555.16
University	2007	5,946.43	5,654.04	292.39
University	2008	6,799.30	6,405.57	393.73
University	2009	4,201.62	3,999.57	202.05
			University Region 2005-2009 Cumulative Savings:	**1,990.07**
			Total All Region Savings:	**19,001.41**

Sources: MDOT Statewide Model and MDOT MAPSCORE Database

MDOT provided a region-specific traffic composition table for 2003 (see table 4), which describes the percentage of annual VHT in a region by *commercial* vehicles.

Table 4
Traffic/Vehicle/Trip Composition

Region	Annual VHT 2003	Annual Commercial VHT	% Commercial VHT
Bay	6,773,797,939	529,866,724	7.8%
Grand	5,816,893,153	485,022,629	8.3%
Metro	18,670,038,645	1,180,231,619	6.3%
North	4,181,195,777	332,043,479	7.9%
Southwest	5,932,884,337	961,165,340	16.2%
Superior	2,219,913,373	205,374,168	9.3%
University	9,846,915,418	1,161,436,917	11.8%

Combining the region-specific traffic composition with the information in table 3, summing over all MDOT regions, we were able to estimate VHT saved for both *commercial* and *auto* categories. Table 4A shows how these VHT savings accumulate over time.

Table 4A
Cumulative Annual VHT Savings, 2005–09

Year	Commercial	Auto
2005	–253,641	–2,904,748
2006	–347,711	–3,890,041
2007	–484,496	–5,301,075
2008	–595,750	–6,481,987
2009	–702,984	–7,705,200

This annual series of VHT saved must be allocated appropriately (and valued) before measuring the added economic benefit to Michigan businesses and households. Table 4B presents the 2005 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.

Table 4B
Annual Trips in Michigan, 2005

	Commercial	Auto
Total number of trips	23,991,343	10,749,413,155
<u>Origin-destination</u>		
Michigan to Michigan	45.97%	98.73%
Michigan to/from other states	44.52%	1.26%
Thru-trips	9.51%	0.01%

Auto Trip—Purpose

Commute	Non-home-based to work	Personal
22.94%	4.78%	72.28%

In addition, for *autos*, table 4B 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*[1] 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 local content. 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[2]) are processed through the model to simulate the effect on the Michigan economy of travel-time savings for business.

[1]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 <u>plus</u> fringe/overhead costs.
[2]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).

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 (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.[3]

The industries encompassed in category (1) are those captured by MDOT's Commodity Flow Data from Reebie Associates (2002). For the same *origin-destination* pairings (and an adjustment for Canadian thru-trips), Reebie data describe, for the year 2000 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 Standard Industrial Classification (SIC) industry categories. For each industry implicitly represented in the Michigan Reebie data, the truck share for 2000 is used to allocate Michigan commercial vehicle savings for each year. The industries encompassed in category (2) focus on services with *on-the-clock* requirements, and all private-sector industries 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.[4] 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 q*uality of life* (non-pecuniary amenity) policy variable.

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[3]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.
[4]For this calculation, the insurance industry is included in services.

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 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 over the past two 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 2005–2009 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. With the cooperation of the Michigan Department of Labor & Economic Growth (MDLEG), 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. A predecessor to MDLEG carried out a special study to identify those industries that would in some part constitute tourism under the Standard Industrial Classification system (Michigan Employment Security Commission 1980). We were able to take that industry list, 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 (these portions are identified in the note at the bottom of table 6).

3. Results

3.1 Travel-time Savings Related to Program Improvements

Implementation of the projects within MDOT's Highway Program is estimated to provide Michigan with the following travel-time savings over the period 2005–2009 (all values are stated in inflation-adjusted 2004 dollars):

(1) Automobiles realize the greatest travel-time savings; 98 percent are trips fully contained within Michigan. The balance are with an origin or destination in Michigan. About 23 percent of these savings are related to trips between home and work, with another 5 percent being non-home-based work-related trips (*on-the-clock* or OTC). The balance of the automobile trips are non-work-related (or personal).

(2) Michigan households realize travel-time savings worth \$21.7 million (2005) to \$57.6 million (2009) per year, using the standard of valuing an hour of an individual's time at one-half the wage of \$18, or \$9 (U.S. Department of Transportation 1997).[5] The

[5]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.

2009 savings are reflective of one hour saved annually per adult in Michigan. This considers time saved for commuting as well as personal trips.

(3) Michigan businesses share part of the savings associated with employees' commute times, and the full amount of the OTC. These are worth between $4.2 million (2005) and $11 million (2009) per year.

(4) Michigan businesses reap savings related to their commercial vehicle time-savings. The standard used here is $50 per hour in vehicle operating costs.[6] These savings would be between $8.7 million (2005) and $24 million (2009) per year.

(5) Combining (3) and (4), Michigan businesses are set to save between $12 million (2005) and $35 million (2009) per year.

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 2005–2009 as a consequence of not funding the activities. The underlying projection of state government employment represents a slower growth in staffing than would be needed for the program. The results reflect the total effect of the program, including the spin-off effects from program activity. The aggregate economic effects are represented in table 5 by employment, population, number of unemployed, labor force, value of shipments (sales), Gross State Product, and categories of personal income.[7] The

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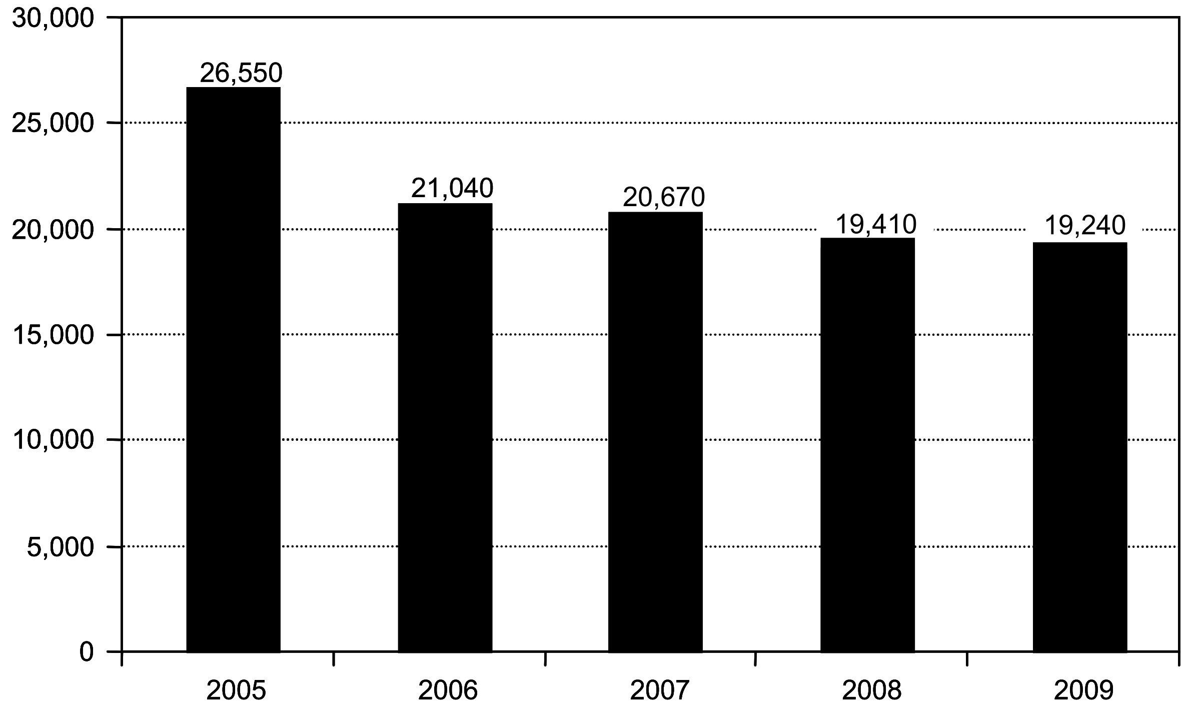
[6]Multi-region annual study by Transport Canada (2000), published value for 2000 U.S. Great Lakes region, $42.46 U.S., updated to 2004 using data published by the U.S. Department of Energy, Energy Information Administration, on diesel prices; and annual wage growth documented in a study by the Wyoming Department of Employment, Planning and Research section (2001), contrasting national trends.
[7]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.

industry effects presented in table 6 focus on employment. The results are shown annually for the duration of the program.

In 2005, MDOT plans to spend $1,496,090,000 on the program, as shown previously in figure 1. MDOT's expenditures decline over the subsequent years of the plan so that by 2009, they total only $1,118,710,000 in current-year dollars. Adjusted for inflation, expenditures decline more rapidly, from $1,470,864,000 (2004 dollars) in 2005 to $1,027,401,000 in 2009.

As shown in figure 3, the program is forecast to generate 26,550 jobs in Michigan in 2005. The employment impact declines over time, reaching 19,240 in 2009.[8] Expenditures per job in 2005 amount to $55,400 (2004 dollars), declining to $53,400 in 2009. The decline in this ratio reflects the fact that the economic benefits of the

Figure 3
Effect on Employment of MDOT's Five-Year Highway Program
2005–2009



[8]Note that the job gains are not cumulative; that is, the job gains in 2005 and 2006 are not added to the gains in 2007 to determine the total job gain in 2007. The only cumulative results shown are the monetary values reported in the final column of table 5, and in figures 4 and 5.

program cumulate over time. Indeed, the benefits that accrue to the state from the Five-Year Highway Program extend beyond 2009, outside of our period of analysis.

Several other metrics gauging the economic benefits of MDOT's expenditures are shown in table 5. During 2005–2009, under the base case, Michigan is forecast to see a continued outmigration of residents. MDOT's expenditures are projected to reduce the number of residents leaving the state by 5,454 in 2005 and 1,775 in 2009 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 the baseline forecast, 5,586 higher in 2005 and 16,110 higher by 2009.

Table 5
Economic Benefits of MDOT's Five-Year Highway Program
2005–2009
(Changes compared with baseline forecast)

	2005	2006	2007	2008	2009	Total 2005-09
Total employment	26,550	21,040	20,670	19,410	19,240	–
Population	5,586	8,914	11,770	14,050	16,110	–
Reduction in outmigration	5,454	3,165	2,639	2,030	1,775	–
Number unemployed	–20,992	–13,106	–10,906	–8,450	–7,310	–
Labor force	5,558	7,934	9,764	10,960	11,930	–
Value of shipments (millions '04 $)	2,664	2,126	2,097	2,015	2,024	10,926
Gross State Product (millions '04 $)	1,539	1,247	1,250	1,201	1,214	6,451
Real personal income (millions '04 $)	954	781	810	797	826	4,168
Labor & proprietors' income (millions $)	1,089	886	899	870	892	4,636
Less: Social insurance taxes (millions $)	64	51	52	50	51	268
Plus: Non-labor income (millions $)	-68	-21	5	32	54	2
Equals: Total personal income (millions $)	957	814	852	852	895	4,370

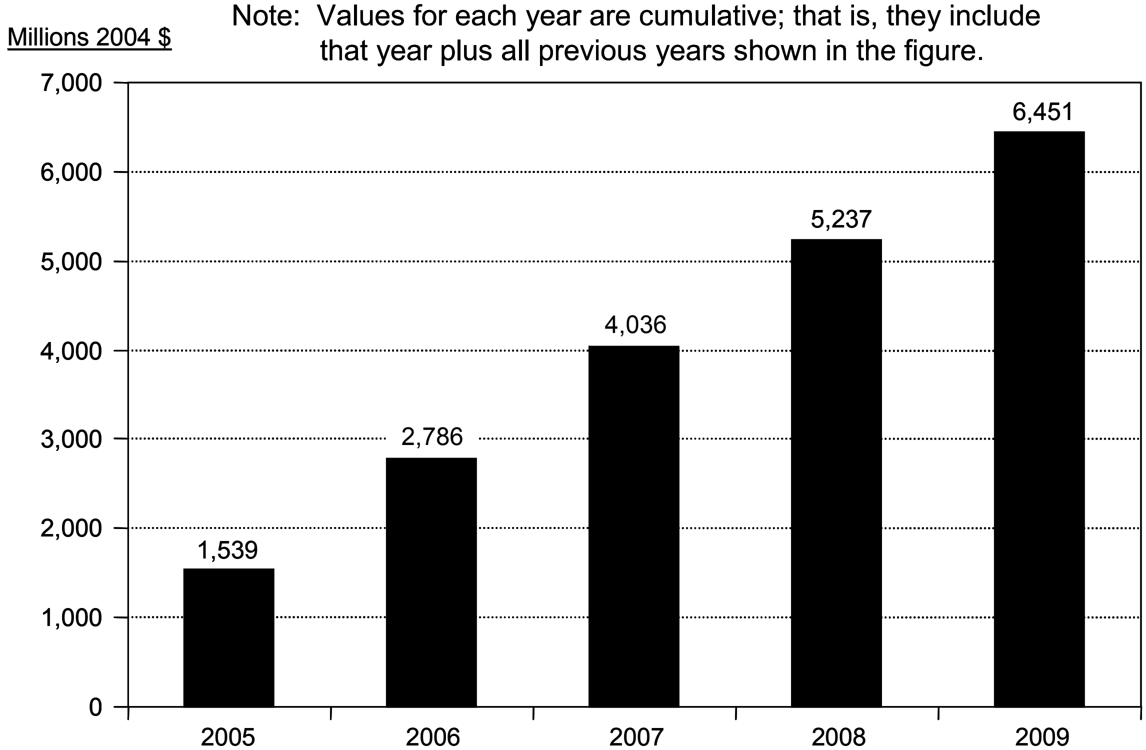
Source: REMI model version 5.5; includes amenity effect, household time savings valued at $9.00 (approximately 1/2 the hourly wage rate).

The impact of the program is to reduce the number of unemployed workers by almost 21,000 in 2005 and by about 7,300 in 2009 compared with the base case. The labor force is also greater and growing over time, mostly because outmigration of the working-age population has been reduced. The total value of shipments is greater by

$2.664 billion (2004 dollars) in 2005, while the real Gross State Product (GSP) is increased by $1.539 billion.[9] As shown in figure 4, the real GSP benefits cumulate from 2005 to 2009, to $6.451 billion. A portion of the value-added, or GSP, benefits becomes personal income tied to the additional jobs created.

Figure 4
Cumulative Effect on Real Gross State Product of MDOT's Five-Year Highway Program, 2005–2009

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

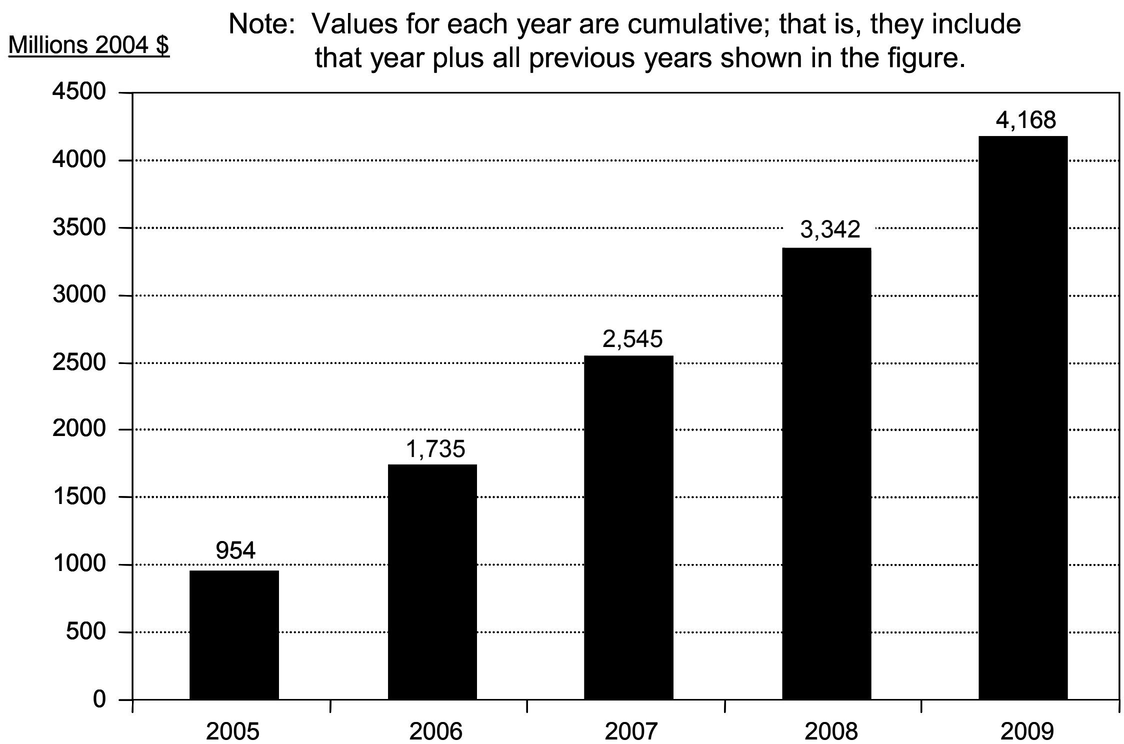


As shown in table 5, real personal income (2004 dollars) is increased by $954 million in 2005, and by $826 million in 2009. This moderation in real income benefits over the time period (–13.4 percent) is not as pronounced as the moderation in employment benefits (–27.5 percent) or real expenditures (–30.1 percent) over the same period. The smaller moderation in income effects over time reflects two factors: (1) a decline in unemployment and welfare payments results in a negative contribution from non-labor income for 2005, but by 2009, this negative contribution is more than offset by an

[9]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.

increase in dividend, interest, and rental income, resulting in a positive contribution; and (2) the economic contribution of a better transportation network cumulates over time, and will extend beyond the time period examined in this report. As shown in figure 5, the real income benefits cumulate from 2005 to 2009, to $4.168 billion.

Figure 5
Cumulative Effect on Real Income of MDOT's Five-Year Highway Program
2005–2009



The employment benefits of MDOT's Five-Year Highway Program are distributed across major industry divisions and years in table 6. Again, the estimates represent direct and spin-off employment, and the totals for each year duplicate the total employment effect reported in table 5. As shown in the table, 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 6

Employment Benefits of MDOT's Five-Year Highway Program By Industry, 2005–2009

(Changes compared with baseline forecast)

Industry	2005	2006	2007	2008	2009
Total employment	26,550	21,040	20,670	19,410	19,240
Manufacturing	1,012	810	796	771	775
Out-of-state tourism	295	228	225	213	213
Nonmanufacturing exc. tourism	25,243	20,002	19,649	18,426	18,252
Construction	9,881	7,807	7,396	7,006	6,818
Professional services	4,693	3,535	3,442	3,112	3,052
Business services	1,270	995	986	940	948
Trucking	137	110	109	107	109
Other	9,262	7,555	7,716	7,261	7,325

Note: Out-of-state tourism consists of air transportation (54.5%), hotels (65.6%), recreation (11.4%), eating and drinking (8.0%), other retail (5.0%), and auto repair (2.9%).

MDOT's focus industries, the manufacturing and out-of-state tourism sectors, make up almost 20 percent of Michigan's economy. In addition to contributing over a million jobs, 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. The Highway Program creates 1,012 jobs in manufacturing in 2005, and 295 jobs in out-of-state tourism.

For context, the total number of jobs attributable to the program in 2005 amounts to about half a percent of total employment in the state. None of these estimates include the nonmeasurable 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 fatal and non-fatal 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.

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 Five-Year Highway Program, using the most complete information available as well as state-of-the-art research tools.

We find that Michigan households realize travel-time savings worth $21.7 million to $57.6 million per year between 2005 and 2009, and Michigan businesses save between $12 million and $35 million per year. These time savings, combined with program expenditures on construction and engineering projects, result in economic benefits accruing to Michigan. In 2005, there are 26,550 jobs created in Michigan due to the program, $1.5 billion in Gross State Product (GSP) is generated, and $954 million in personal income is produced (the latter two measures stated in inflation-adjusted 2004 dollars). Over the duration of the program, from 2005 to 2009, the inflation-adjusted GSP benefits cumulate to $6.5 billion, and real personal income benefits sum to $4.2 billion.

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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APPENDIX

Economic Benefits Analysis Assumptions Memo

Michigan Department of Transportation

OFFICE MEMORANDUM

TO: Project File

FROM: Matt Webb, Special Projects Coordinator
Bureau of Transportation Planning, Project Planning Section

SUBJECT: Economic Benefits Analysis Assumptions Memo

DATE: January 10, 2005

The following memorandum documents data inputs and assumptions used by the University of Michigan's Institute of Labor and Industrial Relations and the Economic Development Research Group to assess the economic benefits of the Michigan Department of Transportation's (MDOT) Five-Year Highway Program.

Capturing Vehicle Hours of Travel and Vehicle Miles Traveled Associated with Improved Capacity and New Roads (IC/NR) Projects

Two key factors were used as a basis to assess the economic impacts associated with MDOT's Five-Year Highway Program. These two factors were the number of vehicle hours traveled (VHT) and vehicle miles traveled (VMT) on MDOT's trunkline system. Using its statewide model, MDOT assessed the changes in VMT and VHT associated with corridor projects within the IC/NR template. VMT and VHT changes were assessed over the model network system as a whole. For example, two representative projects identified as adding capacity to MDOT's trunkline system were the M-6 freeway in the Grand region and the M-24 corridor widening project in the Bay region. The VMT and VHT changes for these representative projects are:

M-6 Impacts: With construction of the M-6 freeway, VMT increases by 31,296 miles a day (777,343,258 with M-6 compared with 777,311,962 without M-6). The VHT goes down by 1,686 hours a day as a result of the construction of the M-6 freeway (14,074,903 with M-6 construction compared with 14,076,589 without constructing M-6).

M-24 Impacts: Widening M-24 to a four-lane boulevard improves free-flow speeds along the corridor by almost 10 m.p.h. (from 45 m.p.h. to 55 m.p.h.). This increase in speed results in a VHT reduction of 386 hours a day (from 2,373 hours a day prior to the improvement to 1,987 hours following the improvement).

VHT and VMT changes associated with projects that add capacity to existing interchanges were not included in this assessment, as MDOT's statewide travel demand model lacks the network detail needed for this type of analysis.

Vehicle Hours of Travel Delay Associated with Poor Pavement Conditions

Capturing travel-time savings associated with preservation projects such as those within MDOT's Repair and Rebuild (R&R) template are much harder to quantify. One such method to quantify expected savings associated with preservation projects is to assess the changes in VHT that are the result of improved ride-quality conditions. Limited research is available correlating 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). As illustrated in figure 2, very small speed reductions occur with slight worsening of ride-quality. Speed begins to fall off noticeably as ride-quality declines to "poor." Pavements that are in an extreme deteriorated condition require vehicles to slow considerably to reduce the impacts of roadway surface.

For the purposes of the economic benefits analysis, MDOT estimated that speeds on free-access roads fall 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 or more m.p.h. may be observed on very poor pavements, but these are unlikely to occur on the state trunkline system.

Using results from MDOT's MAPSCORE database, MDOT identified the surface condition rating for each programmed project within the 2005–2009 Five-Year Highway Program. In accordance with Federal Highway Administration (FHWA) recommendations (Present Serviceability Ratings as outlined in the Road Information Program's April 2004 report, "Bumpy Roads Ahead: Cities with the Roughest Rides and Strategies to Make Our Roads Smoother"), MDOT assigned a "poor" rating to all roadways with a surface condition score of 3.0 or less. Once these projects were identified, MDOT, using its statewide travel demand model, reduced the free-flow speeds along all corridors that had a surface condition rating of 3.0 or less and an R&R project scheduled within the 2005–2009 Five-Year Highway Program. Free-flow speeds were reduced based on the facility type, as previously discussed.

The reductions identified in VHT associated with poor ride-quality were used as the baseline no-action alternative for MDOT's trunkline system. Assuming an R&R project was implemented between 2005 and 2009, MDOT identified the differences between the VHT at free-flow speed (post-construction) and the VHT at reduced speeds associated with poor ride-quality. The resulting difference in VHT represents the savings in VHT associated with MDOT's R&R program.

Sources

The sources for the speed delays estimate for free-access urban and rural trunklines are McFarland, W. F., "Benefit Analysis for Pavement Design Systems: Report No. 123–13," Texas Transportation Institute, Texas A&M University and the Center for Highway Research, University of Texas at Austin, April 1972; and Zaniewski, J. P., "Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors - Final Report," FHWA, June 1982.

The source for the speed delays estimate for freeways is observations by the staff of MDOT's Detroit freeway operations center (now MITS Center) during resurfacing of I-94 in Detroit, in which significant improvements in free-flow speed followed resurfacing of severely deteriorated pavements. These observations were not recorded or researched, but were felt to be reliable. Furthermore, they were associated with delays in the onset of breakdown of traffic flow.

The information on FHWA's guidelines in assessing poor pavement quality is taken from the Road Information Program's "Bumpy Roads Ahead: Cities with the Roughest Rides and Strategies to Make our Roads Smoother," April 2004.