Table of Contents

Executive Summary 2

I. Introduction 4
- **A. Issues** 4
- **B. Methods** 5

II. Findings 6
- **A. State Demographic and Traffic Trends** 6
- **B. Condition and Needs** 8
  - **1. Pavement Repairs** 9
  - **2. Bridge Repairs** 15
  - **3. Capacity-Related Widening** 17
  - **4. Narrow Lanes** 21
  - **5. Narrow Shoulders** 23
  - **6. Physical Maintenance and Operations** 25
  - **7. Winter Maintenance** 26
  - **8. Roadside Maintenance** 27
  - **9. Signals and Other Lighting** 31
  - **10. New Roads, Expansions, Major Bridges and Interchanges** 33
  - **11. Other Needs** 35
  - **12. Administration** 36
  - **13. Total Needs** 37
- **C. Resources Available** 39
  - **1. Federal Funds** 39
  - **2. State and Local Funds** 41
- **D. Gap Between Resources and Needs** 43

III. Discussion 44

Appendices 47
- **County Data** 47
- **Technical Notes and Supporting Tables** 49
- **Acknowledgements** 67
- **About the Authors** 67
- **Endnotes** 68

Executive Summary

Wisconsin has about 114,800 miles of roads, of which about 11,800 constitute the State Highway System. This study assesses the condition and 10-year needs of Wisconsin's State Highway System. It estimates the costs of addressing deficiencies, adding new or expanded facilities, bringing the system up to prudent standards, maintenance and administration. The report then estimates the resources likely to be available for system repair, maintenance and improvement, and the likely gap between resources and needs. It does not cover the needs of localities (counties, towns, municipalities) or needs of other modes, which also have substantial needs that may exceed their resources.

Wisconsin's recent population growth has been slower than the national average, but the state is expected to grow modestly, about 5%, over the next decade. Vehicle registrations and motor vehicle travel are expected to grow at similar but slowing rates. However, given the likely increases in fuel efficiency, motor fuel use is likely to fall, reducing state motor fuel tax revenue.

Wisconsin's State Highway System is similar in overall condition to the U.S. average, but the higher road classes (Interstates, urban freeways and other principal arterials) are in better shape than minor arterials and collectors. Progress has been made in improving the system, and many elements are in better shape than in the past. However, significant portions of the system are in need of repair, replacement, expansion or modernization. About 57% of pavements are judged to potentially require treatment, 52% of bridges need repair, 333 miles need congestion-related widening, and 809 miles of new roads and expansions have also been identified.

The total estimated prudent need for the Wisconsin State Highway System over 10 years is about $28.56 B. This estimate would address most but not all of the repair needs and allow for some system expansion. Highway rehabilitation needs are estimated at about $9.25 B, of which pavement repair, $8.18 B, is the largest part. The need for capacity-related widening and new roads totals about $13.93 B. Maintenance and other improvements total about $3.57 B, and administration totals about $1.81 B. If the proposed widening of I-43 and I-94 in Milwaukee were subtracted, prudent needs would total about $28.15 B.

Fiscal resources likely to be available over the same period are estimated at about $18.63 B. This includes about $5.82 B in federal funds, $11.58 B in state funds and services, $43 M in local contributions, and $1.19 B in bonding. These estimates are summarized in Table ES1.

The estimated gap between likely resources and prudent needs is about $9.93 B, or about $993 M/year on average. (If I-43 and I-94 in Milwaukee were not widened, the gap between resources and prudent needs would be about $952/year). Further, the analysis shows an increasing shortfall compared to earlier studies – i.e. a $242 M per-year gap estimated in 2000 and a $698 M per-year gap estimated in 2006. However, if fuel-related resources decline sharply, this gap could be even greater. But even if all major new projects were deferred, or if all capacity-related widening were deferred, a gap of between $2.1 B and $3.8 B would still remain in meeting the needs for prudent pavement and bridge repairs, maintenance, signals, shoulders and other actions. In short, Wisconsin's 10-year likely resources for the State Highway System appear to cover only about 65% of its 10-year prudent needs. Since the magnitude of the shortfall appears to be growing, serious attention by elected and appointed officials to this issue is timely.

The increasing trend in the magnitude of the shortfall should be cause for concern, and obviously a gap of this magnitude will be difficult to close. This report briefly discusses general options for bringing needs into line with resources. This report does not assess various specific mechanisms for addressing this issue, but by highlighting the magnitude of the problem it hopes to focus discussion on it.

Table ES 1: Summary of Resources and Needs, Wisconsin State Highway System, 2011-2020

Resources, $M, 2011-20		**Needs$M, 2011-20**	
		Highway Rehabilitation	**$9,249**
Federal Funds	**$5,816**	*Pavement Repair*	*$8,175*
State Funds and Services	**$11,582**	*Bridge Repair*	*$678*
Local Funds	**$43**	*Narrow Lanes*	*$362*
Bonding/Debt Service	**$1,189**	*Narrow Shoulders*	$34
		Capacity and Expansion	**$13,931**
		New Roads and Expansions	*$7,776*
		Capacity-related Widening	*$6,154**
		Maintenance and Other	**$3,570**
		Physical Maintenance/Ops	*$1,574*
		Roadside Maintenance	*$685*
		Winter Operations	*$662*
		Signals and Lighting	*$335*
		Other Needs	*$314*
		Administration	**$1,811**
Total	**$18,630**	**Total**	**$28,560***
		**Total less I 43 Mitchell-Silver Spring and I 94 Marquette-Zoo, Milwaukee*	*$28,147**
Gap $9,930		**Gap/year $993 M**	
Gap $9,517*		*Gap*/year $952 M*	

I. Introduction

A. Issues

The Wisconsin State Highway System, about 11,800 miles in length, is the state's primary system for providing residents, businesses, and visitors with access and mobility. The system is a key element in the state's economic progress and must be maintained adequately and expanded prudently. The Wisconsin Department of Transportation (WisDOT) has taken the lead in planning and implementing improvements. The 1994 TransLinks21 study documented the state's growth and the need for sound planning and for needs estimation that's tied to traffic forecasts[1]. In 2000, the 2020 State Highway Plan estimated 21-year needs for the system to be $21.4 billion, against projected revenues of $15.3 billion, for a projected gap of $6.1 billion or about $290 million annually.[2] A 2003 study[3] estimated the cost of repairing and expanding the southeastern Wisconsin freeway system at about $6.2 billion in 2000 dollars, which would undoubtedly be higher today. In 2006, a review of system needs by the Wisconsin Legislature[4] estimated an annual need of $2.408 billion versus revenues of $1.709 billion, for an annual gap of $698 million. However, since 2006 significant economic and technological changes have altered both needs and revenues. Although the system is in generally moderate shape compared to other states, maintenance and repair needs are increasing, congestion and safety remain issues, and revenue sources are flattening.

Table 1 shows comparative state highway system statistics for Wisconsin and neighboring states.[5] The system is slightly smaller than the average state's, as is the budget. Wisconsin spends about the same, per mile of responsibility, as the U.S. average. The state has considerably less money to work with per mile than either Michigan or Illinois but more than Minnesota or Iowa. And the state spends considerably less than its neighbors on road maintenance. The state's percentage of poor mileage is relatively high compared to the U.S. averages, but is similar to that of surrounding states. Overall, Wisconsin is rated 28th nationwide for system cost-effectiveness, better than its neighbors except Minnesota, which is 25th.

Table 1: Highway Performance for Wisconsin and Nearby States

	Statistic (Rank), 2008					
Item	**Wisconsin**	**Michigan**	**Minnesota**	**Iowa**	**Illinois**	**U.S. Avg.**
Miles Under State Control*	**11,839 (22)**	9,688 (30)	12,905 (19)	9,444 (31)	16,747 (13)	**16,312**
Disbursements for State-Admin Roads, $B	**$1.802 (30)**	$2.218 (35)	$1.669 (29)	$0.878 (15)	$5.538 (45)	**$2.378**
Capital/Bridge Disbursements per mile	**$95,479 (35)**	$134,657 (37)	$73,249 (25)	$55,713 (18)	$177,347 (45)	**$77,130**
Maintenance Disbursements per mile	**$19,196 (21)**	$31,145 (37)	$31,434 (38)	$19,663 (23)	$44,360 (41)	**$22,937**
Rural Interstate Percent Poor , rank	**44th**	42nd	45th	38th	1st (tie)	**1.93 %**
Urban Interstate Percent Poor, rank	**41st**	38th	5th	43rd	35th	**5.37%**
Rural Other Principal Arterial Percent Poor, rank	**23rd**	14th	13th	46th	40th	**0.53%**
Bridges, Percent Deficient, rank	**6th**	28th	3rd	34th	9th	**23.7 %**
Urban Interstate Percent Congested,** rank	**27th**	47th	49th	19th	25th	**48.6 %**
Fatal Accident Rate, rank	**14th**	8th	2nd	28th	9th	**1.25**
Rural Principal Arterials Pct Narrow Lanes, rank	**12th**	37th	27th	17th	36th	**9.6 %**
Overall Cost-Effectiveness, rank	**28th**	35th	25th	31st	40th	**--**

Data source: FHWA, Highway Statistics, various tables, 2008

* State owned roads include the state highway system and other small systems (parks, etc)

** In this table, Wisconsin Urban Interstate congestion data is for 2006.

Given the accumulating evidence that significant portions of the State Highway System are in need of repair or upgrade, attention to the road system is prudent. The Wisconsin Policy

Research Institute has recognized these issues and has commissioned an updated assessment of highway needs[6] that can help the state set its transportation priorities.

The purpose of this report is to develop an overall assessment of the condition and major deficiencies in the Wisconsin State Highway System, and to estimate the cost to bring most deficiencies up to prudent standards over the next 10 years, through 2020. The report also looks at the resources likely to be available to accomplish this task. The ultimate goal of the analysis is to assist decision-makers in setting priorities for work and identifying options for financing system maintenance and improvements.

The report does not look at *local* road needs, which may be an equally important issue since the local road system is more extensive and likely in worse shape than the state system. Nor does it review needs for other modes, including transit, pedestrians, bicycles, or other non-highway modes. These are important additional considerations that affect state highway funding, but they are beyond the study scope.

B. Method

The study uses state and federal highway and bridge data to estimate elements with various major deficiencies (pavement, bridge, congestion, safety, shoulders, lane width, signals, etc) and the cost to meet them. Costs of work were also obtained from current construction cost estimates, primarily the Wisconsin four-year State Transportation Improvement Program (STIP),[7] and from other WisDOT information. Other needs (e.g. road maintenance, winter maintenance, signs and signals, rural road widening and new corridors, and administration) are also reviewed. Revenue trends are used to make forecasts of revenue from various sources, adding possible federal actions. Comparing needs and revenues, estimates of the 'gap' are then made. The study does not review specific alternative revenue sources, and given limited resources for this analysis, no section-based forecasts of need are made. However we do prepare summaries by region of the state and by county where the data permits. A summary of road statistics by county is provided in the appendix.

The analysis uses the most recently available information on road conditions, along with current estimates of unit cost and recommended work, to estimate total costs to repair and improve the system. The source of most of this information is data from the Wisconsin Department of Transportation and the long-range plans of the state's urbanized areas. The appendix to this report provides additional notes on the methods used and several supporting tables. More detailed information is available from the authors on request.

This analysis is not intended as a comprehensive section-by-section assessment of Wisconsin highway needs. Instead, it should be viewed as a high-level assessment, based on simplified methods intended to provide an overview of the prudent needs of the State Highway System and likely resources over the next decade. More detailed assessments of the system and individual projects are regularly performed to sharpen the cost and resource estimates.

II. Findings

A. State Demographic and Traffic Trends

Between 2000 and 2008, Wisconsin's population grew modestly at 4.9%, about half the U.S. rate. During that same time, licensed drivers increased by about 8%, vehicle registrations increased by about 14%, and fuel use increased by about 3%. But travel actually increased only 0.3%, perhaps reflecting a decline during the recession.[8] Forecasts of continued modest population growth put the 2020 estimated population at about 5.94 million, about 11% above 2000. Given the increasing saturation of drivers' licenses and travel, we forecast these statistics will move in parallel with population.

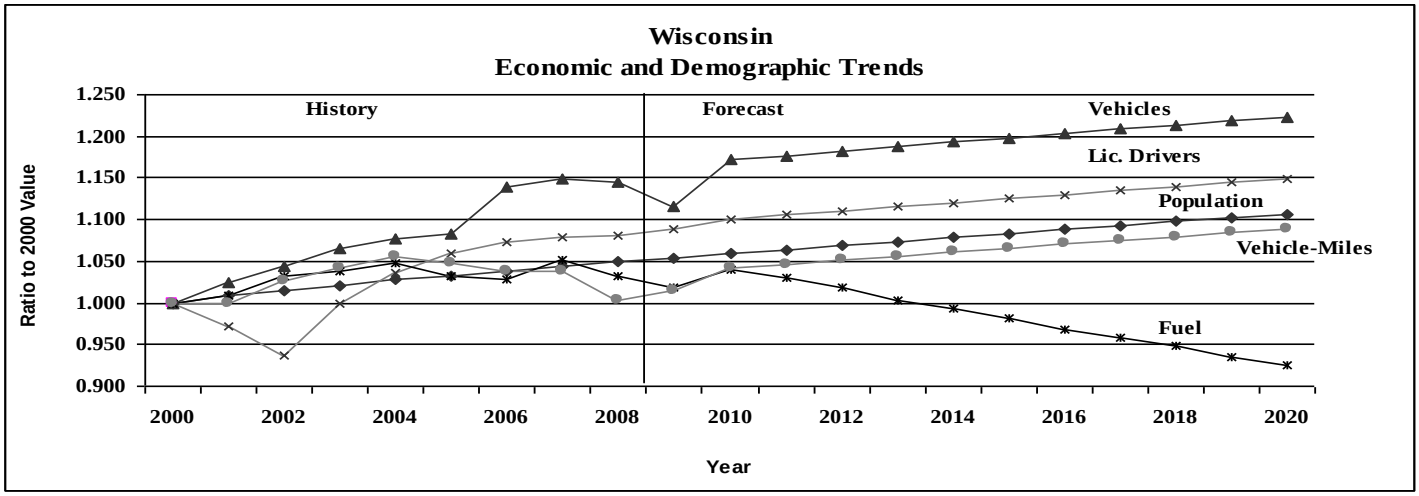
Table 2: Demographic and Travel Related Statistics for Wisconsin

	Historical					Forecast						Percent Change		
	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2000-08	2008-20	2000-20
Population (millions)	5.36	5.45	5.51	5.57	5.63	5.68	5.73	5.79	5.84	5.89	5.94	4.92	5.48	10.67
Employment (millions)	2.85	2.84	2.81	2.87	2.88	2.72	2.81	2.88	2.94	3.00	3.07	0.84	6.59	7.49
Gross state product (billions of dollars)	177.6	190.2	209.3	229.1	241.2							35.77		
Vehicle registrations (millions)	4.37	4.56	4.71	4.97	5.00	5.11	5.16	5.21	5.25	5.30	5.34	14.51	6.87	22.37
Licensed drivers (millions)	3.77	3.53	3.91	4.05	4.08	4.15	4.19	4.22	4.26	4.30	4.33	8.10	6.31	14.92
Fuel use (billions of gallons)	3.06	3.16	3.21	3.15	3.16	3.18	3.12	3.04	2.96	2.90	2.83	3.18	-10.31	-7.45
Vehicle-miles (billions)	57.27	58.75	60.40	59.40	57.46	59.65	60.21	60.76	61.30	61.82	62.33	0.34	8.47	8.83

Source: Federal Highway Administration, Highway Statistics, 2000-08, and U.S. Census 2010. Data submitted by the states. Forecasts by the Hartgen Group.

However, recent federal legislation calling for more fuel efficient cars and trucks is likely to more than offset slowly rising travel, so fuel consumption is projected to decline by 2020, to about 8% less than in 2000. This means that fuel-based state revenues such as per-gallon gasoline and diesel tax revenues are also likely to decline, perhaps by as much as 8% from 2000 to 2020.

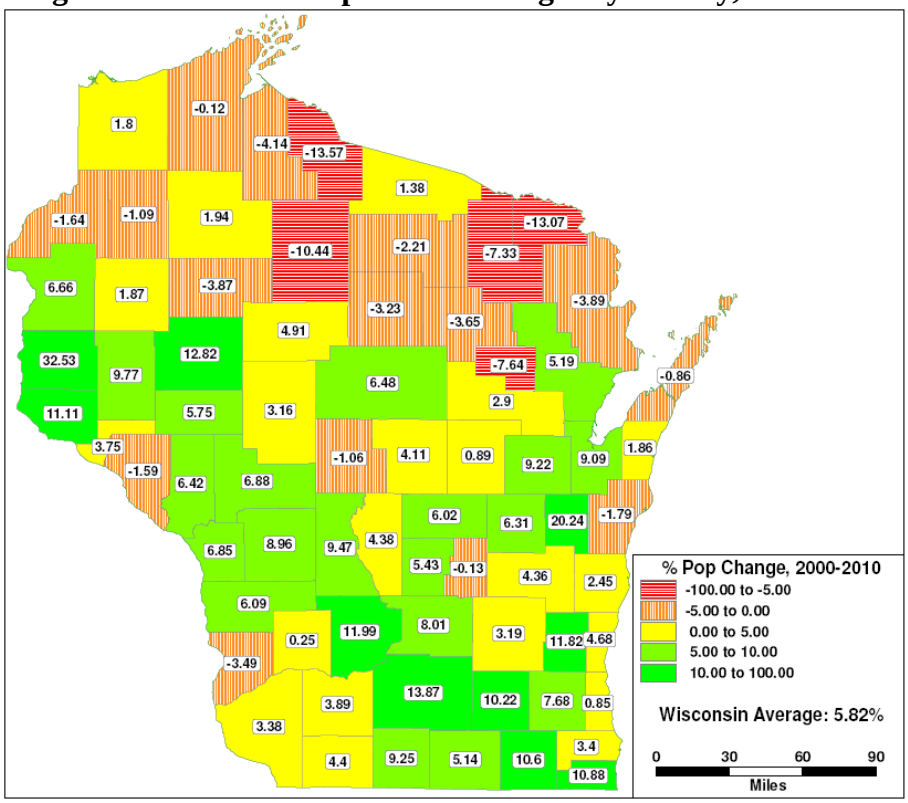
Figure 1: Economic and Demographic Trends, 2000-2020.



Population changes have not been uniform throughout the state. Typically, urbanized areas have grown more rapidly while rural area populations have exhibited slower growth. Figure 2 shows generally faster growth rates in the metropolitan counties and their nearby

suburbs. Counties near to two other major metropolitan areas, Chicago and Minneapolis, also exhibit stronger growth. The most rapidly growing counties are St. Croix, Dane, Kenosha, and Washington. Growth has been considerably slower in rural areas, with a number of counties showing declining populations and a few counties in northern Wisconsin declining by more than 5%.

Figure 2: Wisconsin Population Changes by County, 2000-2010



Source: U.S. Census.

Table 3: Wisconsin Urbanized Area Traffic[9] Growth, 2000-2008

	Daily Vehicle-Miles of Travel (thousands)*		
Urbanized Area	**2000**	**2008**	**% Change**
Milwaukee	31888	32353	1
Madison	6029	8093	34
Green Bay	4509	5113	13
Appleton	3916	4951	26
Duluth-Superior	2703	2907	8
Eau Claire	2136	2699	26
La Crosse	1875	2582	38
Racine	1763	1804	2
Kenosha	1735	2156	24
Wausau	1511	1947	29
Oshkosh	1149	1537	34
Sheboygan	1006	1091	8
Totals	**60220**	**67233**	**12**

*Source: Federal Highway Administration, Highway Statistics, 2000 and 2008.

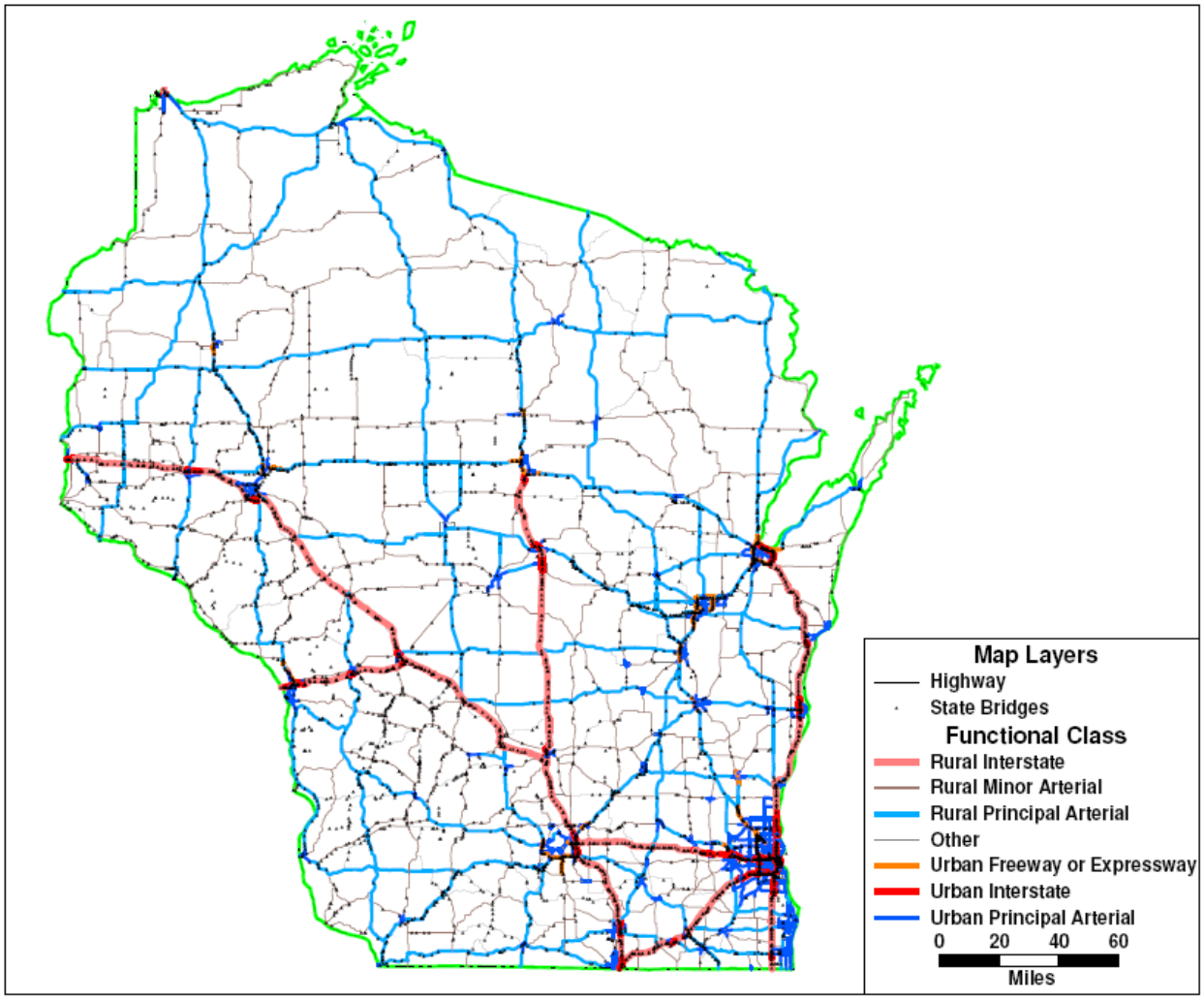
Comparing the metropolitan areas of the state, Table 3 shows that even within some slower-growing counties, metropolitan regions have exhibited more rapid growth but have also grown at varying rates. Milwaukee, the largest, has also shown the slowest growth. But several smaller regions (Madison, La Crosse and Oshkosh) have shown growth rates of over 30%

between 2000 and 2008. The causes include expanding urbanized area borders, but these nevertheless indicate the shifting locations of population growth between the metropolitan counties.

B. Condition and Needs

Wisconsin has about 114,843 centerline miles of road, of which the Wisconsin State Highway System consists of about 11,770 centerline miles (14,412 "roadway" miles[10]). Table 4 summarizes the state's road mileage and the State Highway System (SHS). Although the interstate system consists of only 743 centerline miles, it carries nearly half of the SHS traffic, and about 18% of all state traffic.[11]

Figure 3: Wisconsin Major Highways by Functional Class



Source: TransCAD Highway File and 2009 National Bridge Inventory.

Table 4: Wisconsin State Highway Agency Mileage

	Mileage by Jurisdiction	Centerline Miles	Percent
	State Highway Agency	**11,770**	**10.24**
	County	20,716	18.04
	Municipality	81,449	70.92
	Federal and other	908	0.80
	Total	**114,843**	**100.00**
State Highway Agency Mileage by Functional Class			
Urban or Rural	**Functional Class**	**Centerline Miles**	**Percent**
Rural	Rural Interstate	478	4.06
	Rural Other Principal Arterial	3,166	26.89
	Rural Minor Arterial	4,667	39.64
	Rural Major Collector	1,397	11.87
	Rural Minor Collector	15	0.13
	Rural Local	8	0.07
	TOTAL Rural	**9,731**	**82.67**
Urban	Urban Interstate	265	2.25
	Urban OFE	291	2.47
	Urban OPA	1,301	11.05
	Urban Minor Arterial	179	1.52
	Urban Collector	5	0.04
	Urban Local	-	0.00
	TOTAL Urban	**2,041**	**17.33**
Grand Total		**11,772**	**100.00**

Source: Federal Highway Administration, Highway Statistics, Table HM10 and HM1, 2008

1. Pavement Repairs

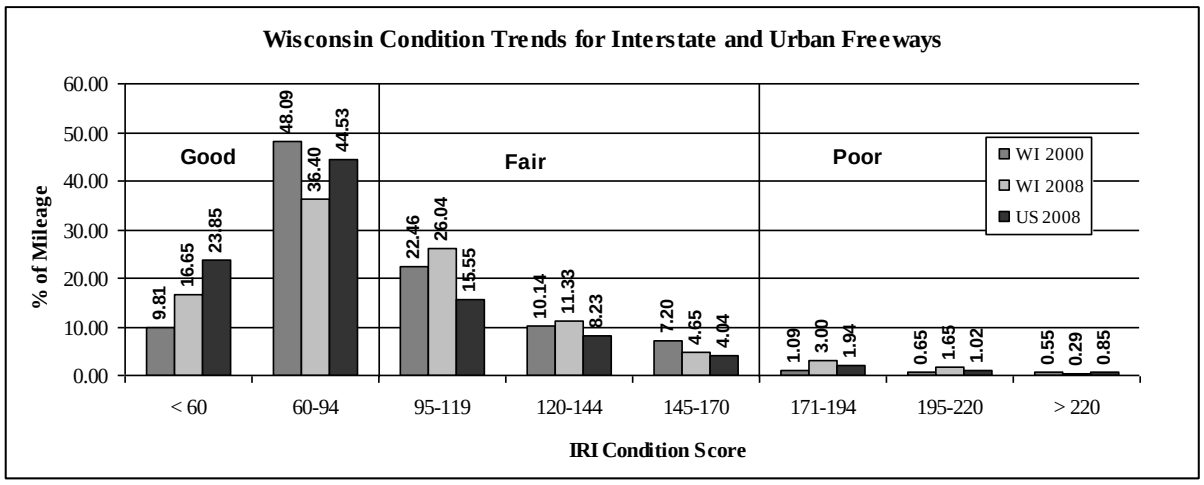
Road needs are determined by assessing the condition of each section of the state road system, then applying various repair actions at varying costs. This section reviews the needs for pavement repair and rehabilitation needs for the State Highway System, which is the 11,772 miles in the table above; needs for road expansions (widening) and for pavement maintenance are discussed in other sections. In this report we do not review the needs for local-jurisdiction roads.

Most states use a combination of methods to rate road condition. For the higher road classes (interstates, expressways, and principal arterials) most states use the International Roughness Index (IRI), a measure of road surface "bumpiness" (vertical deviation) for a given length of road.[12] The data is collected by vehicles equipped with mechanical or electronic roughness meters. On this index, interstates with more than 170 inches of roughness per mile are considered to be in "poor" condition.[13] States also use other indices for rating distress and specifying repair needs. Wisconsin uses both the IRI method and a distress rating based on a 100-point scale. Although Wisconsin's distress ratings are similar, but not identical, to those used by other states, the IRI method is generally used for the higher road systems by most states. Therefore comparisons of IRI condition data between the states are generally appropriate.

Using the national IRI data, the following three figures compare the condition of Wisconsin's roads to the U.S. averages, for 2000 and 2008, the latest year available. For the interstates and urban freeways (Figure 4), the Wisconsin system is in better shape, on average,

than the U.S., and has been improving since 2000. Wisconsin's percentage of mileage in good condition has been increasing and its percentage of mileage in poor condition decreasing since 2000. However, the percentage in fair condition is higher than that of the U.S., suggesting increasing pavement repair needs in the future.

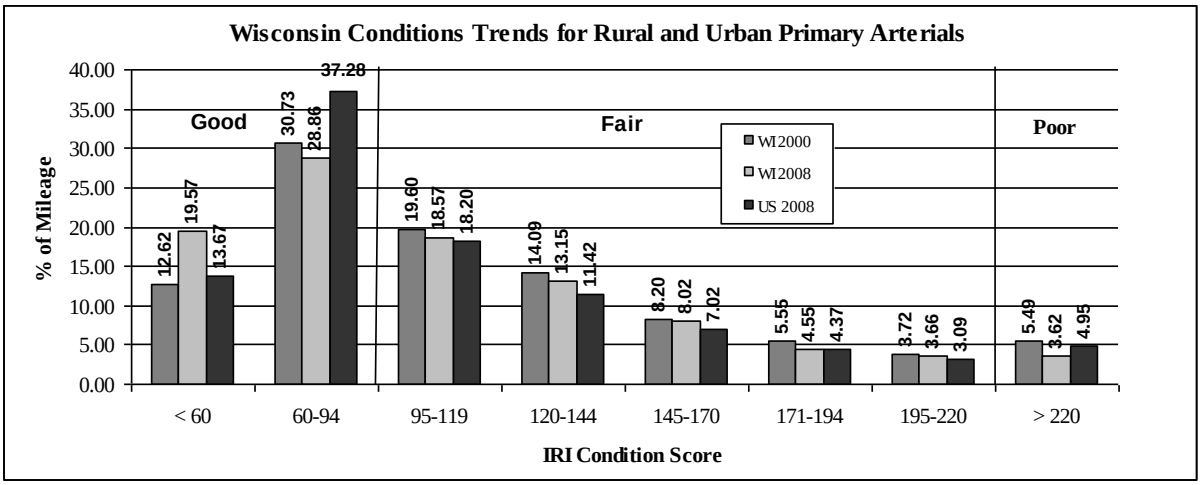
Figure 4: Wisconsin Road Condition Trends, Interstates and Urban Freeways



Source: Federal Highway Administration, Highway Statistics

For primary arterials, the data tell a similar story. For these roads (Figure 5) Wisconsin's percentage of mileage in good condition has been improving and is higher than that of the U.S., and its percentage of roads in fair and poor condition is similar to that of the U.S. average.

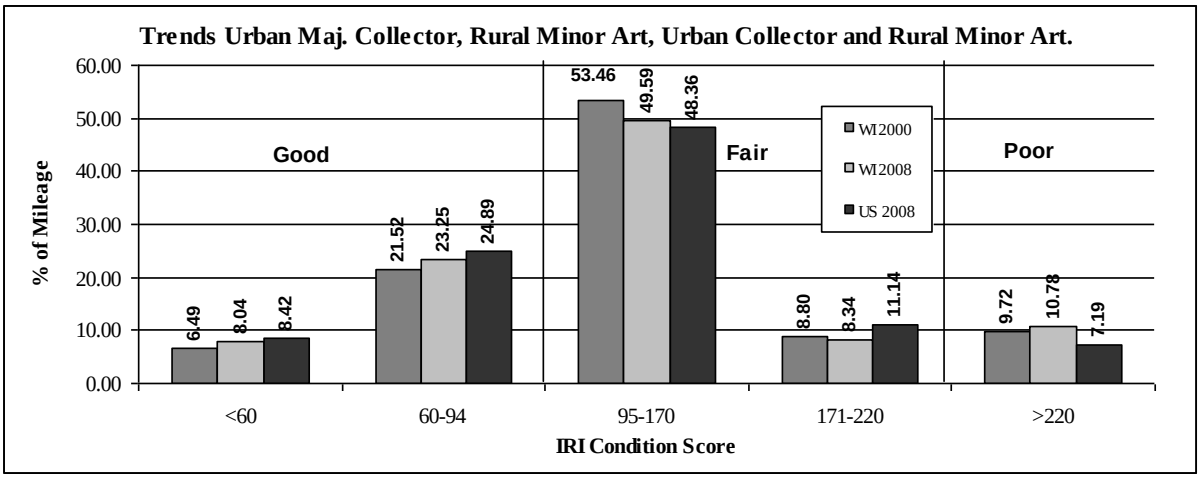
Figure 5: Wisconsin Road Condition Trends for Primary Arterials



Source: Federal Highway Administration, Highway Statistics

For lower-class roads, however, Wisconsin's situation is not as positive. Although the state has been improving the condition of these roads, the improvement is not as dramatic as with the higher systems. Wisconsin's lower-class roads are similar in condition to U.S. averages, and these roads are not in as good shape as higher-class roads (Figure 6).

Figure 6: Wisconsin Road Condition Trends: Collectors and Minor Arterials

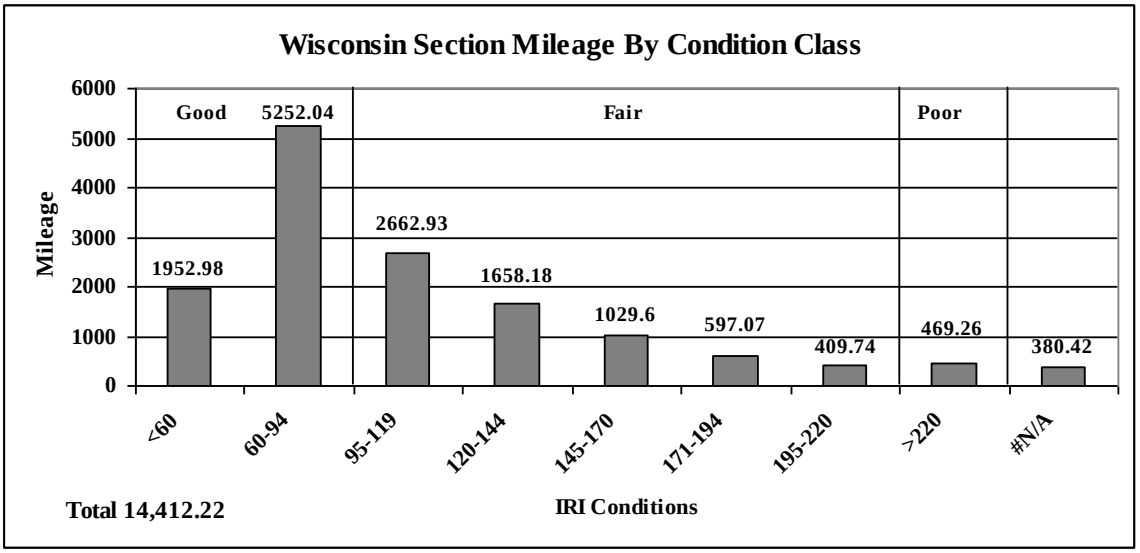


Source: Federal Highway Administration, Highway Statistics

Taken together, these graphics suggest that the state has made considerable progress in improving the condition of its major road systems but less progress in repairing the lower classes of roads. The current and planned extensive repair and freeway-arterial reconstruction work on the Milwaukee, Green Bay and Oshkosh-Appleton systems might widen this difference since it focuses largely on the higher road classes, and also includes expansions and new configurations for capacity.

More recent (2010) data for road condition, from the state's Roadway Inventory File, is shown in Figure 7. According to this data, about 50% of the system is in good condition, and another 44% is in fair condition.[14]

Figure 7: Wisconsin State Highway System: Roadway Miles by Condition, 2010



Source: WisDOT, Road Inventory File for 2010, February 2011.

Wisconsin's Roadway Inventory File contains both ratings of condition and potentially required pavement treatment[15] for the next work to be performed, a significant advantage in planning road needs. Table 5 summarizes the mileage of each of 18 potentially required pavement treatments, depending on pavement type, condition, traffic, pavement age and other

factors. These potential work types are essentially an estimate of mileage needs for various pavement sections. **About 8,208 roadway miles out of 14,412 total roadway miles are judged to require some form of treatment.**

Table 5: Roadway Miles by Potentially Required Pavement Treatment

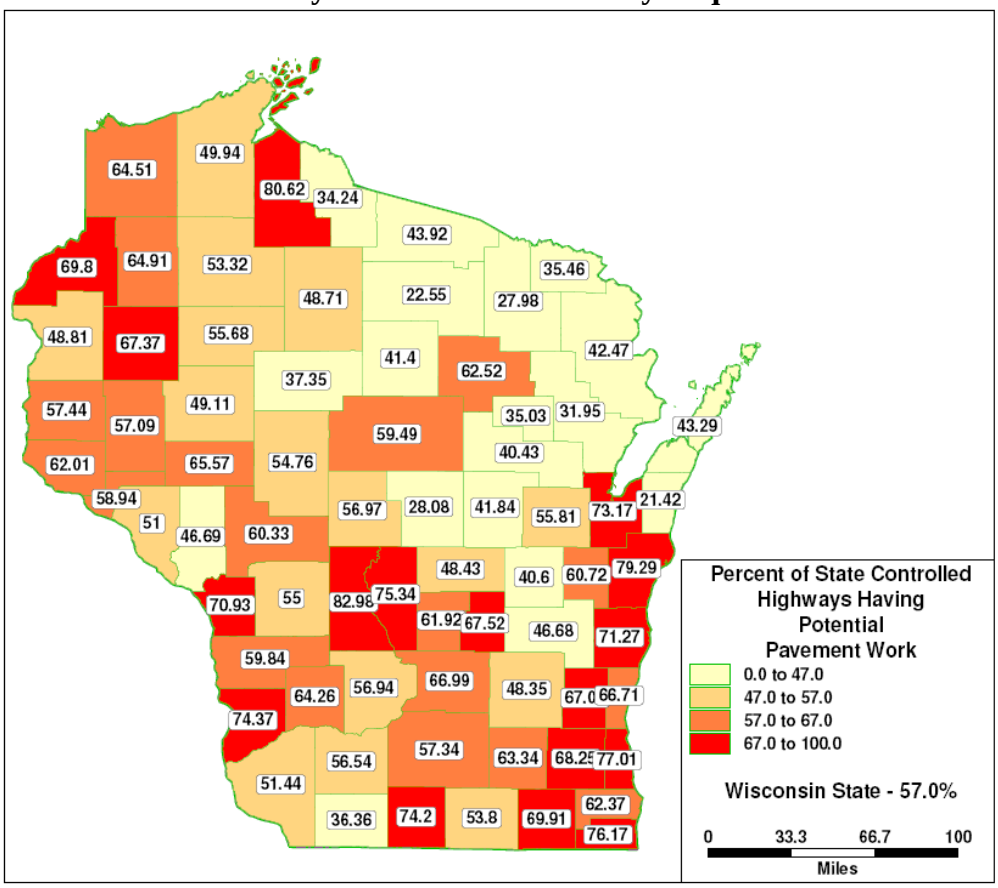
Work Effort Level	Potentially Required Pavement Treatment	2 Lanes ADT < 5K	2 Lanes ADT > 5K	4 Lanes ADT < 25k	4 Lanes ADT > 25k	6+ Lanes, Other	6+ Lane Expy., Milw. Co.	Grand Total Road-way Miles	*Total Roadway Lane-Miles*
	N/A	143.2	119.9	299.6	40.0	17.1	13.9	**633.6**	*1176.0*
1.1	Do Nothing	2810.9	933.8	1440.1	272.3	97.9	15.9	**5570.9**	*11329.0*
1.2	Crack Fill	865.1	253.6	122.1	76.1	5.3	5.1	**1327.4**	*2678.9*
1.3	Rut Fill	5.0	1.1					**6.0**	*12.1*
1.4	Seal Coat	230.9	42.8	4.3		2.1		**280.1**	*564.4*
1.5	Spot Repair (bituminous)	167.8	21.1	12.4		1.8		**203.1**	*416.0*
2.1	Surface Mill	1.7	3.5	0.5				**5.7**	*11.1*
2.2	Thin Overlay	1897.8	621.7	445.6	374.2	101.0	54.8	**3495.0**	*7229.5*
2.3	Thin Overlay over PCC	9.0	8.5	30.3	24.5	6.6		**78.9**	*174.2*
2.4	Thick Overlay	127.5	134.7	170.4	166.1	66.8	14.4	**679.9**	*1462.9*
3.1	Rubblize and Overlay	21.0	65.1	165.9	113.8	41.0	0.3	**407.1**	*873.8*
3.2	Partial Mill and Overlay	331.5	68.3	19.7			1.3	**420.7**	*856.8*
3.3	Cold Recycle	35.0	6.0	2.9	11.3			**55.1**	*112.4*
3.4	Full Depth Mill and Overlay	47.6	16.8	7.0		0.4		**71.7**	*144.0*
7.1	Repair	21.4	28.3	328.1	111.9	22.4		**512.1**	*1069.1*
7.2	Repair and Grind	2.5	10.2	18.4	2.9	4.6		**38.6**	*96.1*
7.3	Repair, Grind, and Thin Overlay	3.1	2.3	32.2	11.5	8.6		**57.7**	*130.2*
7.4	Repair, Patch, Crack/Seat and Thick Overlay	34.0	34.6	159.8	50.9	15.7		**295.0**	*623.5*
7.5	Base Repair <= 5%, Spot Repair, Patch, Thin Overlay	5.1	17.3	58.4	37.3	4.4		**122.6**	*254.0*
7.6	Base Repair > 5%, Spot Repair, Patch, Thin Overlay	6.4	27.8	71.9	36.1	9.0		**151.2**	*330.9*
	Grand Total	**6766.1**	**2417.4**	**3389.4**	**1328.9**	**404.6**	**105.8**	**14412.2**	***29544.9***
	Needing Treatment (Work Effort Levels 1.2-7.6)	**3812.1**	**1363.7**	**1649.7**	**1016.7**	**289.6**	**76.0**	**8207.8**	***17039.9***
	Percent Needing Work	**56.3**	**56.4**	**48.7**	**76.5**	**71.6**	**71.8**	**57.0**	**56.3**

Source: Wisconsin Roadway Inventory File, WisDOT, February 2011. ADT=Average Daily Traffic.

Most of the mileage of potential required pavement treatment is for relatively light treatments such as cracking, patching, and overlays. The greatest portion, about 3,495 roadway miles, is judged to need only thin overlays, and 1,327 miles are judged to need crack filling. Light treatments early in the life of pavements can be highly effective in prolonging pavement life and significantly reduce long-term costs. About 5,571 miles are judged to need no present treatment, and another 634 miles are not rated or were under construction when surveyed.

By region of the state, the percentage of roadway mileage needing treatment is shown in Figure 8. Pavement repair needs are widespread. The counties with the highest percentage of mileage with potential work are Juneau (83%) and Ashland (81%), while those with the lowest percentage of mileage with potential work are Oneida (23%) and Kewaunee (21%). However, this figure does not show the type or likely cost of the potential work.

Figure 8: Percent of Roadway Miles with a Potentially Required Pavement Treatment



Source: Wisconsin Roadway Inventory File, WisDOT, February 2011.

A key issue in determining pavement needs is the "repair cycle," the average time over which most state roads would receive at least one treatment. Over a decade most of the potential required pavement treatments would ideally be accomplished, but it is also likely that some work would not be completed. And some roads might need to be treated more than once per decade while others in good condition might not be treated at all (they would be maintained, however). A recent review of road repair cycles for the greater Milwaukee area[16] found that concrete pavements lasted about 19 years before needing work, the first treatment (typically a milling and overlay) typically lasted another 10 to 15 years, and the second treatment (a lighter milling-resurfacing) lasted about eight to 10 years. Asphalt pavements would typically last shorter periods of time and require more frequent treatment. **Our assessment assumes that on average, repair cycles for pavements will be about 13 years, implying that about 75% of the system could (ideally) be repaired during a 10-year period.** We also assume that no roads would be repaired more than once in a 10-year period. Both of these assumptions may be optimistic, particularly since light treatments often require 'repeat' work more frequently. A more comprehensive needs assessment of individual road sections, which is beyond the scope of this study, would explicitly include these factors.[17]

To estimate the cost of repair for various work types, we summarized the planned pavement work in the 2011-2014 Wisconsin STIP.[18] Typical per-mile costs for various types of repair were determined, then these costs were interpolated for other work types based on complexity. Although each project is of course unique and has factors that raise or reduce costs, these average unit costs are viewed as sufficient for this high-level needs assessment. The appendix to this report shows the cost tables for various treatments.

Total costs of repair are estimated by multiplying the unit repair costs by the percent repaired (assumed to be 75%) and the mileage needing work, adjusted for inflation. Also included was a factor to account for the difference average between basic letting ("LET") costs versus total project costs. This factor, 1.3245, provided by WisDOT[19] would include engineering and right-of-way costs (likely to be modest for pavement repair work), contract change orders, mobilization and traffic control. To be conservative (slightly high in cost estimates) we did not adjust for roadway (as opposed to centerline) mileage, nor did we adjust for the likelihood that pavement treatments might not be applied to the entire length of road sections. Both adjustments, if applied, would lower our cost estimate.

Table 6 and Figure 9 show the results. **Over 10 years, the inflated cost to repair Wisconsin's state highway pavements is about $8.175 billion.** About half of this work (51%) would be targeted to four-lane roads, including rural interstates, and about 36% to two-lane roads. The needs of six-lane or wider roads are about 13% of the total.

Figure 9: Wisconsin SHS 2011-2020 Pavement Repair Needs, 75% Addressed

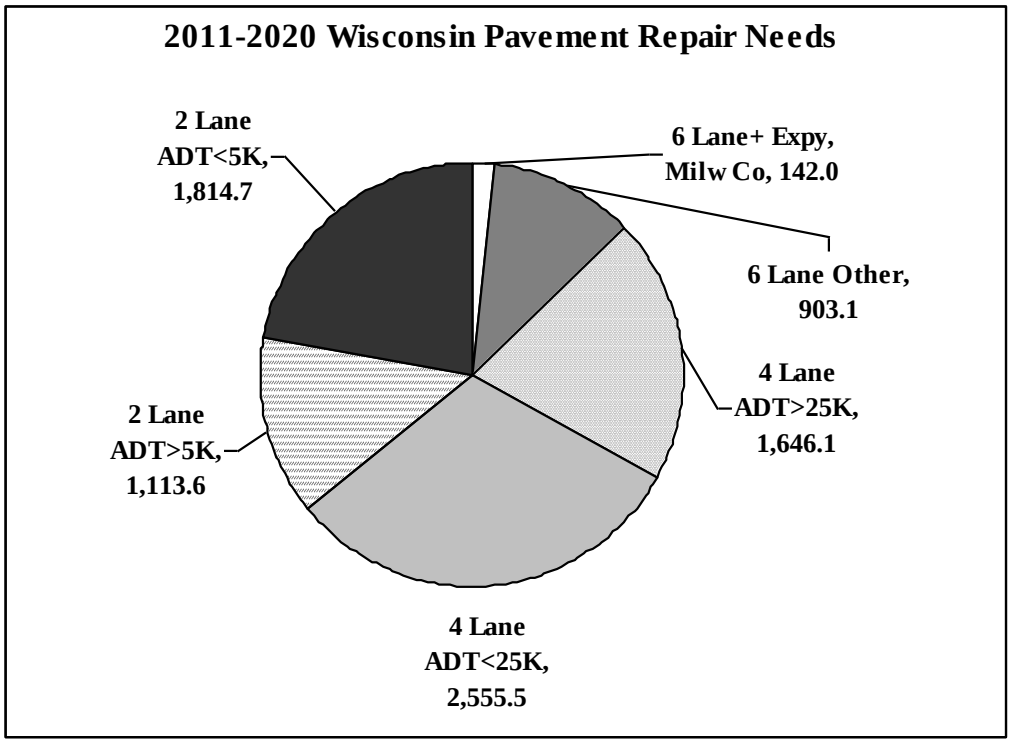


Table 6: Costs of Pavement Repair, 2011-2020, Wisconsin State Highway System

				Policy	1.325 Tot$/Let$ Factor	2011-14		2015-20		Total 2011-20
Maintenance Road Class	**Road-way Miles***	**Roadway Miles with Potential Work***	**Pct with Potential Work**	**% of Potential Work Completed**	**Base Cost, millions of dollars**	**Roadway Miles Repaired**	**Inflated Cost, millions of dollars**	**Roadway Miles Repaired**	**Inflated Cost, millions of dollars**	**Total Inflated Cost, millions of dollars**
6 Lane+ Expy, Milw. Co.	105.8	76.0	72	**75**	123.4	23	52.2	34	89.8	142.0
6 Lane Other	404.6	289.6	72	**75**	784.9	87	331.8	130	571.4	903.1
4 Lane ADT>25K	1,328.9	1,016.7	77	**75**	1,430.6	305	604.7	458	1,041.4	1,646.1
4 Lane ADT<25K	3,389.4	1,649.7	49	**75**	2,220.9	495	938.8	742	1,616.7	2,555.5
2 Lane ADT>5K	2,417.4	1,363.7	56	**75**	967.7	409	409.1	614	704.5	1,113.6
2 Lane ADT<5K	6,766.1	3,812.1	56	**75**	1,577.1	1,144	666.7	1,715	1,148.1	1,814.7
Total	**14,412.2**	**8,207.8**	**57**		**$ 7,104.6**	**2,462**	**$ 3,003.2**	**3,693**	**$ 5,171.8**	**$ 8,175.1**

*Source: Mileage from Wisconsin Roadway Inventory File, WisDOT, February 2011.

As noted, these estimates do not include additional 2nd-round pavement deterioration. And, also noted above, they do not include costs for widening existing lanes or adding new lanes, both of which are covered below.

2. Bridge Repairs

Wisconsin's highway bridges serve as key elements of the system, crossing streams, trails, railroads, rivers, and other roads. As such, they are critical to the system's function. Wisconsin has about 13,900 bridges, one of the larger inventories in the nation. Of these, 4,885 are state-owned. This section reviews needs for repairing Wisconsin's state-owned bridges. Bridge maintenance needs are covered in a subsequent section, and new bridges are discussed in the section on new projects and expansions.

Unlike roads for which the states have many different rating procedures, bridges are rated uniformly nationwide. The federal government maintains the National Bridge Inventory[20] consisting of detailed information about each of the nation's 599,000 highway bridges. Each state regularly inspects each bridge for deficiencies in physical features and function, and it reports its findings to the federal government. All states use the same data recording and rating methods, which are based on rigorous training for field inspectors. The rating is based on observable distress symptoms for:

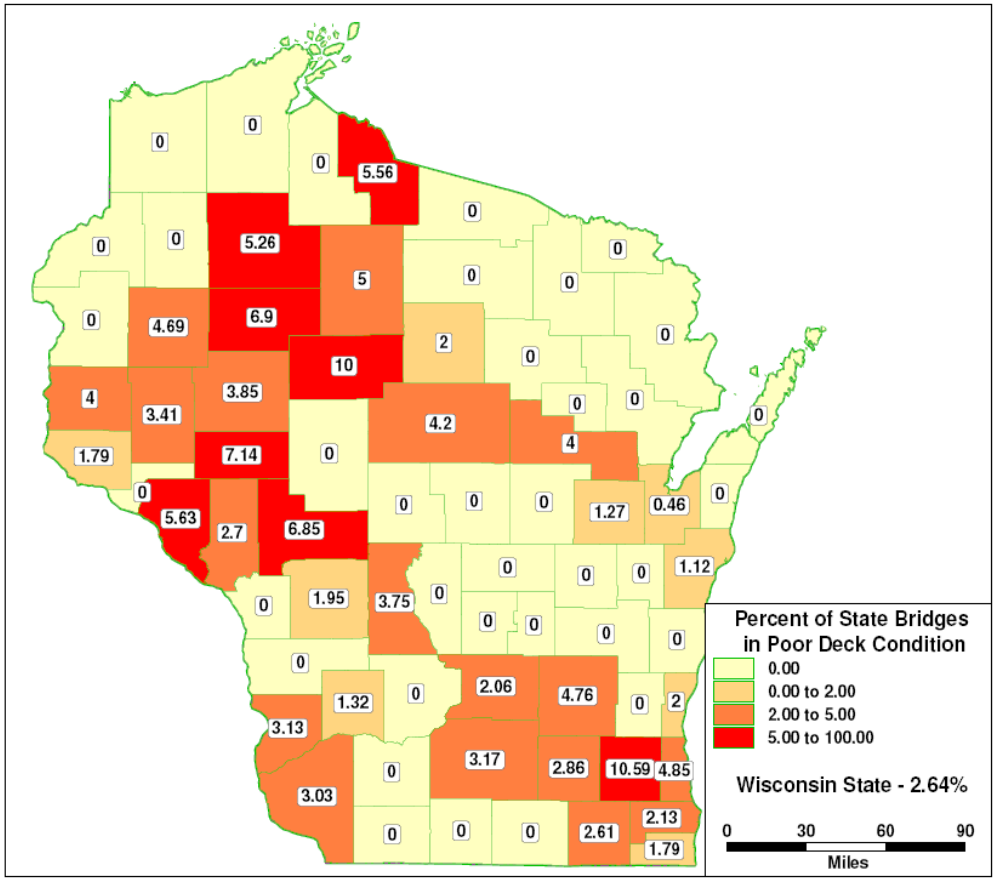
- *Bridge decks* (riding surface, roadway approaches, end joints, curbing, and sidewalks),
- *Superstructures* (side rails, above-road piers and the overhead truss), and
- *Substructures* (deck undercarriage, piers, footings, abutments and erosion protection.

For each component, a 1-9 rating scale is used, where 4 or less is defined as "poor" condition. An overall rating based on a 100-point scale is also calculated, based on traffic, load carrying capacity, design, and condition. Bridges are rated "deficient" if they fail to meet either condition or functional adequacy. Since federal law requires that a bridge must be rated "deficient" in order for federal money to be spent on its repair, and since repair costs are often substantial, most states focus their bridge repair effort on bridges that are rated deficient.

Wisconsin's bridges are in generally better shape than those of the nation as a whole. According to 2009 data, **about 14.3 percent of Wisconsin's 13,900 highway bridges are rated deficient, compared with 23.7 percent nationwide**; this places Wisconsin sixth among the states. Table 7 shows that **about 129 state-owned bridges, 2.6 percent of the state-owned total, have decks rated "poor" or worse.** However, a significant number of additional bridges have decks in fair condition, just above the "poor" level, and others are in moderate condition. With time, traffic and weather these bridges are likely to deteriorate to "poor" condition in the future.

The geographic distribution of bridge condition shown in Figure 10 indicates a scattered pattern, with over half of the counties (37 of 72) having no poor-deck state-owned bridges, but eight counties having 5% or more of their state-owned bridge decks in poor condition. The northwest and the southeast seem to have more problems with bridge decks than the other areas of the state. Waukesha and Rusk Counties have the highest percentage of poor-deck state-owned bridges, each about 10%.

Figure 10: Percentage of State-Owned Bridges with Poor Deck Condition.



Source: USDOT, National Transportation Analysis Database, 2009 National Bridge Inventory.

Repair costs for bridges are estimated based on WisDOT estimated costs, for which the federal government requires periodic estimates.[21] In estimating needs, we used the estimated *total* bridge repair costs as reported in the 2009 National Bridge Inventory.[22] These include the additional modest widening work to accommodate improved road geometry, engineering, mobilization and traffic control, but not inflation. We assumed that not all bridges would be repaired within the 10-year time frame. Nor do the estimates include costs for widening bridges

to accommodate more traffic (capacity-based widening), or for modernizing older designs such as lift bridges.

Table 7 indicates that **about $677.5 million would be needed over the next 10 years to prudently address Wisconsin's state-owned bridge repair needs.** Of this, about $169 million would be targeted at bridges with poor-condition decks, with the remainder targeted at bridges in better shape to slow their deterioration. (If all bridge repair needs were addressed, the need would be about $946 million.)

Table 7: 10-Year Bridge Repair Needs, Wisconsin State-Owned Bridges

							2010		2011-14		2015-20		2011-20
Condition Status	**Deck Rating**	**Number State-Owned Bridges**	**Bridges with Cost Est****	**Policy: Percent Repaired**	**Avg. Cost/ Bridge, in $K**	**Num-ber Fixed**	**Num-ber Fixed**	**Cost, in M$ Infla-ted**	**Num-ber Fixed**	**Cost, in M$ Infla-ted**	**Num-ber Fixed**	**Cost, in M$, Infla-ted**	**Total Cost, in M$, Infla-ted**
NA/NR	N	607	12	20	7	121	11	0.1	**44**	**0.3**	**66**	**0.6**	**0.9**
Excellent	9	149	25	30	503*	45	4	2.0	**16**	**8.6**	**24**	**14.9**	**23.5**
Very Good	8	923	90	50	136	462	42	5.7	**168**	**24.1**	**252**	**41.6**	**65.7**
Good	7	1,665	163	60	117	999	91	10.7	**363**	**45.1**	**545**	**77.6**	**122.7**
Satisfactory	6	1,004	172	70	246	703	64	15.7	**256**	**66.3**	**383**	**114.2**	**180.5**
Fair	5	408	95	80	336	326	30	10.0	**119**	**42.2**	**178**	**72.6**	**114.8**
Poor	4	125	125	100	1,247	125	11	14.2	**45**	**59.9**	**68**	**103.1**	**163.0**
Serious	3	4	4	100	1,504	4	0	0.5	**1**	**2.3**	**2**	**4.0**	**6.3**
Critical	2	0	0			0	0	0.0	**0**	**0.0**	**0**	**0.0**	**0.0**
In Failure	1	0	0			0	0	0.0	**0**	**0.0**	**0**	**0.0**	**0.0**
Failed	0	0	0			0	0	0.0	**0**	**0.0**	**0**	**0.0**	**0.0**
Totals		4,885	686	57	233	**2,785**	253	58.9	**1,013**	**248.9**	**1,519**	**428.6**	**677.5**

Source: NTAD 2009, National Bridge Inventory (NBI), Wisconsin portion.
* Almost 75% is for the bridges on interstates and principal arterials, which tend to be more expensive to repair.
** Bridges in Wisconsin's 2009 NBI that have estimated repair costs. These are typically bridges rated "deficient."

To account for higher future costs, we inflated repair costs in future years at 2.8% per year. Further, recognizing that not all work could be done within the 10-year horizon, we have also reduced the estimate by limiting repairs to only a portion of the bridges in each condition category. We also subtracted out needed repairs for the 2010 calendar year, which have been partially done, but added inflation for repair work done beyond 2011. However, we do *not* include locally owned bridges, or the needs for bridge widening for capacity purposes or other reasons, nor do we include replacement costs for major bridge replacements such as the St. Croix River bridge at Stillwater, Minn.; some of these are covered in the New Roads and Bridges section below.

3. Capacity-Related Widening.

Wisconsin's highways also have substantial congestion-related widening needs. Traffic engineers measure congestion by comparing the peak-hour traffic to a roadway's carrying capacity. For interstates, the maximum flow rate of a modern lane of freeway is about 2,400 vehicles per hour, or about 25,000 vehicles per day using typical peak hour factors.[23] So, a modern four-lane freeway can carry about 100,000 vehicles a day, maximum. Several six-lane roads in the Milwaukee area carry traffic of nearly 130,000 vehicles per day. As traffic on roads builds up, the volume-to-capacity ratio approaches 1.0 and traffic spreads out in time so roads are congested for longer periods. Typically, roads with volume-to-capacity ratios over 0.95 are

considered to be severely or extremely congested, and roads with volume-to-capacity ratios 0.80-0.95 are considered moderately congested.

Data on road congestion comes from several sources. Several private firms (such as INRIX) monitor real-time traffic congestion in major cities (including Milwaukee and Madison) using travel time reports from drivers with GPS devices.[24] Using this data, a recent study[25] put Milwaukee's U.S. 45 southbound (the Zoo Freeway) at 26th among the nation's worst 50 commuter routes. All states, including Wisconsin, use the Federal Highway Capacity Manual[26] (HCM) to calculate the rated capacities of their highways. For national comparisons, the states submit information annually to the federal government through a data reporting system known as the Highway Performance Monitoring System (HPMS).[27] This data is based on a sample of road sections in each state, monitored over time for condition and congestion, among other things. Wisconsin submits data to the federal government under this program. The data is summarized by the federal government and reported annually in Highway Statistics. However, the last published information for Wisconsin is from 2006.

WisDOT also calculates the HCM Level of Service (LOS) for each roadway section in the state Roadway Inventory File, and also converts the classification used in HPMS to a numeric classification noted in the table below (Table 8). This data is more recent, for 2010, and was the basis for our assessment.

Table 8: Wisconsin Traffic Congestion Levels of Service

Level of Service (Alpha Value, HCM)	Description of Congestion	WisDOT Level of Service (Numeric Value)
A	Not congested	1.01 - 2.00
B	Not congested	2.01 - 3.00
C	Minimal congestion	3.01 - 4.00
D	Moderate congestion	4.01 - 5.00
E	Severe congestion	5.01 - 6.00
F	Extreme congestion	6.01+

Source: WisDOT FDM, available at: http://roadwaystandards.dot.wi.gov/standards/fdm/11-05.pdf

Based on this numeric classification and the level of urbanization in which the highway is located, WisDOT has established LOS thresholds for various portions of the State Highway System:

Table 9: Acceptable Congestion Levels of Service

SHS Sub-System	Rural & Small Urban Areas	Urbanized Areas with Population > 50,000
C2020 Backbone Routes	LOS C (< = 4.0)	LOS C (< = 4.0)
C2020 Connector Routes and NHS Routes (not including NHS Backbone Routes)	LOS C (< = 4.0)	Mid LOS D (< = 4.5)
Other Principal Arterials	LOS D (< = 5.0)	Mid LOS E (< = 5.5)
Minor Arterials	LOS D (< = 5.0)	Mid LOS E (<= 5.5)
Collectors and Local Function Roads	LOS D (< = 5.0)	Mid LOS E (<= 5.5)

Source: WisDOT FDM, Table 3.1, Chapter 11, available at:
http://roadwaystandards.dot.wi.gov/standards/fdm/11-05.pdf

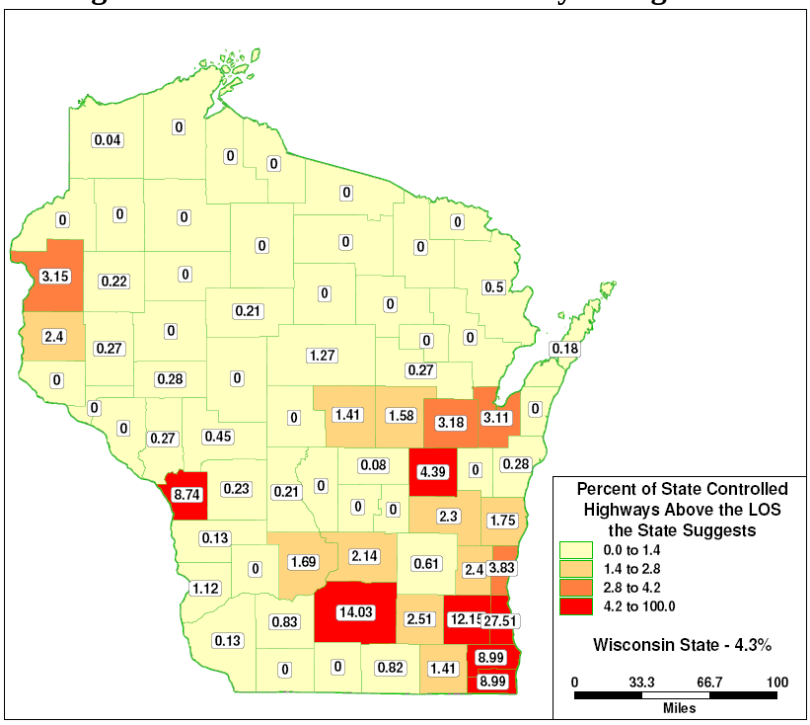
We have adapted these thresholds to the six road classes as follows. "Backbone" routes operate at higher levels of service, but urban routes are permitted more congestion. Therefore, six-lane roads should be permitted to operate at "D" (LOS>4.0), but higher-volume four-lane routes are allowed to carry more traffic (LOS>4.5). Lower-volume four- and two-lane roads are mostly rural. This translates into capacity criteria as shown in Table 10.

Table 10: Roadway Capacity Thresholds

Category	LOS Adequacy Threshold	Widen When LOS is
6+Lane Expy., Milw. Co.	LOS C (< = 4.0)	D (> 4.0)
6+Lanes, Other	LOS C (< = 4.0)	D (> 4.0)
4 Lane ADT > 25k	LOS D (< = 4.5)	D (> 4.5)
4 Lane ADT < 25k	LOS C (< = 4.0)	D (> 4.0)
2 Lane ADT > 5K	LOS E (< = 5.5)	E (> 5.5)
2 Lane ADT < 5K	LOS D (< = 5.0)	D (> 5.0)

Following these criteria, most of Wisconsin's State Highway System is only mildly congested. About 4.3% of the State Highway System exceeds the thresholds. However, the number is much higher for Milwaukee County expressways of six lanes or more (68%), and for other six-lane-or-more roads throughout the state (27%). This is evident in Figure 11, which shows that capacity issues tend to be an urban problem, with more roads needing widening in the areas in and around Milwaukee, Madison, La Crosse, Oshkosh, and Green Bay. The estimates using the above methodology may be low since they are based on a single uniform LOS threshold for each category, while in practice multiple thresholds apply. This increases the number of miles over capacity standards.[28]

Figure 11: Percent of State Roadways Congested



Source: Wisconsin Roadway Inventory File, WisDOT, February 2011.

Of course, not all these roads could or should be widened, and there are other means to improve congestion.[29] Actions such as improved traffic control, partial and directional treatments, bottleneck treatments, alternative modes, and similar steps should be considered before major capacity-related widening is undertaken. New technologies for traffic control are evolving that permit better use of real-time information, safer roads, and reduced delay. Some of these options are appropriate for higher-class roads such as freeways and major arterials, and others are appropriate for urban streets and other lower-class roads. Therefore, the proportion of roads that might be actually widened is likely to be higher for major facilities but lower for lower-class roads. Table 11 follows this approach by assuming that about 70% of congested six-or-more-lane highways would be widened over a decade, but that only 50% of higher volume two- and four-lane roads, and 30% of lower volume two- and four-lane roads that are congested would be widened. In developing the cost estimates, we also adjusted for centerline-to-roadway mileage, total cost to letting cost, and inflation.

Following this strategy, Table 11 indicates that **about 333.4 roadway miles would need to be widened to meet a prudent widening policy, at a cost of about $6.124 billion.** This estimate is probably a low estimate of capacity-related widening needs, since it does not include work on moderately congested roads, modest traffic growth over time, higher costs of widening in other major urban areas (outside of Milwaukee County), and some related bridge and interchange work.

Table 11: Cost to Add Capacity to Roadways that Are Over the LOS Standard

								Total $ to letting $ ratio	1.325**	1.057	Infl $	1.213	Infl $	
										2011-14		**2015-20**		**2011-20**
Category	**2010 Roadway Miles***	**LOS Std***	**Roadway Miles Over LOS Std****	**Percent Over Std**	**Policy: Percent Widened**	**Roadway Miles Widened**	**Cost to Widen per Centerline Mile, in $M**	**Centerline miles to Roadway Miles Ratio***	**Total Base Year Cost, in $M**	**Roadway Miles Widen**	**Total Costs, in Millions, Inflated**	**Roadway Miles Widen**	**Total Costs, in $M Inflated**	**Grand Total Inflated Costs, in $M**
6+Lane Expy., Milw. Co.	106	D (>4.0)	72.2	68.2	**70**	50.5	75.0	0.50	2,511	20	1,061	30	1,828	2,889
Other 6+Lns	405	D (>4.0)	107.5	26.6	**70**	75.2	30.0	0.50	1,495	30	632	45	1,088	1,720
4 Lane ADT> 25k	1,329	D (>4.5)	144.7	10.9	**50**	72.3	10.0	0.50	479	29	203	43	349	551
4 Lane ADT< 25k	3,389	D (>4.0)	50.3	1.5	**30**	15.1	8.0	0.53	84	6	36	9	61	97
2 Lane ADT>5K	2,417	E (>5.5)	240.5	9.9	**50**	120.3	5.0	0.98	779	48	329	72	567	897
2 Lane ADT<5K	6,766	D (>5.0)	0.0	0.0	**-**	-	-	-	-	-	-	-	-	-
Total	**14,412**		**615.1**	**4.3**		**333.4**			**$ 5,349**	**133**	**$ 2,261**	**200**	**$3,894**	**$ 6,154**
I-43 Mitchell to Silver Spring interchanges, plus I-94 Marquette to Zoo interchanges			**-38**			**-38**			**- $ 268**			**-38**	**-$ 431**	**-$ 431**
Total - Above			**577.1**			**295.4**			**$ 5,081**	**$ 133**	**$ 2,261**	**162**	**$ 3,463**	**$ 5,724**

*Sources: WisDOT Roadway Inventory File, Feb 2011. Unit cost data from analysis of Wisconsin 2011-14 STIP (see Appendix).
LOS standards from WisDOT Facilities Design Manual. Centerline/Roadway ratio from RIF. (see appendix)
** Provided by WisDOT, April 26, 2011, Wolfgram to Lightbourn.

Two major proposed projects, I-43(Mitchell to Silver Spring interchanges) and I-94 (Marquette to Zoo interchanges) are treated separately. These projects propose widening that is very expensive and would probably affect the surrounding areas. The incremental cost of widening for these two projects has been estimated at about $268 million,[30] or about $431 million in future inflated dollars. Since no decision has been made regarding whether to widen these facilities, we show them as a separate alternative in Table 11. If these two projects were deleted, about $5.724 billion ($431 million less) would be needed.

The decision to add capacity is a complex one, balancing congestion, funding, safety, pavement condition, community impacts and many other factors. The benefits of increased roadway capacity are primarily higher travel speeds and reduced congestion-related delays, primarily in urban areas. Commuters also benefit from reduced accident rates and lower vehicle operating costs. Increased road capacity also increases accessibility and facilitates truck flows, thus improving local economies, and it can reduce air pollution through lower emissions rates. On the other hand, some widening projects also create additional traffic (so-called induced traffic), which eats into travel time savings and air pollution gains, and may encourage development and sprawl. This report does not evaluate specific capacity improvements but does attempt to estimate their effect on state highway needs.

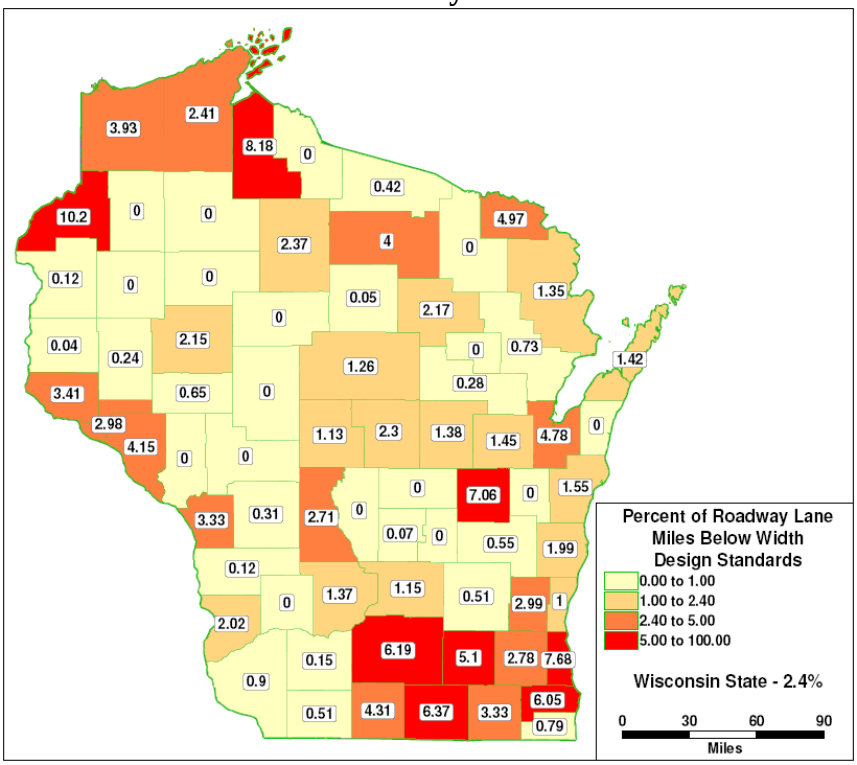
4. Narrow Lanes

Another important deficiency in highway systems is narrow lanes -- that is, lanes less than standard design width. Many studies of road safety indicate that narrow lanes are a major factor in head-on vehicle collisions and sideswipes, in which the severity of the accident tends to be greater than in other accidents. They are also a major factor in roadway run-off accidents. Narrow lanes also contribute to lower driving speeds, thus reducing system efficiency and accessibility. They also contribute marginally to reduced capacity in cases where narrow lane width slows driving speeds and increases vehicle spacing in congested areas.

The WisDOT standard for lane width, as shown in the Facilities Development Manual (FDM), is 12 feet for the interstate system.[31] Lane widths for the other portions of the State Highway System depend on functional class, traffic volume and speed. For arterials, the lane width standard is 12 feet (both urban[32] and rural[33]); for collectors and most local roads, the lane width standard is 11 feet (for both urban and rural). In low-volume roads and subdivisions, 10-foot lanes (20-foot pavement width) are permissible, although the need for bikeways may increase widths somewhat. For our purposes, we have used the 12-foot guideline as a standard for all multilane highways, as well as the high volume two-lane facilities. For the lower-volume two-lane roads, we used the 11-foot guideline as the standard, recognizing that not all two-lane roads need to be widened to 22 feet.

Analysis of the Wisconsin State Highway System indicates that **of Wisconsin's 29,545 roadway lane-miles, about 710 lane-miles (2.4%) have lane widths less than design standard (Figure 12).** The map below indicates that the percentage of roadway lane-miles with narrow lanes is geographically dispersed, with the southeast, southwest and northwest regions having the highest percentages. Burnett County has the highest percent of narrow roadway lane-miles, 10.2%, followed by Ashland County (8.2%) and Milwaukee County (7.7%).

Figure 12: Percent of State Roadway Lane-Miles with Narrow Lanes



Source: Wisconsin Roadway Inventory File, WisDOT, February 2011.

However not all of these narrow lanes should or even could be widened, since some are limited by urban street geometry, terrain limitations, wetland avoidance, right-of-way limits or other factors. Therefore, the percentage of narrow lanes that might be prudently widened is less than 100% except for major freeways and arterials. Also the unit cost of lane widening is somewhat less than that of lane additions such as needed for capacity; we estimated these costs by reviewing 2011-14 STIP projects. **Prudent widening of existing lanes to meet design standards would cost about $362 million over 10 years (Table 12).**

Table 12: Cost to Widen Narrow Lanes, in Millions of Dollars.

					POLICY				2011-14		2015-20		2011-20
Category	**2010 Roadway Miles**	**2010 Lane-Miles**	**Std Lane Width**	**Lane-Miles below Std**	**Per-cent Wid-ened**	**Cost per Lane-Mile to Widen, in Thous ands**	**Lane-Miles Wid-ened**	**Total Base Cost, in Thous-ands**	**Lane-Miles Wid-ened**	**Infla-ted Cost, in M$**	**Lane-Miles Wid-ened**	**Inflate d Cost, in M$**	**Inflated Cost, Total, M$**
6+Lane Exp, Milw Co	106	322	**12 ft**	0	**100**	950	0	0	0	0	0	0	0
6+Lanes, Other	405	1,244	**12 ft**	88	**100**	950	88	84.0	35	35.5	53	61.2	96.7
4 Lanes ADT > 25k	1,329	2,658	**12 ft**	24	**75**	808	18	14.6	7	6.2	11	10.6	16.8
4 Lanes ADT < 25k	3,389	7,138	**12 ft**	259	**75**	808	194	156.9	78	66.4	117	1143	180.6
2 Lanes ADT > 5K	2,417	4,744	**12 ft**	157	**50**	475	78	37.3	31	15.8	47	27.1	429
2 Lanes ADT < 5K	6,766	13,439	**11 ft**	182	**25**	475	45	21.6	18	9.1	27	15.7	24.8
Totals	**14,412**	**29,545**		**710**			**425**	**$ 314.4**	**170**	**$ 132.9**	**255**	**$ 228.8**	**$ 361.8**

Sources: Lane widths: WisDOT Roadway Inventory File, Feb 2011. Unit cost data: Wisconsin STIP analysis.

The benefits of lane width improvements on accident rates can be substantial. The Texas A&M Roadway Safety Design Workbook[34] indicates that for rural two-lane arterials, improving lane width from 10 feet to 11 feet can reduce crash rates by about 12%. For urban arterials, the effect is smaller, about 5%. Of course, these reductions would be applied only to those roads that have their lane widths widened, not to all of the system.

5. Narrow Shoulders

Adequate shoulders are another important highway system design feature. Adequate shoulders provide a margin of safety for vehicles that need to pull over to the roadside, and they reduce the chance and severity of run-off accidents. They also increase sight distance by ensuring that trees and other obstructions are set back from the pavement edge.

The design standard for shoulder width for the collectors, arterials and interstates or freeways varies from 2 feet to 10 feet, depending on traffic, posted speed and road classification.[35] Many of the state's narrow-shoulder roads have not been re-engineered to the current standards; they have always had narrow shoulders. If these roads were re-constructed, good engineering practice would be to try to bring them up to standards for both lane width and shoulder width. For most roads, except subdivisions or very low volume roads, a minimum of 6 feet would be the design standard, and most roads widened or improved would be provided with at least 6-foot shoulders.

To estimate the need for shoulder widening, we looked only at right-side road shoulders not constrained by curbs or retaining walls, guide rails or other roadside features.[36] Table 13 summarizes the status of the Wisconsin state-owned highway system for shoulder widths. **About 4,828 miles, or 22.4% of the 21,596 miles of eligible right-shoulders in the State Highway System have narrow shoulders that are less than design standards.** Figure 13 shows that this problem occurs throughout the state, although the north central and southwest regions seem to have more than their share. Eleven counties have greater than 35% of their roads with shoulders

of less than design width. (Menominee County, the former Indian reservation, has almost 93% of shoulders below standard width but also significant first-growth forest protection.)

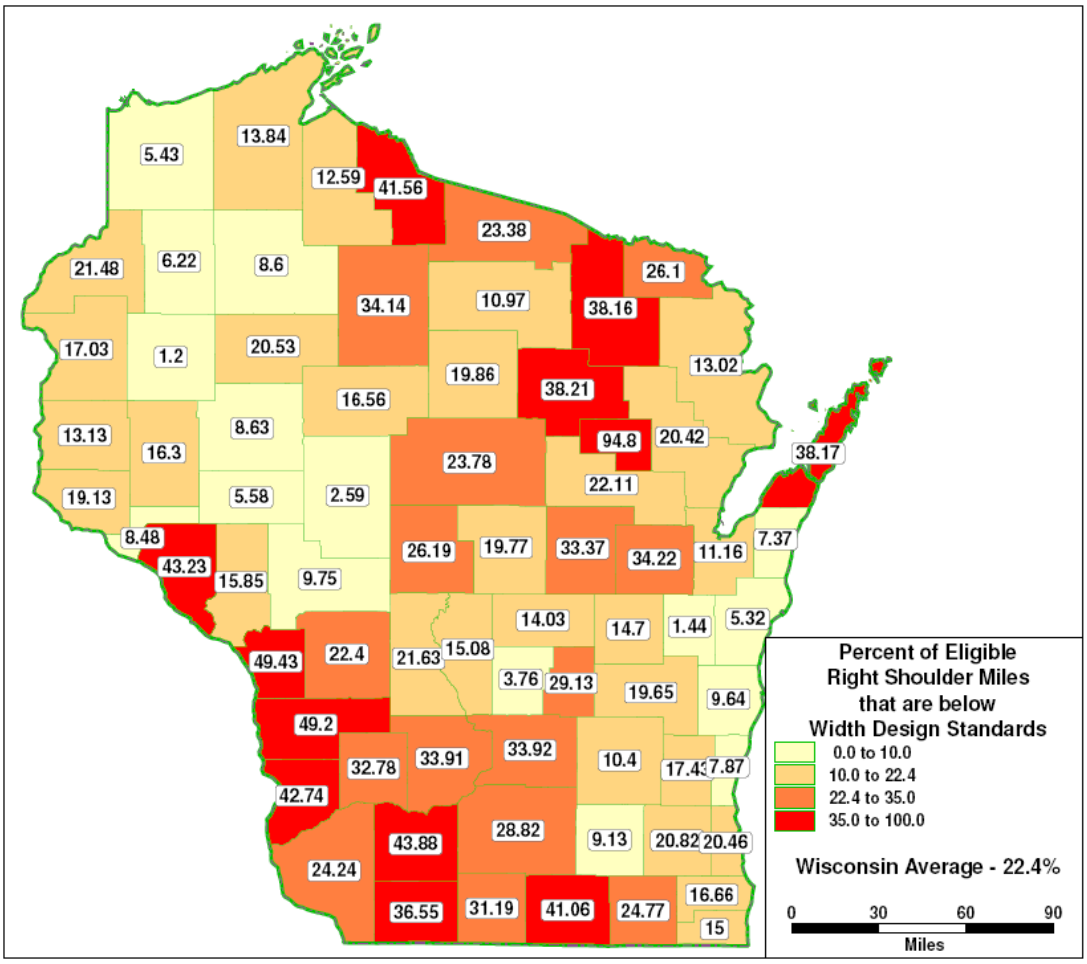
Cost estimates to widen the shoulders of roads are based on widening the current shoulder width out to design specifications for those shoulders that are currently below standard. Table 13 indicates that about 12,900 foot-miles of shoulder would need to be widened if *all* narrow shoulders were widened to design standards. However, not all of these could be widened due to geometric limitations or other factors. If about half of these were widened for major roads, and 25% for lower volume roads, with costs per foot-mile ranging from $5,000 to $10,000, **about $34.2 million would be needed to bring half of the state's road shoulders up to minimum width standards.** This estimate is probably on the low side, since it does not include the cost of roadbed widening in hilly areas, which could be substantially more than the per-foot-mile estimates, or the cost of right-of-way, which would be needed if the shoulder widening encroached onto private property.

Table 13: Cost to Widen Narrow Shoulders, in Thousands of Dollars

					Policy				2011-14		2015-20		2011-2020
Category	**2010 Eligible Right Shoul-der Miles**	**Stand-ard Shoul-der Width**	**Shoul-der Miles below Std**	**Shoul-der Foot-Miles Needed**	**Per-cent Wid-ened**	**Cost per Foot-Mile to Widen, in Thousa nds**	**Foot-Miles Wid-ened**	**Total Cost, in M**	**Foot-Miles Wid-ened**	**Inflat ed Cost, in M**	**Foot-Miles Wid-ened**	**Inflat ed Cost, in M**	**Inflat ed Cost, Total, M**
6+Lane Expy, Milw. Co.	98	10 ft	16	45	**50**	10.0	22	0.2	9	0.1	13	0.2	0.3
6+Lanes, Other	256	10 ft	27	90	**50**	10.0	45	0.4	18	0.2	27	0.3	0.5
4 Lanes, ADT > 25k	2,763	10 ft	71	207	**50**	10.0	103	1.0	41	0.4	62	0.8	1.2
4 Lanes, ADT < 25k	1,306	10 ft	290	1,086	**50**	10.0	543	5.4	217	2.3	326	3.9	6.2
2 Lanes, ADT > 5K	4,093	8 ft	948	2,197	**50**	10.0	1,098	11.0	439	4.6	659	8.0	12.6
2 Lanes, ADT < 5K	13,079	6 ft	3,476	9,297	**25**	5.0	2,324	11.6	930	4.9	1,395	8.5	13.4
Totals	**21,596**		**4,828**	**12,921**			**4,136**	**$ 29.7**	**1,655**	**$ 12.6**	**2,482**	**$ 21.7**	**$ 34.2**

Sources: Shoulder widths: WisDOT Roadway Inventory File, Feb 2011.

Figure 13: Percent of Eligible Right-Shoulder Miles Below Width Design Standards



Source: Wisconsin Roadway Inventory File, WisDOT, February 2011.

Although a formal cost-benefit assessment of a shoulder-widening initiative is beyond the scope of this review, it is believed that the initiative would be quite cost-effective, resulting in a reduction in frequency and severity of some accidents. A 1988 study reviewing data from seven states[37] found a 16% reduction in accident rates from adding a 2-foot paved shoulder and a 29% reduction for adding a 4-foot shoulder. The Texas A&M safety manual[38] notes that in rural areas, increasing shoulder width from 3 to 8 feet on four-lane and high-volume two-lane roads reduces accidents about 15%. In urban areas, widening shoulders from 2 to 4 feet on four-lane arterials reduces accidents about 5.4% and on two-lane arterials about 11.5%. The geometries and configurations of the individual highway sections may well prohibit shoulder expansion, and any reductions in accident frequency factors would, of course, have to be applied only to the sections treated. Still these reductions do show that the magnitude of the shoulder widening effect can be substantial, an effect that would be difficult to achieve in other ways for similar costs.

6. Physical Maintenance and Operations

Physical maintenance and roadway operations are also important regular activities. Numerous studies indicate that early regular maintenance of roads and bridges lengthens their service life and lowers overall costs by reducing later higher expenses. However, the vulnerability of maintenance costs to budget cuts sometimes makes them an easy short-term target, an action that can lead to significantly higher costs later.

Maintenance refers to activities that are intended to provide intermediate relief for road and bridge conditions but do not add to long-term life or system improvements. Typical activities under this category include light road treatments such as pothole filling and some crack sealing, shoulder maintenance, ditching, signs and vegetation, and snow and ice removal. Operations include activities related to traffic monitoring and management, lift bridge operations, management of signs, markings and signals, and similar functions.

In its 2011-13 biennial budget, Wisconsin identifies about $200.2 million for "highway maintenance, repair, and traffic operations" for state fiscal year 2012.[39] However, this includes funds for snow and ice removal, roadside maintenance, some signal maintenance, and some light road repairs. In our analysis we break out snow and ice removal, roadside maintenance, signal repairs, and higher-cost pavement repairs and treat them separately. Therefore our analysis of maintenance includes primarily light physical and bridge maintenance and traffic operations such as the traffic control center in Milwaukee, and is therefore somewhat lower in total cost than the state's budget estimates.

Differing from most (if not all) other states, Wisconsin uses *localities* to maintain state roads, even the higher-level roads such as the interstate system. These arrangements are contracted by the state with individual counties, at about $100 million annually, and are separate from the "grants to localities" that the WisDOT also administers for local road assistance.

Table 14 estimates pavement and bridge maintenance and traffic operations costs for the coming decade. We used the state's reported 2008 base year total, about $140.5 million annually (which excludes snow and ice treatment) to estimate future needs. We also assumed a slower growth rate, 2% annually, than for major contracts, since these funds are largely under state budgetary control. Assuming a modest increase for 2011-14 (about 6%, on average) and a somewhat higher increase for 2015-20 (about 16%, on average) we estimate that **about $1.574 billion will be needed for pavement and bridge maintenance and traffic operations over the next decade,** excluding snow and ice, roadside, and signal replacements.

Table 14: Physical Maintenance and Operations, in Millions of Dollars

Expenditure Category	2000	2004	2008	2011-14	2015-20	Total, 2011-20
Physical Maintenance	93.2	95.5	66.7			
Other Maintenance Services	-	-	33.3			
Traffic Operations	21.9	42.2	40.5			
(Subtotal)	**115.1**	**137.7**	**140.5**	**$ 595.9**	**$ 978.2**	**$1,574.0**
Snow and Ice Maintenance	32. 8	40.3	86.7			

Source: 2000-08, FHWA Highway Statistics, Table SF4C, various years. Forecast: WisDOT budget statistics.

This assessment assumes no major changes in present maintenance and operations practices, such as might occur if the state were to expand its traffic operations center to cover the whole state or restructure its maintenance contract arrangements with counties by initiating private maintenance contracts.

7. Winter Maintenance

Regular pavement and bridge maintenance is covered in the discussion above. However, additional costs of winter-related maintenance are not covered there. The cost of winter maintenance obviously depends on the severity of a particular winter and the duration, nature, geographical location, and timing of the various storm events. Another important factor is the desired level of service -- for instance, the percentage of roads cleared to bare pavement two hours after a storm ends. The costs can vary widely, as shown in Table 15 below. The winter of 2008 cost 88% more than the one in 2006.

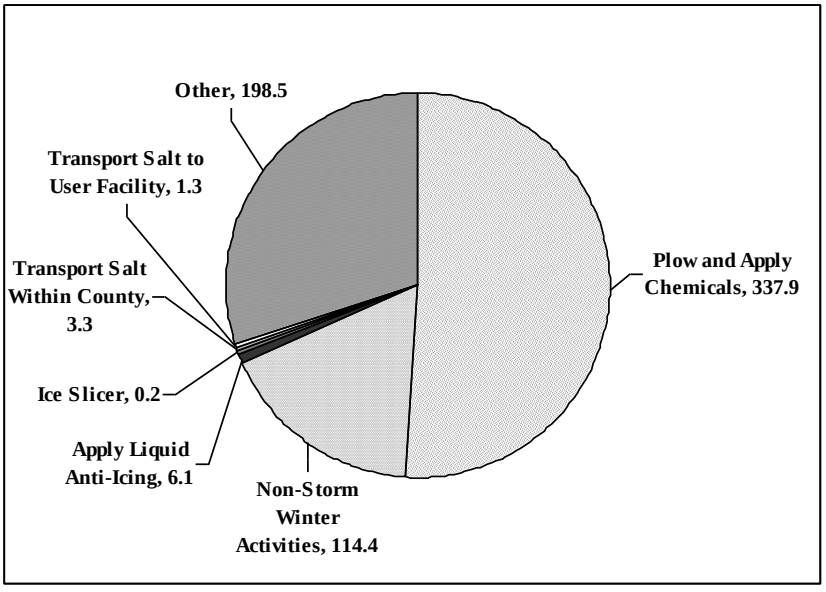
Winter maintenance operations consist predominantly of the winter-specific activities noted in the table below, but they also include activities such as public service announcements and Road Weather Information System (RWIS) monitoring. A review of the Compass Report and the Budget Report found these other activities to be about 30% of the total. The projections are based on the historical data which comes from these two reports. As evident in Figure 14, the majority of the cost (51%) is in the plowing and chemical application process.

Table 15: Historical and Projected Cost of Winter Operations, in Millions of Dollars

	Historical						Projected		Total
Activity Description	**2006**	**2007**	**2008**	**2009**	**2010**		**2011-14**	**2015-20**	**2011-20**
Plow and Apply Chemicals	24.9	26.7	49.0	41.4	28.9		124.1	213.8	337.9
Non-Storm Winter Activities	7.7	8.4	10.3	10.1	9.8		42.0	72.4	114.4
Apply Liquid Anti-Icing	0.3	0.4	0.4	0.4	0.5		2.2	3.9	6.1
Ice Slicer	0.0	0.0	0.0	0.1	0.0		0.1	0.1	0.2
Transport Salt Within County	0.3	0.2	0.5	0.4	0.3		1.2	2.1	3.3
Transport Salt to User Facility	0.1	0.1	0.7	0.3	0.1		0.5	0.8	1.3
Other Costs	12.4	15.6	25.5	26.7	17.0		72.9	125.6	198.5
Totals	**45.8**	**51.5**	**86.3**	**79.3**	**56.7**		**243.0**	**418.8**	**661.8**

Sources: Base activities and costs: WisDOT winter cost budget estimates, February 2011. Other activities, WisDOT Compass Report 2009

Figure 14: Total Projected Costs of Winter Operations, 2011-2020.



Based on recent expenditures and historical trends, **this expenditure is estimated at about $661.8 million over the next decade.** This estimate includes inflation.

8. Roadside Maintenance

The roadsides along highways also require regular systematic maintenance. The WisDOT annual Compass Report[40] classifies roadside maintenance into four categories (shoulders, drainage, roadside, and traffic and safety) and then addresses the percent of the system that is backlogged and how well the particular features of each category are maintained, both as an absolute grade and in relation to the grade that WisDOT seeks to maintain.

The *Shoulders* category includes the basic maintenance of the shoulders (but not their widening), the removal of hazardous debris, the build-up of drop-off areas, and repair of eroded areas. WisDOT has identified a significant backlog of shoulder projects, especially in the repair of cracking in paved shoulders and drop-off areas in unpaved shoulders – both of these features received an F grade in 2009. According to the Compass report, while progress has been achieved in reducing the backlog in hazardous debris removal and pothole repair, the state system has seen some slippage in cross-slope and shoulder cracking repair. Still, only one feature, shoulder cracking, did not meet target goals.

Table 16: Percent of Shoulder Maintenance Backlogged and Status of Features.

	Percent of the System Backlogged							Feature Grade		
Shoulders Feature	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**	**% Chg 05-09**	**Target Grade**	**2009 Grade**	**Status**
Hazardous debris	12	13	9	9	8	10.2	-33.3	C	C	Met
Cracking (paved)	52	50	53	53	62	54.0	19.2	D	**F**	**Below**
Drop-off/build-up (paved)					4	4.0	NA	New	B	New
Potholes/raveling (paved)	7	5	6	6	6	6.0	-14.3	B	**A**	**Over**
Cross-slope (unpaved)	14	25	18	18	22	19.4	57.1	C	C	Met
Drop-off/build-up (unpaved)	36	40	40	44	34	38.8	-5.6	F	F	Met
Erosion (unpaved)	3	3	1	2	3	2.4	0.0	A	A	Met
Average	**20.7**	**22.7**	**21.2**	**22.0**	**19.9**	**21.3**				

Source: WisDOT Compass Report 2009

The *Drainage* category includes basic maintenance and repair of the ditches, culverts, gutters, etc. that help move water off and away from the highway. There is a sizable backlog in several areas to include culverts, flumes, and under-drains and edge drains, and this backlog worsened from 2005 to 2009. Only one area, curb and gutter, saw improvement during this time period (and is rated above its target), while two, flumes and the storm sewer system, saw increases in the backlog of 89% or more. And these two are also rated below their targets.

Table 17: Percent of Drainage System Backlogged and Status of Features.

	Percent of the System Backlogged							Feature Grade		
Drainage Feature	**2005**	**2006**	**2007**	**2008**	**2009**	**Avg**	**% Chg 05-09**	**Target Grade**	**2009 Grade**	**Status**
Culverts	18	15	20	28	23	20.8	27.8	C	C	Met
Curb and gutter	7	8	8	5	5	6.6	-28.6	B	**A**	**Over**
Ditches	2	3	2	2	2	2.2	0.0	A	A	Met
Flumes	19	27	25	39	36	29.2	89.5	C	**D**	**Below**
Storm sewer system	9	9	11	16	19	12.8	111.1	B	**C**	**Below**
Under-drains/edge-drains	20	13	20	30	24	21.4	20.0	C	C	Met
Average	**12.5**	**12.5**	**14.3**	**20.0**	**18.2**	**15.5**				

Source: WisDOT Compass Report 2009

The *Roadsides* category includes basic maintenance and repair of fences, litter removal, control of noxious weeds and woody vegetation, and mowing. The problem areas in this category are litter removal, mowing and the control of noxious weeds, which have backlogs of 33% or more. The backlog in each category has been relatively consistent in recent years, and maintenance in each feature met or exceeded target goals.

Table 18: Percent of Roadsides System Backlogged and Status of Features.

	Percent of the System Backlogged							Feature Grade		
Roadsides Feature	**2005**	**2006**	**2007**	**2008**	**2009**	**Avg**	**% Chg 05-09**	**Target Grade**	**2009 Grade**	**Status**
Fences	2	3	2	1	3	**2.2**	50.0	C	**A**	**Over**
Litter	62	64	60	61	66	**62.6**	6.5	D	D	Met
Mowing	35	39	36	42	35	**37.4**	0.0	C	C	Met
Mowing for vision		2	2	3	5	**3.0**		B	B	Met
Noxious weeds	29	34	29	38	33	**32.6**	13.8	F	**C**	**Over**
Woody vegetation control	3	3	3	2	4	**3.0**	33.3	B	**A**	**Over**
Woody vegetation control for vision	1	1	2	1	0.4	**1.1**	-60.0	A	A	Met
Average	**22.0**	**20.9**	**19.1**	**21.1**	**20.9**	**20.8**				

Source: WisDOT Compass Report 2009

The *Traffic and Safety* category includes signage (but not signals), pavement markings, and protective barriers. On the whole, efforts in this category seem to be on target (only one area, centerline markings, was below the goal) and all areas have a C rating or above except one, the routine replacement of non-regulatory/warning signs. The backlog is high in this area, as well, at 55%. Gains have been realized in reducing the backlogs in several areas (emergency repair of non-regulatory/warning signs, the routine replacement of signs of all types, protective barriers, and delineators). Edge-line and special pavement markings have seen dramatic increases in backlogs.

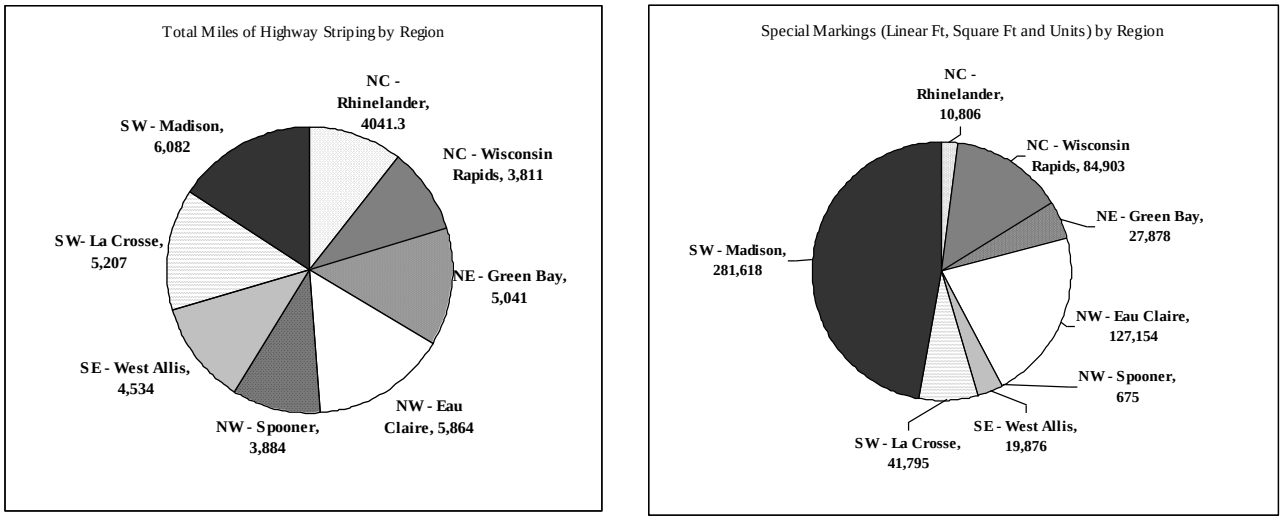
Table 19: Percent of Traffic/Safety System Backlogged and Status of Features.

	Percent of the System Backlogged							Feature Grade		
Traffic/Safety Feature	**2005**	**2006**	**2007**	**2008**	**2009**	**Avg**	**% Chg 05-09**	**Target Grade**	**2009 Grade**	**Status**
Centerline markings	5	4	3	3	7	**4.4**	40.0	B	**C**	**Below**
Delineators	24	21	21	26	20	**22.4**	-16.7	C	C	Met
Edge-line markings	5	6	4	4	12	**6.2**	140.0	C	C	Met
Detour/object marker/recreation/guide signs (emergency repair)	1	1	0.3	0.4	0.3	**0.6**	-70.0	A	A	Met
Detour/object marker/recreation/guide signs (routine replacement)	59	55	56	55	51	**55.2**	-13.6	F	**D**	**Over**
Protective barriers	4	4	5	3	3	**3.8**	-25.0	A	A	Met
Regulatory/warning signs (emergency)	1	1	1	1	1	**1.0**	0.0	A	A	Met
Regulatory/warning signs (routine replacement)	41	31	25	23	23	**28.6**	-43.9	C	C	Met
Special pavement markings	5	3	10	7	10	**7.0**	100.0	D	**B**	**Over**
Average	**16.1**	**14.0**	**13.9**	**13.6**	**14.1**	**14.4**				

Source: WisDOT Compass Report 2009

Centerline and special markings are broken out by WisDOT region in Figure 15 below. Interestingly, while highway striping seems to be distributed evenly throughout all regions, the special markings are overwhelmingly in the Southwest-Madison region.

Figure 15: Long-line Miles of Highway Striping and Special Markings, By Region



Source: WisDOT Long-line Painting and Special Pavement Markings data, February 2011.

Future costs for these activities are estimated using historical trends. Over the past several years, these expenditures have averaged about $50M to $60M/year, with traffic and safety receiving the biggest portion of the roadside maintenance budget. **The projected cost for roadside maintenance for the next decade, including inflation, is $684.5 million (Table 20).**

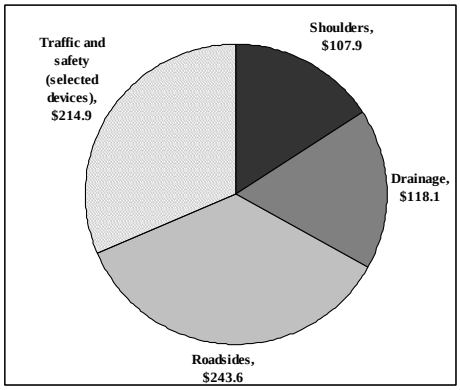
Table 20: Historical and Projected Cost of Roadside Maintenance, in Millions of Dollars.

	Historical					Forecast	Projected		
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011-14**	**2015-20**	**2011-20**
Shoulders	7.5	8.2	9.8	8.2	9.0	9.2	39.6	68.3	**107.9**
Drainage	5.7	5.1	7.2	8.0	9.8	10.1	43.4	74.7	**118.1**
Roadsides	20.2	21.9	24.0	19.4	20.3	20.9	89.4	154.1	**243.6**
Traffic and safety (selected devices)	15.8	16.4	17.2	17.3	17.9	18.4	78.9	136.0	**214.9**
Totals	**49.2**	**51.6**	**58.2**	**52.9**	**57.0**	**58.6**	**251.3**	**433.1**	**684.5**

Source: WisDOT Compass Report 2009

The largest share is for roadside maintenance, followed by traffic and safety activities (Figure 16).

Figure 16: Projected Roadside Maintenance Costs by Category, in Millions



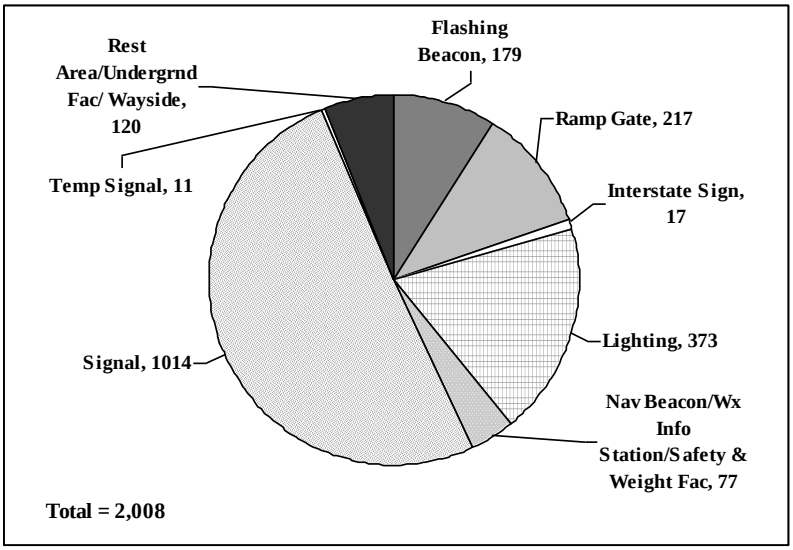
Source: WisDOT Compass Report, 2009

9. Signals and Lighting

Traffic signals and other lighted features are a critical element of the State Highway System, providing for control and management of traffic and ensuring safe use of intersections and other roadway elements. Maintaining, upgrading and occasional replacing these features are important activities.

The Wisconsin State Highway System has about 1,014 traffic signal sites, and another 994 sites with other special signals or lighting. Figure 17 summarizes the types of signal sites and other lighted sites on the State Highway System. Of the 2,008 sites, about half (1014) are signals, and another 20% (373) are roadway lighting sites. The others are special lights, gates, beacons and service area lighting.

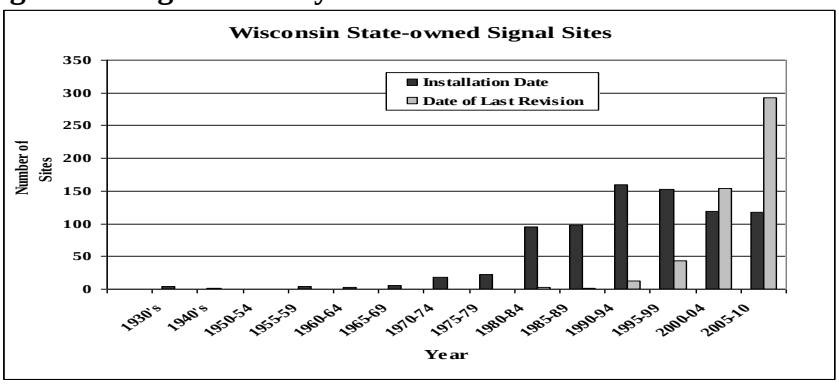
Figure 17: Lighted Sites, Wisconsin State Highway System



Source: WisDOT Signal Sites Library, February 2011.

The earliest installations of Wisconsin's signals dates from the 1930s (Figure 18) but most are much newer and many new signals have been installed in the 1990s and after 2000, as traffic has risen and suburban growth around regions has necessitated additional traffic control. Almost all traffic signals have been revised, retimed or replaced since 1990, and about 57% of the state's signal sites have been revised since 2005.

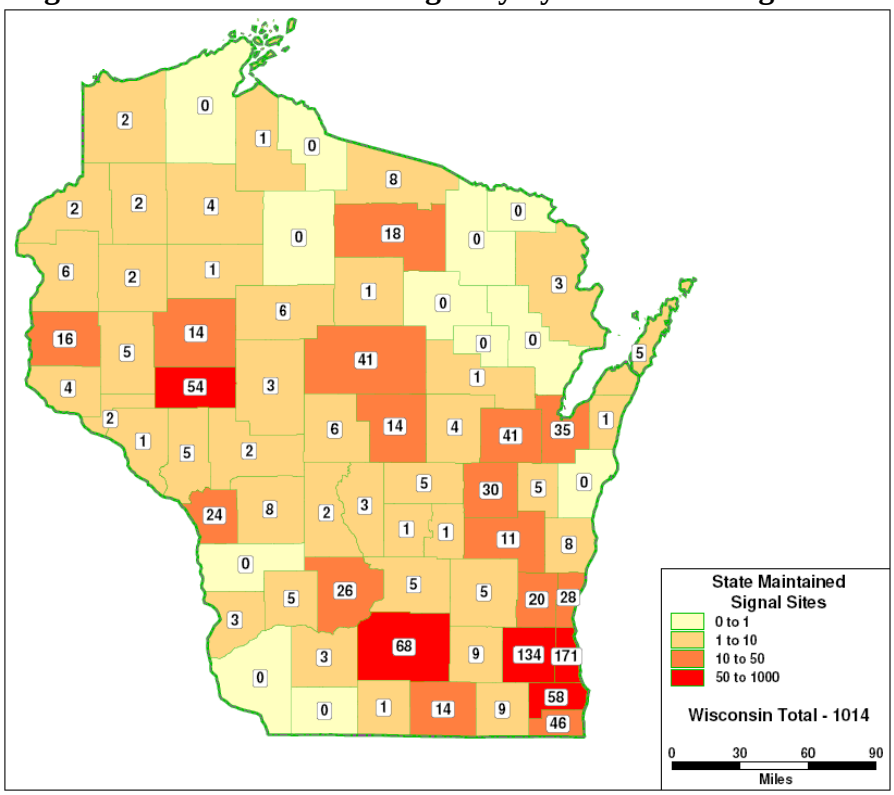
Figure 18: Signal Sites by Installation and Year of Last Revision



Source: WisDOT Signal Sites Inventory, February 2011.

The geographic distribution of signal sites generally follows the state's urban population distribution by county (Figure 19). Milwaukee County (171 signal sites) and Waukesha County (134 sites) lead the list, with Dane, Racine and Eau Claire counties each having over 50 sites. Other counties have proportionally fewer.

Figure 19: Wisconsin State Highway System Traffic Signal Sites



Source: WisDOT Signal Sites Inventory, February 2011.

Data on the condition and adequacy of signals is not readily available for the Wisconsin signal inventory. However a recent national study[41] rated the overall U.S. signal program as earning a grade of D, and it found that about 43% of the jurisdictions responding to a national signal survey had no regular program for signal timing or maintenance. The study further recommended that maintenance of coordinated signals should be scheduled at least every three years.

To estimate needs for signals and other lighted sites, we first identified sites by installation date and revision date. Review of this information suggests regular maintenance and replacement schedules. Older signals would need to be visited at least annually for retiming, while newer signal sites might need somewhat less maintenance. For replacement, we assumed that most but not all older signal sites would be replaced in the next decade, but a lower portion of newly installed sites would likely need replacement. We used typical literature-based costs for maintenance ($2,500 to $6,000 per site per year) and replacement costs of $50,000 per signal head group (four to 10 signal head groups per site depending on intersection configuration).[42]

Table 21: Signal and Other Lighted Sites: Needs, 2011-2020, in Millions of Dollars

			POLICY		POLICY				2011-14		2015-20		Total
Site Install Year	**Sites**	**Per-cent**	**Per-cent Main-tained per year**	**Annual Main-tenance Cost per Site**	**Per-cent Repla-ced in 10 years**	**Avg Signal Head Group per Site***	**Repla-cement Cost per Signal Head Group**	**Total Base Cost, in Millions**	**Sites with Signals Replaced**	**Mainten-ance and Replace-ment Cost, Inflated, in Millions**	**Sites with Signals Replaced**	**Maintena nce and Replacem ent Cost, Inflated, in Millions**	**Total Cost, in Millions, 2011-20**
1930-49	5	0.6	**100**	2500	**80**	4	50000	$0.9	2	**$0.4**	2	**$0.7**	**$1.1**
1950s	4	0.5	**100**	2500	**70**	4	50000	$0.7	1	**$0.3**	2	**$0.5**	**$0.8**
1960s	9	1.1	**100**	2500	**70**	6	50000	$2.1	3	**$0.9**	4	**$1.5**	**$2.4**
1970s	41	5.1	**100**	3500	**60**	8	50000	$11. 3	10	**$4.8**	15	**$8.2**	**$13.0**
1980s	193	24.1	**100**	5000	**50**	12	50000	$67.6	39	**$28.6**	58	**$49.3**	**$77.9**
1990s	312	39.0	**85**	5000	**30**	12	50000	$69.4	37	**$29.4**	56	**$50 .7**	**$80.0**
2000-04	119	14.9	**60**	6000	**10**	16	50000	$13.8	5	**$5.8**	7	**$10.1**	**$15.9**
2005-10	117	14.6	**60**	6000	**5**	16	50000	$8.9	2	**$3.8**	4	**$6.5**	**$10.3**
No date	214	N/A	**50**	3500	**50**	8	50000	$46.5	43	**$19. 7**	64	**$34.0**	**$53.7**
Subtotal	**1,014**	**100**						**$221.2**	**141**	**$93.5**	**212**	**$161.5**	**$255.0**
Other Sites	**994**	**100**	**50**	2000	**30**	4	50000	**$69.6**	119	**$29.4**	179	**$50.8**	**$80.2**
Total	**2,008**							**$290.8**	**260**	**$122.9**	**390**	**$212.3**	**$335.3**

Source: WisDOT Signal Site Inventory, February 2011. *Average 17.7 signal heads per intersection.

Table 21 summarizes the findings. **The estimated total 10-year need for prudent maintenance and replacement of signals and other lighted sites is about $335 million. Of this, about $255 million is for signals.** These costs include an adjustment for inflation.

10. New Roads, Expansions, Major Bridges and Interchanges.

Repairs and maintenance for the existing road system are not the only Wisconsin road needs. As the population grows or standards change, new or expanded facilities are also needed. The STIP consolidates needs for the state's urban areas and for rural counties outside urbanized area boundaries, but only for 2011-14. The STIP also contains preliminary work for some (but not all) longer-range projects that are on the drawing boards for later years, beyond the end of the 2011-14 funding cycle.

To determine needs for major widening and new road projects, we first reviewed the STIP for major bypasses, new roads, new bridges and similar actions. We also reviewed the long-range plans of the 14 urbanized areas and contacted each Metropolitan Planning Organization (MPO) to identify major projects in their plans that are beyond the STIP in time but are likely to see progress in the next 10 years. We also reviewed the project lists of the Wisconsin Transportation Projects Commission and other sources for large statewide projects that might be initiated in the next 10 years. We also added several projects recently proposed or potentially on the list.

Most projects that involve expansion also need other improvements such as pavement repairs, bridge work, lane width, shoulder work, and other actions. Therefore, expansion projects should have their costs reduced somewhat to account for this 'overlap' work which we have already considered above. In addition, not all major new or expansion projects are on the State Highway System (although most are) and some projects are not scheduled for action until after 2020, our 10-year horizon. Adjusting for these reductions is necessary for consistency. To account for these concerns, we reduced the estimated cost of these projects by 20% to 50%, depending on circumstances. However, we did not eliminate all projects, since some are clearly new roads on new alignments or similar, and as such constitute system additions. The appendix to this report contains the complete list of major projects for each region and describes in detail the cost adjustments for these considerations.

Table 22 is a summary of these findings for each region and for other statewide projects. Including several recent announcements (most recently, the governor's $1.5 billion proposal to upgrade 142 miles of U.S. 41 to interstate status[43]), about 809 additional miles of major projects are planned for the 2011-20 time frame. Adjusting for overlap in work categories, state ownership and the 10-year horizon, **about $2.278 billion in the 2011-14 time period and about $5.498 billion in the 2015-20 time (about $7.776 billion total) is needed for the state's share of additional major projects over the next decade.**

Table 22: Major New and Expansion Needs, Wisconsin State Highway System, 2011-2020

Region	Total Length, 2011-20 Projects	2011-14 Base Year Costs	2011-14 Cost Adjusted for Inflation and Overlap	2015-20 Base Year Costs	2015-20 Cost Adjusted for Inflation and Overlap	2011-20 Cost Adjusted for Inflation and Overlap	2020+ Base Year Costs	2020+ Cost Adjusted for Inflation and Overlap
Duluth-Superior	25.0	$41.5	$17.2	$28.6	$8.3	**$25.4**	$0.0	$0.0
Beloit	1.5	$5.0	$1.3	$10.0	$2.9	**$4.2**	$0.0	$0.0
Janesville	18.1	$70.7	$66.9	$13.6	$9.5	**$76.4**	$225.0	$295.8
Dubuque, Iowa	No major projects in Wisconsin							
Chippewa Falls-Eau Claire	5.0	$0.0	$0.0	$17.7	$8.2	**$8.2**	$11.7	$1.7
Wausau	6.2	$20.4	$13.3	$9.6	$9.4	**$22.8**	$4.1	$5.0
La Crosse	18.6	$129.6	$91.8	$133.8	$117.5	**$209.3**	$0.0	$0.0
Oshkosh	19.5	$90.1	$64.4	$23.7	$23.0	**$87.3**	$50.8	$42.8
Fond du Lac	6.0	$0.0	$0.0	$61.4	$21.2	**$21.2**	$25.0	$29.1
Appleton	19.5	$31.0	$19.4	$0.0	$0.0	**$19.4**	$150.0	$188.8
Sheboygan	13.1	$30.4	$14.3	$10.5	$0.0	**$14.3**	$18.2	$9.8
Madison	20.2	$97.5	$57.4	$55.2	$10.9	**$68.4**	$10.0	$11.1
Green Bay	26.5	$382.7	$232.4	$10.5	$3.1	**$235.5**	$128.0	$84.9
SE Wisc. RPC	97.1	$1,215.2	$916.9	$2,320.9	$2,123.7	**$3,040.7**	$5,201.5	$4,390.2
(Subtotal-MPOs)	**276.3**	**$2,114.1**	$1,495.4	**$2,695.5**	**$2,337.8**	**$3,833.1**	**$5,824.3**	**$5,059.2**
State Transportation Project Commission	317.1	$1,206.8	$782.2	$350.6	$287.9	**$1,070.1**	$0.0	$0.0
(recd for adding 2011)	70.0	$0.0	$0.0	$1,355.0	$1,009.2	**$1,009.2**	$0.0	$0.0
St. Croix Bridge and U.S. 41 Upgrade to Interstate	146.0	$0.0	$0.0	$1,800.0	$1,863.9	**$1,863.9**	$0.0	$0.0
	533.1	**$1,206.8**	$782.2	**$3,505.6**	**$3,161.0**	**$3,943.2**	**$0.0**	**$0.0**
Grand Total	**809.4**	**$3,320.9**	$2,277.6	**$6,201.1**	**$5,498.8**	**$7,776.4**	**$5,824.3**	**$5,059.2**

Source: MPO long range plans and Wisconsin State Transportation Projects Commission. Adjusted for overlap with other categories. See appendix for complete list.

An additional $5.059 billion in identified needs are beyond the 10-year time frame of our study. This is likely to be a low estimate, since several of the state's regional plans and the State Transportation Projects Commission do not show details sufficient to quantify that longer-range need. As these plans are updated, the needs beyond 2020 will become more apparent.

11. Other Needs

In addition to needs for major projects, pavement and bridge repairs, capacity needs and other items, the State Highway System is also regularly improved in smaller but important ways. These improvements include upgrades of individual intersections to provide turning capacity, traffic signals, railroad grade crossing improvements, replacements of signalized intersections with roundabouts, pedestrian crossings and bicycle paths/greenways, and park-and-ride lots.

It is not feasible in this study to review all local and statewide plans for such actions, and for the years 2015-20 it is likely that all such actions have not yet been identified. Therefore, to estimate the needs related to these actions we reviewed the STIP for cases and examples of these projects. We adjusted costs for inflation, and for an assumed continuation of program activity.

Table 23 summarizes the findings. The largest portion of these needs is for intersection upgrades, usually adding turning lanes and improved signals. About $76 million is targeted for this work in the 2011-14 STIP, at an average cost of about $1.2 million per intersection. Looking forward, the total is estimated at about $219.5 million over 2011-20.

Wisconsin has also been active in installing roundabouts as substitutes for signalized intersections. About nine listed cases totaling $15.2 million are in the current STIP, and if trends continue, a total of $43.7 million is likely to be spent on this activity in the next decade.

Table 23: Needs for Other Actions, in Millions of Dollars

	2011-14				2015-20		Total 2011-20
	Number of Cases	STIP Total Cost, in Millions	STIP Ave Cost per Case, in Millions	Inflated Total Cost, in Millions	Number of Cases	Inflated Total Cost, in Millions	Total for 2010-20
Intersection Upgrades	62	$76.32	$1.23	$80. 7	93	$138.9	$219.5
Roundabouts	9	$15.20	$1.69	$16.1	14	$27.7	$43.7
Bike-Ped-Park/Ride	10	$9.65	$0.97	$10.2	15	$17.6	$27.8
Intersection Signals	10	$6.07	$0.61	$6.4	15	$11.1	$17.5
Railroad Crossing Signals	13	$2.02	$0.16	$2.1	20	$3.7	$5.8
Totals	**104**	**$109.27**	**$1.05**	**$115.5**	**156**	**$198.8**	**$314.3**

Source: Wisconsin 2011-14 STIP.

Additional improvements for bicycle-pedestrian-park and ride actions are estimated to total about $27.8 million, improved intersection signaling (without roadwork) about $17.5 million, and railroad grade crossing signaling about $5.8 million.

All total, **needs for these other actions that improve system quality are estimated to be about $314 million over the next decade.**

11. Administration

In addition to specific repair and expansion costs, there are also needs for administration and planning of agency programs. Federal rules for reporting administrative expenditures indicate that the costs should be only the *non-project* agency administrative costs *related to the State Highway Program.* The primary costs included are for general administration, non-project planning, general data gathering and research. Excluded are administrative costs for other functions such as motor vehicles or non-highway modes, engineering costs (which are mostly project specific) and maintenance costs.

We used the Highway Statistics tables from the Federal Highway Administration (specifically, Table SF4 and SF4C), to analyze administrative costs. This is data submitted by each state to FHWA and reflects each state's assessments of expenditures by category. Unfortunately the data is from 2008 at the latest. We used the 2% annual growth rate proposed in the 2011-13 Wisconsin state budget to forecast these amounts; this leads to a 6% average growth for the period 2011-14 and a 16% average growth for the period 2015-20.

Table 24 summarizes the findings. Over the past decade, WisDOT reports that administrative costs have increased to about $161.7 million in 2008, at that time about 7% of the budget. Some of that cost (about $66 million) was paid from highway rehabilitation and maintenance programs.[44] Going forward, **about $1.811 billion will be needed to administer the State Highway System over the next decade.**

Table 24: Administrative-Planning-Research Needs, 2011-2020, in Millions of Dollars

	2000	2004	2008	2011-14*	2015-20**	Total, 2011-20
Admin-Planning-Research	$122.98	$153.39	$161.69	$685.5	$1,125.3	$1,810.9

Source: WisDOT as reported In FHWA Highway Statistics, Table SF4 and SF 4C.
*Average 6% growth over 2008 (2%/year) **Average 16% growth over 2008 (2%/year)

This analysis assumes no major changes in the size of the department staff or its responsibilities, modest increases in agency administrative costs, but also no additional growth in these costs for possible increased activities. In other words, it assumes a somewhat leaner agency administrative function in the future.

12. Total Needs

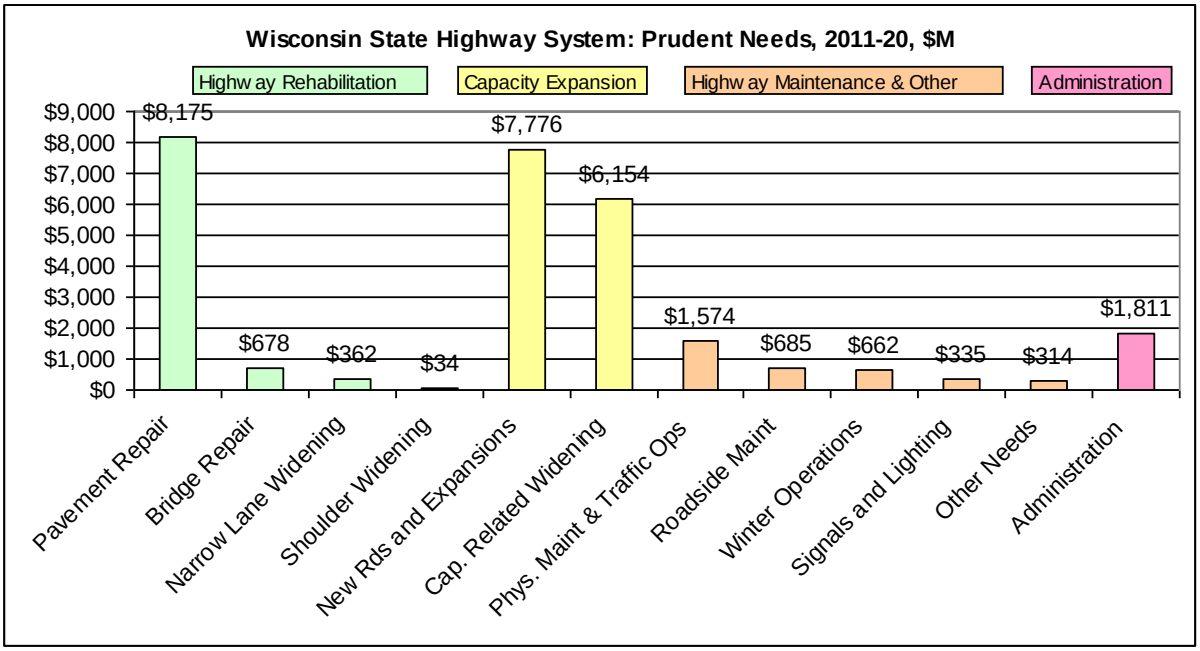
Summarizing the separate sections above, Table 25 indicates that **the total need for the Wisconsin State Highway System over the next decade is estimated at about $28.56 billion.** As noted in the various sections, this need is not the maximum need, nor a cut-down estimate, but rather an estimate of what might prudently be accomplished applying design standards along with some limitations on work completed. If the incremental widening costs of two major interstate widening projects in Milwaukee (about $431 million) are excluded, the estimate is about $28.15 million.

Table 25: Summary of Needs, Wisconsin State Highway System, 2011-2020

			2011-14		2015-20		2011-2020	
Category	**Units**	**Unit Need Count**	**Units Addressed**	**Inflated Cost, in Millions**	**Units Addressed**	**Inflated Cost, in Millions**	**Units Addressed**	**Total Inflated Cost, in Milions**
Highway Rehabilitation								
Pavement Repair	Miles	8,208	2,462	$3,003	3,693	$5,172	6,156	**$8,175**
Bridge Repair	Bridges	4,885	1,013	$249	1,519	$429	2,532	**$678**
Narrow Lane Widening	Lane-Miles	710	170	$133	255	$229	425	**$362**
Shoulder Widening	Foot-Miles	12,921	1,655	$13	2,482	$22	4,137	**$34**
Subtotal		**26,724**	**5,300**	**$3,398**	**7,949**	**$5,851**	**13,250**	**$9,249**
Capacity and Expansion								
New Roads/Expansions	Miles	809	485	$2,278	324	$5,499	809	**$7,776**
Capacity Related Widening	Miles	615	133	$2,261	200	$3,894	333	**$6,154***
Subtotal		**1,424**	**618**	**$4,539**	**524**	**$9,392**	**1,143**	**$13,931**
Maintenance and Other								
Physical Maintenance and Operations				$596		$978		**$1,574**
Roadside Maintenance				$251		$433		**$685**
Winter Operations				$243		$419		**$662**
Signals and Lighting	Sites	2,008	260	$123	390	$212	650	**$335**
Other Needs	Cases	260	104	$115	156	$199	260	**$314**
Subtotal		**2,268**	**364**	**$1,329**	**546**	**$2,241**	**910**	**$3,570**
Administration				**$686**		**$1,125**		**$1,811**
Total Prudent Needs		**30,416**	**6,283**	**$9,951**	**9,020**	**$18,609**	**15,303**	**$28,560***
Total, Less I-43 and I-94 in Milwaukee				**$9.951**		**$18,178**		**$28,147***

Highway rehabilitation needs total about $9.25 billion, of which the largest share is for pavement repair, $8.18 billion. Capacity needs and other expansions are estimated to need about $13.93 billion, of which new roads and expansions total about $7.78 billion and capacity needs total about $6.15 billion. Maintenance and other needs total about $3.57 billion, of which the largest amount is for physical maintenance. Administration totals about $1.81 billion, about 6.3% of the total. The three largest sub-categories of need are pavement repairs ($8.2 billion), major new projects ($7.8 billion) and capacity-related widening ($6.2 billion). These three categories are about 77% of all prudent needs. Figure 20 summarizes the needs in graphic form.

Figure 20: Summary of Needs, Wisconsin State Highway System, 2011-2020



C. Resources Available

In the above sections, we have developed an estimate of prudent repair and system expansion needs for the Wisconsin state-owned highway system over the next decade. In this section, we estimate the funds likely to be available, from all sources, to meet these needs.

1. Federal Funds

Although federal funds account for only about a third of all State Highway System road expenditures nationally, all states rely extensively on the federal government to provide funds for repair and expansion of major roads. Most federal funds are distributed to the states annually using formulas developed by Congress periodically in major transportation funding initiatives ("authorizations") that are funded annually ("appropriations"). The major funding categories and their allocation criteria are:

- *Interstate Maintenance*;
- *National Highway System;*
- *Surface Transportation Program;*
- *Highway Bridge Rehabilitation and Restoration;*
- *Congestion Mitigation and Air Quality.*

In addition to these major categories, states also receive funds for other purposes, including high-priority projects and other allocations, and also receive adjustments for minimum funding and equity bonuses. A new category, ARRA[45] (stimulus funds), provided additional funding for 2009 and 2010 but is scheduled to end in 2011, although some prior funds are still being spent. Considerable flexibility in funding decisions is also permitted, so not all federal funds are spent on state-administered highways, and some are also spent for other modes. Wisconsin has traditionally been a "donor" state, contributing more in federal highway dollars than it gets back, but in 2009 it was a "donee" state, receiving about 4% more than it contributed (subtracting out general fund transfers).[46]

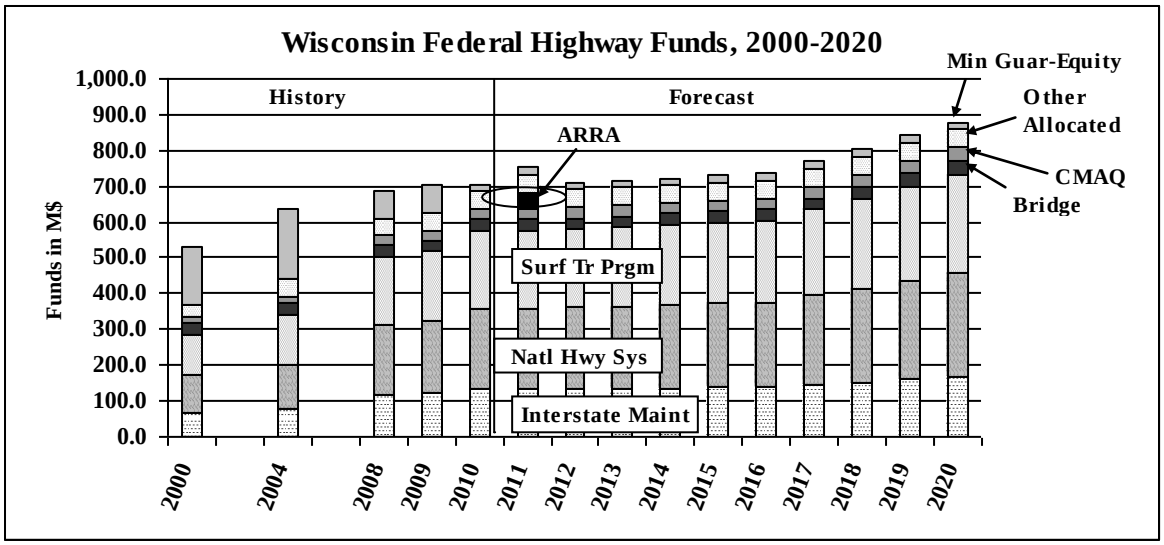
The current federal highway bill, known as SAFETEA-LU, covered the federal fiscal years 2003-09 and expired on September 30, 2009. However, numerous factors have intervened to impede reauthorization. These include the current recession and improving fuel efficiency, which have slowed revenues into the federal Highway Trust Fund; a lack of consensus about the future of the program and the appropriate federal role; and a reluctance to raise the federal gasoline tax rate, now 18.4 cents per gallon, and the diesel tax rate, 24.4 cents per gallon.

As a result of these uncertainties, Congress has not yet addressed a comprehensive new highway funding program but has continued funding the current program through periodic continuing resolutions and several infusions of federal dollars. The last continuation, a seven-month extension to September 30, 2011, came on March 3, 2011.

Although several national commissions[47] have studied the issue and have called for new sources of funding as well as a longer-term conversion to a per-mile tax, the new Congress with a more conservative inclination has yet to take action. The Obama administration's recent proposal for a $556 billion six-year program and its earlier fiscal year 2012 $50 billion funding request has been met with considerable skepticism. Congress has signaled that future federal spending will be aligned with revenues from *existing* user fees, without further transfers from the general fund.[48] There is even a distinct possibility (perhaps even a probability) that federal highway dollars could *fall* if the economic recovery stalls or Congress cuts federal budgets sharply. The continuing fiscal year 2011 budget resolution passed by Congress on April 14, 2011[49] cut transportation funds for the remainder of fiscal 2011, canceled some unused earmarks, and reduced transit and intercity rail funding. Another consideration is that Wisconsin's share of the federal total appears to be dropping slowly, from 2.26% in 2000 to 1.81% in 2008,[50] as other states show faster growth in traffic, population and Highway Trust Fund contributions.

These considerations mean that forecasts of federal funds for Wisconsin are likely to show only modest growth. Table 26 reflects that by forecasting only a modest increase in federal funding for the State Highway System for 2011-14 and a slightly higher forecast for 2015-20. Figure 21 shows the forecast for federal funds. However, since this assessment is largely based on assumptions concerning how Congress is likely to deal with transportation issues in the next several months, it should be reviewed periodically.

Figure 21: Wisconsin Federal Highway Funds, 2000-2020



However, not all federal highway funds are spent on state-administered roads; some goes to local roads, to locally-owned bridges, and to other non-road projects. Reviewing the fiscal

year 2009-10 state budget, we estimate that about $605 million in federal funds was spent on the State Highway System. However for fiscal years 2010-11, we estimate that that number is less, about $534 million, and will remain at that level through fiscal years 2013-14. Beyond that, we have assumed a very small increase in federal funds, about 1% per year, through 2017, when (it is to be hoped) yet another federal highway bill will permit a modest increase of 5% per year through 2020.

2. State and Local Funds

In addition to federal funds, each state also has its own highway-related revenues. Most states rely primarily on motor fuel taxes, vehicle registration fees, tolls, bonds, direct appropriations and federal funds for most of their highway-related revenues. However, Wisconsin's state fuel tax (30.9 cents per gallon) and vehicle registration fees are also used for other purposes -- 39% goes to local roads and streets, 8.3% to transit support, and 16.7% to general fund and non-highway uses.[51] Therefore, only about 35.9% of this revenue goes to the State Highway System. As a result, only about 34% of the State Highway System funding comes from user fees. Wisconsin has no toll roads, but it does have a modest bonding program.

Forecasts of likely resources for the State Highway System are based on data from the Wisconsin state budget for state fiscal years 2011-13, as proposed in February 2011. Table 26 summarizes the key portions of the budget dealing with the State Highway System; the appendix to this report identifies the exact items.[52] According to the budget, for 2009-10 about $1.371 billion was spent for "state highway facilities." To that we added portions of the 2009-10 budget dealing with general administration and operations ($112 million), the "safety and enforcement" (state police, truck weights, etc.) portions of motor vehicle and licensing functions ($73 million) and debt service ($104 million). For state fiscal years 2009-10, these resources totaled about $1.661 billion, and about $1.656 billion in fiscal years 2010-11.

For future years, the state budget forecast for 2011-13 assumes modest growth in state highway system funding as the economy improves. Our view is not quite so optimistic, since slowing federal revenues, improving vehicle fuel efficiency, modest state population growth rates and (most recently) rising gasoline prices all suggest slow growth (or possible decline) in the primary revenue sources. But Wisconsin's state fuel taxes constitute only about 22% of its State Highway System funding,[53] so even a 5% decline in fuel consumption between 2011 and 2020 would translate to about a 1% reduction in total program resources. This amount is below the accuracy of our other estimates. Therefore, we have elected instead to use the state's projection of state resources for 2012-13. Using the same procedures as above, this works out to $1.757 billion for state fiscal years 2011-12 and 2012-13. Beyond that, we assume a modest rise, about 2% per year, through 2017-18, then growth that's a bit more rapid to 2020. We assumed more modest growth or flat projections for general transportation operations, law enforcement and safety, and debt service. These forecasts may turn out to be optimistic: a recent WisDOT estimate forecasts a 2.4% decline in motor fuel revenues but a 2% increase in vehicle registration revenues, with the two together estimated at a 1.2% decline between 2010 and 2020.[54]

Consolidating these forecasts, we estimate that Wisconsin resources for the State Highway System are likely to grow modestly, from about $1.656 billion in state fiscal year 2010-11 to about $2.144 billion in 2019-20. **Over the 10-year period 2011-2020, about $18.63 billion in resources is reasonably likely to be available.**

Table 26: Revenue Sources, Wisconsin State Highway System, 2011-2020

In millions of dollars	Wisconsin State Budgets		2011-13 Wisconsin State Budget		Forecast							Sum for 2011-14	Sum for 2015-20	Sum for 2011-20
Program	**2009−10**	**2010−11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2010-11 thru 2013-14**	**2015-20**	**2011-20**
Aid, Highway														
Federal funds	2	2	2	2										
State + Service funds	431	441	441	441										
Local funds	0	0	0	0										
Subtotal	**432**	**443**	**443**	**443**										
Local Transportation Assistance, Highway														
Federal funds	128	115	115	115										
State + Service funds	32	31	31	31										
Local funds	52	52	52	52										
Subtotal	**212**	**199**	**199**	**199**										
STATE HIGHWAY SYSTEM														
State Highway Facilities														
Federal funds	577	507	507	507	512	517	522	527	533	679	713	2032	3492	5524
State + Service funds	791	840	944	944	963	982	1001	1022	1042	1063	1084	3690	6194	9884
Local funds	4	4	4	4	4	4	4	4	4	4	4	16	23	39
Subtotal	**1371**	**1351**	**1454**	**1454**	**1478**	**1503**	**1528**	**1553**	**1579**	**1746**	**1801**	**5738**	**9709**	**15447**
General Transportation Operations														
Federal funds	14	14	14	14	15	15	15	15	15	19	20	58	99	157
State + Service funds	97	98	99	99	101	103	105	107	109	111	114	397	649	1045
Local funds	0	0	0	0	0	0	0	0	0	0	0	1	2	4
Subtotal	**112**	**113**	**114**	**114**	**116**	**118**	**120**	**122**	**125**	**131**	**134**	**456**	**751**	**1206**
Motor Vehicle Law Enforcement and Safety														
Federal funds	13	12	12	12	12	13	13	13	13	17	17	49	85	134
State + Service funds	60	61	62	62	63	64	66	67	68	70	71	248	406	654
Local funds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**73**	**73**	**74**	**74**	**76**	**77**	**78**	**80**	**81**	**86**	**88**	**297**	**491**	**788**
Debt Service (principle repayment plus interest)														
Subtotal	**104**	**120**	**115**	**115**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**469**	**720**	**1189**
STATE HIGHWAY SYSTEM TOTAL														
Federal funds	605	534	534	534	539	544	550	555	561	715	751	2140	3676	5816
State + Service funds	948	999	1104	1104	1127	1149	1172	1195	1219	1244	1269	4334	7248	11583
Local funds	4	4	4	4	4	4	4	4	4	4	4	17	26	43
Debt Service (all State money)	104	120	115	115	120	120	120	120	120	120	120	469	720	1189
Total	**1661**	**1656**	**1757**	**1757**	**1790**	**1818**	**1846**	**1875**	**1905**	**2083**	**2144**	**6960**	**11670**	**18631**
% Federal	36.4	32.2	30.4	30.4	30.1	29.9	29.8	29.6	29.4	34.3	35.0	30.7	31.5	31.2
% State	57.1	60.3	62.9	62.9	62.9	63.2	63.5	63.8	64.0	59.7	59.2	62.3	62.1	62.2
% Local	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
% Debt Service	6.3	7.2	6.5	6.5	6.7	6.6	6.5	6.4	6.3	5.8	5.6	6.7	6.2	6.4
	100.0	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Wisconsin State Budget Request, 2011-13, Department of Transportation, February 2011. See appendix for details.

This assessment of likely resources is dependent on several key factors that are uncertain. Noted above is the uncertainty of federal funding, which could be significantly lower than estimated if Congress determines that government-wide budget cuts are needed, or if Congress passes a more conservative highway bill. A second major uncertainty is the national trend in motor fuel use, which most analysts believe to be slowing (perhaps even declining) as vehicles become more efficient. A third factor is the ability of the state to get ahead of deterioration and

complete necessary repairs on the southeastern Wisconsin road system on time and at predicted costs. All of these concerns would increase costs or lower revenues, widening the gap.

D. Gap between Resources and Needs

Estimation of the "gap" between resources likely to be available and prudent needs is of course an exercise based on a series of assumptions. There is no one estimate of the "gap" but many that depend on the underlying assumptions. Using the assumptions outlined in this report, Table 27 indicates that **over the next 10 years the gap between resources likely to be available and prudent needs is about $9.93 billion, or about $993 million per year.** If the widening of I-43 and I-94 in Milwaukee are deleted, the gap would be about $9.52 billion, or about $952 million per year.

Table 27: Comparison of Needs and Resources, in Millions of Dollars

Resources, 2011-20		**Needs, 2011-20**	
		Highway Rehabilitation	**$9,249**
Federal Funds	**$5,816**	*Pavement Repair*	*$8,175*
State Funds and Services	**$11,582**	*Bridge Repair*	*$678*
Local Funds	**$43**	*Narrow Lanes*	*$362*
Bonding/Debt Service	**$1,189**	*Narrow Shoulders*	*$34*
		Capacity and Expansion	**$13,931**
		New Roads and Expansions	*$7,776*
		Capacity-related Widening	*$6,154**
		Maintenance and Other	**$3,570**
		Physical Maintenance/Ops	*$1,574*
		Roadside Maintenance	*$685*
		Winter Operations	*$662*
		Signals and Lighting	*$335*
		Other Needs	*$314*
		Administration	**$1,811**
Total	**$18,630**	**Total**	**$28,560***
		**Total less I-43 Mitchell-Silver Spring and I-94 Marquette-Zoo, Milwaukee*	*$28,147**
Gap $9,930		**Gap per year $993**	
Gap $9,517*		*Gap* per year $ 952*	

Our estimate of the gap, averaging $993 million per year, suggests an increasing shortfall compared to earlier studies – for instance, the $242 million per year gap estimated in 2000 and the $698 million per year gap estimated in 2006. If fuel-related resources decline sharply, this gap could be even greater. Clearly this increasing trend should be cause for concern.

In summary, the analysis finds that expected resources are likely to cover only about 65% of the prudent highway needs over the next 10 years. But even if all major new projects were

deferred, or if all capacity-related widening were deferred, a gap of between $2.1 billion and $3.8 billion would still remain in meeting the needs for prudent pavement and bridge repairs, maintenance, signals, shoulders and other actions.

III. Discussion

This report finds that the prudent need for maintenance, repairs, expansions and related activities to support the Wisconsin State Highway System is about $28.56 billion over the next 10 years, compared with likely resources of about $18.63 billion. Therefore, the gap between likely resourses and prudent needs is about $9.93 billion, or about $829 million per year. The magnitude of the shortfall appears to be increasing.

This assessment does not consider local roads or other modes. These systems are also important not only because they support the State Highway System in providing access and mobility, but also because their sound condition is also a key element of quality of life. Review of the prudent needs and likely resources for these other systems should also be undertaken.

An additional consideration is that many of the assumptions made in this study have the effect of lessening need or raising resources and thus lowering the gap between resources and needs. We purposely did not consider all needs for the State Highway System, instead identifying *prudent* needs that might realistically be met over a decade. Had we included all needs for all repairs, the total would have been substantially higher. Similarly on the resources side, we considered the resources likely to be *realistically* available over the coming decade, assuming no major changes in state funding mechanisms and a cautious view of federal resources. This approach has the effect of perhaps overestimating resources, since some of these assumptions (particularly those regarding state fuel taxes and federal funds) may be optimistic. Therefore, it is possible that our assessment underestimates the gap between resources and needs.

Closing a gap of this magnitude would be a significant challenge even with more resources, but given the state's present fiscal circumstances, it is even more daunting. It is beyond the scope of this study to evaluate or recommend specific means of dealing with this issue; indeed, a study of various approaches and their suitability for Wisconsin would be extensive in its own right. However, it is appropriate for us to make general observations regarding the basic options.

First among those are, of course, actions to ***raise more revenue***. These include actions such as:

- *Use more of state road revenues for state roads.* One option is to use more of the state's road-user fees and registration fees for state-owned roads. But this would increase the pressure on funding other activities now funded with those revenues: local roads and transit, among others. The needs of these systems are also substantial.
- *Increasing user fees* such as the state fuel tax rate and registration fees, with possibly the dedication of increased revenues to state roads. These rates are comparable but in some cases higher than in other states. However, even significant increases in them might not raise enough revenue. Further, they directly affect people's pocketbooks and are likely to be unpopular. A newer idea, mileage-based fees, is also being widely discussed as a potential new (or replacement) form of user fee, but most analysts judge it infeasible for single states.
- *Bonding* is another option that might be attractive with current low interest rates. In recent years many states have increased bonding activities to take advantage of various federal programs such as GARVEE bonds and Build America Bonds, or lines of credit such as TIFIA. Wisconsin's bonding program is modest compared to many

states, but bonding also passes debt to future generations that will have their own needs, too.

- *Public-private-participation* and *tolls* as a revenue stream are also options. PPP initiatives have been used in many recent major road projects throughout the U.S., but they generally cover only major projects. Tolls do not increase revenues but merely allow for a mechanism to pay back an investment made by other means. They are also generally applied in unique situations where the benefits of tolling and their revenues clearly relate to specific projects.
- *Congestion pricing*, a form of tolling in which toll rates vary by congestion level, has also been tried in a few very large regions, but there is uncertainty about their applicability to other cities.
- *Increased federal funds* or other national resources are also a possibility, but we judge that major increases are unlikely in the current national fiscal environment, and there might be a significant decrease instead.
- *State infrastructure banks* or other mechanisms can improve the ability of localities to fund local road needs, thus reducing pressure on state resources.

Another basic approach is to ***lower needs.*** Although we have made what we consider a prudent estimate of needs by not addressing all needs, one might go further:

- *Restricting project selection*, for instance by increasing priority for projects that show higher user and non-user economic benefits of projects or create new jobs and economic activity. This would mean evaluating projects head-to-head across the state.
- *Raising the criteria for treatment.* For instance, tightening the criteria for road widening and allowing congestion to worsen above the current state standards would in effect delay some capacity-related widening. In response, drivers might shift times of travel, use ridesharing or transit, combine trip purposes or even change destinations. But this means lowering public expectations for when treatment is needed and what to do about it.
- *Lengthening repair cycles* is an option, but can result in greater costs later when more extensive work is required. Additionally, many of the state's higher-volume roads have conditions that already warrant action and cannot be delayed much longer.
- *Lowering demand* for road capacity and new roads through such actions as improved transit service, carpool and HOT lanes, flexible work hours, better traffic operations and controls and similar actions are also possible actions if undertaken in a cost-effective manner. But as traffic continues to grow, they often provide only interim relief.
- *Privatizing maintenance and other functions* such as engineering can have some effect on costs, but are unlikely to be large enough in and of themselves to significantly reduce overall needs, and might not even reduce costs in the long run.
- *Implementing interim measures* such as partial widening, one-side climbing lanes or truck lanes, partial intersection treatments, bottleneck removals, better incident response and better traffic operations are also options that can be cost-effective as well as delay the need for major work.
- *Restricting access* for improved roads is a means of retaining the public's investment in road capacity longer.
- *Reducing maintenance* is also an option but usually results in greater needs later.
- *Stretching out new investments* for road expansions and widening is another option, but this delays some improvements that could benefit the state's economy.

- *Shifting cost responsibility* to other governments or to the private sector is also an option, but does not reduce the total need and is judged less feasible.
- *Speeding up road improvements* through accelerated environmental review, design-build and other fast-track construction can also lower costs by reducing the effect of inflation and delivering user benefits faster.
- *Designing roads to last longer*, sometimes called 'European' construction, and performance-based contracting can lower costs over the longer term.
- *Innovative contracting*, such as using design-build, project performance warrantees, construction incentives and penalties, and similar options are also ways of dealing with rising costs.

Some of these options also have geographic implications, since their impacts would probably not be uniform throughout the state. This brief overview of various approaches is not intended to be definitive for Wisconsin but merely touches on the most frequently mentioned approaches. Review of such options and their applicability to Wisconsin is a significant study in its own right.

This report identifies significant issues regarding the future of Wisconsin's State Highway System. It finds that Wisconsin's 10-year needs for the State Highway System significantly exceed its likely resources and that this shortfall appears to be growing. Therefore, serious attention by elected and appointed officials to this issue is timely.

Continuing efforts to accurately monitor and estimate future costs and revenues of highway services in Wisconsin are essential to ensure that discussions about future transportation needs are based on solid information. This should include accurate estimates of revenue yields from present and potential resources as well as assessment of standards and criteria for transportation investment. If this report increases discussion and assists with activities intended to address this issue, then the authors will have achieved their objective.

Appendices

County Data

The following table provides basic information on the condition of Wisconsin's State Highway System at the *county* level. The source of this information is the WisDOT Roadway Inventory File, the National Bridge Inventory, and the WisDOT Signal Site File.

Table C1: Wisconsin State Highway System County Statistics

WisDOT Region	Wisconsin County	Total Roadway Miles	Miles Needing Pavement Repair	Shoulder-Miles Needing Wider Shoulders	Lane-Miles Needing Lane Widening	Roadway Miles Needing Capacity Widening	Count of Signal and Light Sites	Count of Special Markings	State-owned Bridges Total	Count of Bridges with Est. Repair Cost
NC	ADAMS	92.8	70.0	27.2	0.0	0.0	7	73	7	0
NC	FLORENCE	67.9	24.1	34.7	6.7	0.0	0	7	8	0
NC	FOREST	152.6	42.7	114.2	0.0	0.0	2	10	11	0
NC	GREEN LAKE	70.2	47.4	37.0	0.0	0.0	4	53	10	0
NC	IRON	115.0	39.4	91.3	0.0	0.0	3	15	18	2
NC	LANGLADE	145.1	90.7	105.2	6.6	0.0	2	10	10	1
NC	LINCOLN	186.2	77.1	57.7	0.2	0.0	10	24	50	7
NC	MARATHON	376.7	224.1	116.3	9.7	4.8	52	316	143	14
NC	MARQUETTE	111.3	68.9	6.3	0.2	0.0	3	37	35	0
NC	MENOMINEE	40.7	14.3	75.4	0.0	0.0	0	0	3	0
NC	ONEIDA	181.9	41.0	33.7	15.5	0.0	32	101	14	2
NC	PORTAGE	231.8	65.1	57.7	10.8	3.3	17	271	78	1
NC	PRICE	155.6	75.8	103.8	7.5	0.0	4	16	20	3
NC	SHAWANO	237.9	96.2	75.6	1.4	0.7	5	21	19	2
NC	VILAS	136.1	59.8	59.8	1.2	0.0	11	34	11	0
NC	WAUPACA	237.7	99.5	124.2	6.6	3.8	9	238	62	11
NC	WAUSHARA	154.7	74.9	35.6	0.0	0.1	7	117	21	1
NC	WOOD	206.5	117.6	80.8	4.7	0.0	11	138	49	7
NC Total		**2900.6**	**1328.4**	**1236.5**	**71.0**	**12.6**	**179**	**1481**	**569**	**51**
NE	BROWN	291.4	213.2	33.3	29.4	9.1	111	222	217	12
NE	CALUMET	103.4	62.8	2.6	0.0	0.0	19	64	12	1
NE	DOOR	124.7	54.0	74.5	3.5	0.2	16	182	9	0
NE	FOND DU LAC	256.6	119.8	73.5	2.8	5.9	29	252	70	11
NE	KEWAUNEE	64.3	13.8	8.6	0.0	0.0	2	7	18	1
NE	MANITOWOC	206.0	163.3	14.0	6.4	0.6	44	229	89	9
NE	MARINETTE	178.9	76.0	38.8	4.9	0.9	12	34	26	2
NE	OCONTO	196.4	62.8	59.3	2.9	0.0	17	97	37	1
NE	OUTAGAMIE	226.9	126.6	107.1	6.8	7.2	100	371	79	6
NE	SHEBOYGAN	230.1	164.0	28.8	9.2	4.0	28	145	50	7
NE	WINNEBAGO	241.4	98.0	41.1	36.8	10.6	111	404	129	17
NE Total		**2120.1**	**1154.2**	**481.6**	**102.8**	**38.5**	**489**	**2007**	**736**	**67**
NW	ASHLAND	126.3	101.8	29.1	20.8	0.0	1	102	19	0
NW	BARRON	178.8	120.4	3.3	0.0	0.4	19	93	64	3
NW	BAYFIELD	155.7	77.8	42.1	7.5	0.0	5	19	34	0
NW	BUFFALO	148.3	75.7	123.0	12.3	0.0	4	29	71	12
NW	BURNETT	108.1	75.5	45.4	22.0	0.0	3	12	14	0
NW	CHIPPEWA	288.3	141.6	35.3	12.4	0.0	47	243	130	23
NW	CLARK	187.9	102.9	7.9	0.0	0.0	11	65	42	1
NW	DOUGLAS	217.6	140.4	16.0	17.2	0.1	25	169	62	1
NW	DUNN	240.6	137.3	64.8	1.2	0.6	15	151	88	9
NW	EAU CLAIRE	213.8	140.2	15.7	2.9	0.6	90	540	112	19
NW	JACKSON	230.4	139.0	35.0	0.0	1.0	6	82	73	8
NW	PEPIN	48.0	28.3	7.8	2.9	0.0	6	38	16	1
NW	PIERCE	165.0	102.3	61.1	11.3	0.0	20	111	56	5
NW	POLK	169.6	82.8	52.8	0.4	5.3	9	100	13	1
NW	RUSK	105.1	58.5	42.7	0.0	0.0	3	36	29	2
NW	SAWYER	162.3	86.6	27.4	0.0	0.0	5	26	79	8
NW	ST. CROIX	262.1	150.5	51.2	0.2	6.3	59	324	87	3

NW	TAYLOR	110.9	41.4	35.4	0.0	0.2	10	64	20	4
NW	TREMPEALEAU	182.3	85.1	53.2	0.0	0.5	9	95	74	7
NW	WASHBURN	175.5	113.9	16.6	0.0	0.0	8	42	20	1
NW Total		**3476.5**	**2002.0**	**765.7**	**111.0**	**15.1**	**355**	**2341**	**1103**	**108**
SE	KENOSHA	174.6	133.0	27.6	3.1	15.7	73	2	56	6
SE	MILWAUKEE	439.8	338.7	44.7	83.2	121.0	216	1	495	213
SE	OZAUKEE	130.9	87.3	10.3	2.6	5.0	34	6	50	2
SE	RACINE	220.0	137.2	43.3	29.1	19.8	77	11	47	5
SE	WALWORTH	295.2	206.4	99.9	19.7	4.2	23	4	115	9
SE	WASHINGTON	249.7	167.4	58.1	15.3	6.0	36	240	73	3
SE	WAUKESHA	368.2	251.3	81.7	22.0	44.7	177	33	170	37
SE Total		**1878.5**	**1321.3**	**365.6**	**175.2**	**216.4**	**636**	**297**	**1006**	**275**
SW	COLUMBIA	322.6	216.1	176.0	7.9	6.9	22	584	97	14
SW	CRAWFORD	182.3	135.6	145.2	7.5	2.1	8	10	64	11
SW	DANE	577.8	331.3	209.0	77.1	81.1	136	1245	284	55
SW	DODGE	275.8	133.4	45.6	2.8	1.7	16	520	63	10
SW	GRANT	282.5	145.3	116.0	5.0	0.4	4	36	66	10
SW	GREEN	133.0	98.7	71.9	11.5	0.0	2	174	28	1
SW	IOWA	202.4	114.4	144.8	0.6	1.7	7	204	56	3
SW	JEFFERSON	212.4	134.5	29.4	21.6	5.3	20	388	70	7
SW	JUNEAU	226.7	188.1	78.0	12.3	0.5	6	45	80	6
SW	LA CROSSE	210.1	149.1	122.0	14.4	18.4	32	26	103	15
SW	LAFAYETTE	138.6	50.4	88.4	1.4	0.0	1	98	41	2
SW	MONROE	292.6	160.9	102.9	1.8	0.7	13	95	154	10
SW	RICHLAND	157.2	101.0	96.6	0.0	0.0	7	32	76	4
SW	ROCK	314.7	169.3	178.8	41.9	2.6	30	487	115	25
SW	SAUK	255.3	145.4	135.8	7.1	4.3	41	684	100	10
SW	VERNON	214.7	128.5	199.5	0.5	0.3	3	59	74	2
SW Total		**3998.7**	**2401.9**	**1940.0**	**213.6**	**125.7**	**348**	**4687**	**1471**	**185**
	(blank)	37.8	0.0	38.8	36.4	0.0	1	0		
	Grand Total	**14412.2**	**8207.8**	**4828.2**	**709.9**	**408.3**	**2008**	**10813**	**4885**	**686**

Technical Notes and Details

This brief technical appendix provides, in bullet form, additional information on the computation methods used in this report. Several additional key tables are also included.

Demographic and Travel Data

- Comparative highway statistics: source is Tables SF3, SF4, HM 61, and HM 42, Highway Statistics, 2008. Data are submitted annually by the states. Data include other state-administered systems -- for instance, toll roads, ferries, universities and parks -- but these are a very small part of the total in Wisconsin.
- Economic and demographic data is from AASHTO Innovative Highway Financing website, various years, as reported in Highway Statistics. Sources are the state highway agencies.
- Urbanized area data: source is Highway Statistics, various years. Data for urbanized areas includes increased boundaries, as defined by the U.S. Census.

Pavement Repairs

- Mileage for pavements in various condition levels comes from WisDOT Roadway Inventory File (RIF), February 2011, representing 2010 conditions.
- For each road section, pavement roughness (IRI in "inches per mile") is converted from IRI in "millimeters/kilometer" reported in the RIF.
- Roadway file groupings are obtained from WisDOT 2009 Compass Report, using the six "Maintenance Road Groupings," from the Compass Report. We use these road groupings throughout our work, since the study covers more than the southeastern Wisconsin area and many types of needs are being computed.
- For each roadway section in the RIF, the Maintenance Road Group is determined based on total ADT, as reported in the file, number of lanes (doubled for divided highways) and county (Milwaukee vs. the rest of the state).
- Data are summed using pivot tables.
- For costs of road repairs, we reviewed the 2011-14 STIP to determine average costs per mainline mile for various types of work. To obtain these, we first calculated midpoint cost estimates (midway between "high" and "low" cost estimates in the STIP). We then identified only "mainline" portions of projects, since the STIP contains numerous contracts for the same location or job. We then computed average "mainline" costs per centerline mile for projects for various types using pivot tables.
- These overall average costs (shown in **BOLD** in Table T1 below), range from a high of about $73.4 million per centerline mile for six-lanes-or-more interstate reconstruction and expansion in Milwaukee County down to less than $100,000 per centerline mile for very light repairs. The remainder of Table T1 is then interpolated to other work types based on complexity and location.

Table T1. Unit Costs per Centerline Mile of Roadway Construction and Repair Activities, 2010 in Thousands of Dollars

			Unit Costs From STIP, thousands of dollars per centerline mile		
Order of Complexity	**Potentially Required Pavement Treatment**	**STIP Concept Code**	**Interstates**	**U.S.-Numbered Highways**	**State-Numbered Highways**
1.1	Do Nothing (annual maintenance work)	RDMTM	7 per yr	6 per yr	5 per yr
1.2	Crack Fill	RDMTM	150	75	75
1.3	Rut Fill	RDMTM	150	100	100
1.4	**Seal Coat**	**RDMTM**	**267**	**256**	**247**
1.5	Spot Repair (bituminous)	RDMTM	500	450	400
2.1	Surface Mill	RESURF	1000	900	800
2.2	**Thin Overlay**	**RESURF**	**1164**	**750**	**862**
2.3	Thin Overlay over PCC	RESURF	1500	800	900
2.4	Thick Overlay	RESURF	2000	850	900
3.1	Rubblize and Overlay	PVRPLA	2000	900	950
3.2	**Partial Mill and Overlay**	**PVRPLA**	**2263**	**979**	**1034**
3.3	Cold Recycle	PVRPLA	2500	1100	900
3.4	Full Depth Mill and Overlay	PVRPLA	2500	1200	900
7.1	Repair	RECOND	3000	1300	900
7.2	Repair and Grind	RECOND	3500	1400	900
7.3	**Repair, Grind, and Thin Overlay**	**RECOND**	4000	**1575**	**927**
7.4	Repair, Patch, Crack/Seat and Thick Overlay	RECOND	5000	2000	1500
7.5	Base Repair <= 5%, Spot Repair, Patch, Thin Overlay	RECNST	15000	3000	2000
7.6	**Base Repair > 5%, Spot Repair, Patch, Thin Overlay**	**RECNST**	**19519**	**5222**	**3216**
8.1	**Reconstruct and expand**	**RECSTE**	**73442**	30000	**6639**

- These costs are further disaggregated by traffic volume and region of the state as shown in Table T2.

Table T2. Unit Costs per Centerline Mile, 2010 Thousands of Dollars, by Treatment and Road Class

		Maintenance Road Class Letter Code and Description					
Order of Complexity	**Potentially Required Pavement Treatment**	**2 Lane ADT<5K**	**2 Lane ADT>5K**	**4 Lane ADT<25K**	**4 Lane ADT>25K**	**6+ Lane Other**	**6+Lane Expressway Milwaukee Co.**
		F	**E**	**D**	**C**	**B**	**A**
1.1	Do Nothing (unit cost per mile per year)	3	5	6	7	10	10
1.2	Crack Fill	50	50	75	100	150	200
1.3	Rut Fill	100	100	100	150	200	200
1.4	**Seal Coat**	**150**	**150**	**250**	**250**	**300**	**300**
1.5	Spot Repair (bituminous)	300	400	400	500	500	600
2.1	Surface Mill	400	500	600	750	1000	1200
2.2	**Thin Overlay**	**500**	**750**	**750**	**1000**	**1500**	**1500**
2.3	Thin Overlay over PCC	600	800	900	1000	2000	2000
2.4	Thick Overlay	600	800	1000	1100	2500	2500
3.1	Rubblize and Overlay	700	850	1100	1100	2500	2500
3.2	**Partial Mill and Overlay**	**750**	**900**	**1100**	**1200**	**2500**	**3000**
3.3	Cold Recycle	800	1000	1100	1500	2700	3000
3.4	Full Depth Mill and Overlay	800	1000	1100	1500	2700	3000
7.1	Repair	900	1000	1300	1750	3000	3500
7.2	Repair and Grind	900	1000	1400	1750	3500	4000
7.3	**Repair, Grind, and Thin Overlay**	**1000**	**1000**	**1500**	**2000**	**4000**	**5000**
7.4	Repair, Patch, Crack/Seat and Thick Overlay	1300	1500	2500	3000	6000	7000
7.5	Base Repair <= 5%, Spot Repair, Patch, Thin Overlay	1500	2500	3500	4000	1000	20000
7.6	Base Repair > 5%, Spot Repair, Patch, Thin Overlay	2000	3000	5000	5000	15000	25000
8.1	**Reconstruct and expand**	4000	5000	8000	**10000**	30000	**75000**

- After summaries were prepared, we then expanded costs to account for non-mainline contracts, using the ratios of mainline letting contracts to all contracts for various work types. These typically average about 5% to 15% higher than the mainline contracts. We used the expansion factor provided by WisDOT, 1.3245.[55]
- For forecasts, road cost summaries are then inflated by 1.0575 for the 2011-14 period, and by 1.213 for the 2015-20 period. This corresponds to an average of 2.8% annually, averaged over each time period.

Bridge Repairs

- Bridge condition data comes from the 2009 National Bridge Inventory, representing 2009 conditions (although some bridges would have been surveyed in 2008).
- For Wisconsin, 4,885 state-owned bridges are extracted from the 13,800 bridges in the Wisconsin portion of the inventory.
- State-owned bridges are grouped by deck condition.
- For each bridge rated poor (a rating of 4) or worse on deck condition, and for many other higher-rated bridges, the "cost to repair" is a data item on the file. These are bridges typically rated "deficient," for which costs to repair are needed for federal fund apportionment. We used Total Repair Cost (Item 96 in the file) which includes

mobilization and approach work, as well as roadway and other costs. Bridge repair costs are then summed by deck condition using pivot tables.

- Average per-bridge repair costs are calculated for each deck condition level, and then multiplied by the percent to be repaired. This "percent to be repaired" is higher than the percent of deficient bridges, since many bridges not rated deficient will also need work over the course of a decade.
- We did not expand bridge repair costs for additional costs such as engineering or contract adjustments. This is because federal guidelines call for the repair cost in Item 96 to include all costs in addition to those related to roadway and to bridge work, and in fact for most of the bridges in the Wisconsin file, total costs are about 10% to 15% higher than the sum of bridge and roadways costs. We therefore assumed that no additional expansion was needed.
- After summation, total costs are then inflated for the forecast years, using a factor of 1.0575 for the 2011-14 period and 1.213 for the 2015-20 period. This corresponds to an average of 2.8% annually, averaged over each time period.

Capacity-Related Widening

- Congestion data for roadway sections comes from WisDOT Roadway Inventory File (RIF), February 2011, representing 2010 conditions.
- We use the Level of Service (LOS) data field in the RIF, in conjunction with the thresholds noted in the WisDOT Facility Design Manual, to determine which links are in need of widening. However, this is a preliminary estimate based on just one congestion criterion.
- We sum the mileage of the links that need widening, and group them by Maintenance Road Group using pivot tables. Upon review of this analysis, WisDOT recommended slightly larger mileage for widening[56] based on additional criteria, so we used their revised numbers.
- Average costs per centerline mile to add capacity come from the various projects identified as Reconstruction and Expansion (RECSTE) projects in the 2011-14 STIP. We use costs as noted in Table T2 above.
- These costs are based on centerline miles, whereas "miles needing widening" is based on roadways miles. We convert centerline miles to roadway miles using the "DIV or UNDIVIDE" column in the WisDOT RIF, calculating the number of centerline miles from the roadway miles (centerline miles are half the roadway miles for divided highways, and the same as roadways miles for undivided highways and one-way facilities) and then determining the ratio of the two. The following table summarizes the data:

Table T3: Centerline/Roadway Mileage by Road Maintenance Group

Maintenance Group	1-lane	Divided	Undivided	Total	Centerline Miles	Centerline/Roadway Ratio
2 Lane ADT < 5K	63.41	55.2	6647.52	6766.13	6738.53	**0.996**
2 Lane ADT > 5K	40.91	107.66	2268.84	2417.41	2363.58	**0.978**
4 Lane ADT < 25k	1.18	3209.30	178.89	3389.37	1784.72	**0.527**
4 Lane ADT > 25k		1328.91		1328.91	664.46	**0.500**
6+Lane Expy Milwaukee Co.		105.79		105.79	52.89	**0.500**
6+Lanes, Other		404.61		404.61	202.31	**0.500**
Total	**105.50**	**5211.47**	**9095.25**	**14412.22**	**11604.18**	

- We used this ratio to convert centerline mile costs to roadway mile costs.
- We then expanded costs to account for non-mainline contracts, similar to Pavement Repairs above, using the expansion factor provided by WisDOT, 1.3245.[57]
- Costs are then inflated for the forecast years, using a factor of 1.0575 for 2011-14 and 1.213 for 2015-20. This corresponds to an average of 2.8% annually, averaged over the time periods.

Narrow Lanes

- Lane width data for road segments comes from WisDOT Roadway Inventory File (RIF), February 2011, representing 2010 conditions.
- We use the "Average Lane Width" data in the RIF file, in conjunction with the design standards in the WisDOT Facility Design Manual, to identify those road segments with lanes below standard width.
- We calculate the lane-miles needed to bring the lanes up to design width using "Miles," "Num Lanes," and links with a "Narrow Lane Code," summing this data and grouping it by Maintenance Road Group, using pivot tables.
- Average costs per lane-mile to add capacity come from the Reconditioning (RECOND) costs in the STIP cost analysis, reduced proportionally by feet.
- We then expand costs to account for non-mainline contracts, similar to Pavement Repairs above, using the expansion factor calculated from the STIP analysis, 1.0259. We use this expansion factor rather than the one provided by WisDOT (1.3245[58]) because these costs are relatively minor and have less external costs.
- Costs are then inflated for the forecast years, using a factor of 1.0575 for the 2011-14 time period and 1.213 for the 2015-20 time period. This corresponds to an average of 2.8% annually, averaged over the time periods.

Narrow Shoulders

- Shoulder width data for road segments comes from WisDOT Roadway Inventory File (RIF), February 2011, representing 2010 conditions.
- Using the shoulder types provided in the WisDOT RIF, we consider as eligible for widening only right-side shoulders of types 1 through 5. Left-side shoulders and shoulders with existing constraints (barriers, guard rails, curbs and gutters) are not considered.

Table T4. WisDOT Shoulder Types

Type	Definition
1	**Not paved**
2	**PC concrete**
3	**Asphalt**
4	**Rumble strip - PC concrete**
5	**Rumble strip – Bituminous**
6	**Concrete barrier - s/f =< 42" high**
7	**Concrete barrier - s/f > 42" high**
8	**Concrete barrier - d/f =< 42" high**
9	**Concrete barrier - d/f > 42" high**
10	**Guard Rail**
11	**Cable Guard**
12	**Curb and Gutter**
13	**Continuous Left-turn Median (Left Shoulder)**
15	**Curb Only - No Gutter**

- We use the right shoulder width data in the RIF file, in conjunction with the design standards in the WisDOT Facility Design Manual, to determine which roadway have shoulders that are below standard.
- We calculate the eligible right-shoulder miles using the "Miles," "Div or Undiv," and "Right Shoulder Type" columns. We sum this data, grouping it by county, using pivot tables.
- We calculate the eligible right-shoulder miles needing widening using the design standards, and the "Right Shoulder Total Width" column. We sum this data, grouping it by county, using pivot tables.
- We calculate the foot-miles needed for each link to bring the right shoulder up to the design standard, and sum this data, grouping it by Maintenance Road Group, using pivot tables.
- We estimate average costs per foot-mile to add capacity using STIP data, data from the literature, and experience. Since these costs are relatively minor and have less external costs, we do not adjust for off-site or engineering costs.
- Costs are then inflated for the forecast years, using a factor of 1.0575 for the 2011-14 time period, and 1.213 for the 2015-20 time period. This corresponds to an average of 2.8% annually, averaged over the time periods.

Physical Maintenance and Operations

- Data on physical maintenance expenditures were obtained from FHWA Highway Statistics, Table SF4C, for Wisconsin 2000-08. This data was adjusted downward for winter maintenance. This data is submitted by the states to FHWA annually.
- For forecasting, an inflation of 1.06 was used for the 2011-14 time period, and 1.16 for the 2015-20 time period, assuming 2% per year) forecasts of growth of state expenditures.

Winter Maintenance

- Winter maintenance data comes from WisDOT 2009 Compass Report, January 2011, representing 2009 conditions, as well as a WisDOT Winterization Budget Report listing expenditures for selected winter operation items for 2006-2010.
- We use both data sources to determine the breakout of winter operations costs for 2010 and inflate this cost for each of the forecast years (2011-2010), using an average inflation factor of 2.8% annually.
- We then aggregate the data into two forecast periods (2011-14 and 2015-20) to be in line with the other analyses.

Roadside Maintenance

- Roadside maintenance data comes from WisDOT 2009 Compass Report, January 2011, representing 2009 conditions.
- We use cost data for each of the four categories in Roadside Maintenance -- shoulders, drainage, roadsides, traffic and safety (selected devices) -- for 2010 and inflate this cost for each of the forecast years (2011-2010), using an average inflation factor of 2.8% annually.
- We then aggregate the data into two forecast periods (2011-14 and 2015-20) to be in line with the other analyses.

Signals and Other Lighting

- WisDOT provided several key files documenting signals, the Roadway Lighting Inventory, containing data for about 2008 lighted sites (including signals), and a more detailed file containing data on signal head installations at each site. A separate paper listing was also obtained for signals showing their installation and revisited dates. In the files, 1,014 signal sites are identified (containing 16,211 signal heads for 915 sites).
- This data was summed using pivot tables and some hand tabulations.
- Each signal site contains several signal heads. A typical four-leg rural intersection would have about 12 to 35 signal heads (green, yellow, red, turns, flashers, etc) arrayed facing each approach. Intersections on multilane roads typically have 35 to 60 signal heads.
- Estimates of the cost of signal replacement were obtained from separate email correspondence with WisDOT. These were extrapolated to estimate replacement costs at larger sites based on the number of signal heads per site. Older sites (those not recently visited) were assumed to have fewer signal heads per site.
- For forecasting, inflation factors of 1.057 and 1.213 were used for the periods 2011-14 and 2015-20, respectively (2.8% annually).

New Roads, Expansions, Major Bridges and Interchanges

- Preliminary lists of major capacity-adding and expansion projects were developed by reviewing the STIP for each metropolitan planning organization (MPO) region.
- The long-range plans for each region were reviewed to identify potential projects that are beyond the STIP but that are in the 2015-20 time period.
- Regional MPO staffs were contacted by phone to clarify the status of major projects and to identify recent changes from published long-range plans.
- Projects on the list of the Wisconsin Transportation Projects Review Board, including those recommended in October 2010, were added. Several projects were partially duplicated on the MPO lists; the costs for these were reduced accordingly. Two potential

projects (the St. Croix River bridge at Stillwater, and the governor' recently announced (5/3/2011) proposed upgrade of U.S. 41 to interstate status) were added.

- After the draft project list was prepared, it was sent to MPOs and the state for review to ensure that no major projects have been overlooked. Some revisions were received, being primarily dates (typically further out in time) and costs (typically higher). Several projects completed in 2010 were removed.
- WisDOT comments suggested that some, perhaps all, such projects were essentially "overlaps" with other work categories.[59] Review of the list suggests that some projects are clearly on new alignments or are not otherwise accounted for. On the other hand, some projects are likely to have components (particularly capacity and pavement repair) that duplicate other needs. Therefore, to account for this possibility, the list was further refined as follows:

    1. Costs for projects *partially* on the State Highway system were adjusted as follows:

Project not on SHS	0% SHS
County road with minor SHS	20% SHS
County road with one end on SHS	25% SHS
County road with both ends on SHS	50% SHS
SEWRPC area: various arterials	80%-100% SHS

    2. Reduce potential project costs to account for possible "overlap" with other work categories, particularly capacity-related widening (covered in capacity widening) and reconstruction (would be covered in pavement repairs). The reduction to costs is as follows:

Reconstruction	50% of cost is "new"
Urban widenings	50% of cost is "new"
Urban widening+ interchange	60% of cost is "new"
Rural widenings	70% of cost is "new"
Upgraded interchange	70% of cost is "new"
Rural widen + partial expwy	80% of cost is "new"
Rural widen+ new bypass	80% of cost is "new"
Upgraded interchange	80% of cost is "new"
New interchange	100% of cost is "new"
Bypass (but no other work)	100% of cost is "new"
New facility on new align.	100% of cost is "new"
New bridge	100% of cost is "new"

    3. All costs are updated for inflation, depending on the projected YOE ("year-of-estimate," which is year of completion) and the year of the Base Year cost estimate. The completion years are assumed to be the midpoint years (2013, 2017, and 2025). Inflation is assumed at 2.8% per year. The formulas for cost computation are:

    4. YOE Cost = (Base year cost)*[1+ (0.028)*(YOE year – Base year)]
       YOE Cost Adjusted for Overlap = YOE Cost*(% SHS)*(% new)

- The complete list, showing the reported "Base Year" costs and the above adjustments, follows:

Table T5. New Roads, Expansions, Major Bridges and Interchanges, By Region

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
Duluth-Superior	Douglas	U.S. 2	Bong Bridge		Rehabilitation	100	50	2	$ 18.0	$ 9.5	$ -	$ -	$ -	$ -
	Douglas	I-535	Blatnik Bridge ramps		Preservation	100	50	0.5	$ 5.5	$ 2.9	$ -	$ -	$ -	$ -
	Douglas	Tower Ave	Belknap	3rd St.	Reduce 4L>2L		100	0.5	$ 9.0	$ -	$ -	$ -	$ -	$ -
	Douglas	U.S. 2	U.S. 53	Cty. Hwy. D	Recondition	100	50	5	$ 9.0	$ 4.8	$ -	$ -	$ -	$ -
	Douglas	Cty. Hwy. C	Wis. 35	MN line	Reconstruction	15	50	12	$ -	$ -	$ 17.0	$ 1.5	$ -	$ -
	Douglas	U.S. 2	U.S. 53	Belknap	Reconstruction	100	50	5	$ -	$ -	$ 11.6	$ 6.8	$ -	$ -
(TOTAL)								**25**	**$ 41.5**	**$ 17.2**	**$ 28.6**	**$ 8.3**	**$ -**	**$ -**
Beloit	Rock	Inman Ext	Cty. Hwy. G	Shopiere Rd.	New 2-3L arterial	25	100	1.5	$ 5.0	$ 1.3	$ 10.0	$ 2.9	$ -	$ -
(TOTAL)								**1.5**	**$ 5.0**	**$ 1.3**	**$ 10.0**	**$ 2.9**	**$ -**	**$ -**
Janesville	Rock*	Wis. 26, ph2	Cty. Hwy. Y	Townline Rd.	Widen 2L>4L	100	50	3.2	$ 14.1	$ 7.4	$ -	$ -	$ -	$ -
	Rock*	Wis. 26, ph1	Townline Rd	Cty. Hwy. N	Wis. 59 interchange relocation	100	80	0.5	$ 1.7	$ 1.4	$ -	$ -	$ -	$ -
	Rock*	Wis. 26, ph3-4	Townline Rd	Cty. Hwy. N	New 4L arterial	100	100	4.4	$ 34.8	$ 36.7	$ -	$ -	$ -	$ -
	Rock*	Wis. 26, ph5	Cty. Hwy. N	S Fork Int	New 4L arterial	100	100	1.8	$ 20.1	$ 21.3	$ -	$ -	$ -	$ -
	Rock	U.S. 14	Wis. 11	U.S. 51	2L>4 and 6L	100	60	8.2	$ -	$ -	$ 13.6	$ 9.5	$ -	$ -
	Rock	U.S. 14	Janesville	I-43 East	New 4L freeway/arterial	100	100	18	$ -	$ -	$ -	$ -	$ 200.0	$ 278.4
	Rock	Western Connector	Wis. 11	U.S. 14	New 4L arterial	50	100	4	$ -	$ -	$ -	$ -	$ 25.0	$ 17.4
(TOTAL)								**40.1**	**$ 70.7**	**$ 66.9**	**$ 13.6**	**$ 9.5**	**$ 225.0**	**$ 295.8**
Dubuque IA	Grant								$ -	$ -	$ -	$ -	$ -	$ -
Chippewa-Eau Claire	Chippewa	Cty. Hwy. T	Alpine Road	Old Wis. 29	Expansion 2L > 4L	25	100	3.5	$ -	$ -	$ 10.5	$ 3.1	$ -	$ -
	Eau Claire	U.S. 12	Winchester W	Elco Road	Expansion/ improvement interchanges	100	70	1.5	$ -	$ -	$ 7.2	$ 5.2	$ -	$ -
	Chippewa	Cty. Hwy. X	Wis. 29	Cty. Hwy. K	Expand 2L > 4L	25	50	4.5	$ -	$ -	$ -	$ -	$ 11.7	$ 1.7
(TOTAL)								**9.5**	**$ -**	**$ -**	**$ 17.7**	**$ 8.2**	**$ 11.7**	**$ 1.7**
Wausau	Marathon	U.S. 51	Bridge St	Decatur	Repaving/ and replacement	100	50	2.2	$ 10.9	$ 6.5	$ -	$ -	$ -	$ -
	Marathon	I-39/U.S. 51	Foxglove	Bus U.S. 51	Recon+ bridge	100	60	1.5	$ 9.5	$ 6.8	$ -	$ -	$ -	$ -

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
					widen									
	Marathon	I-39 /U.S. 51	Maple Ridge Rd. Int.		Reconstruction interchange	100	70	0.5	$ -	$ -	$ 4.8	$ 4.4	$ -	$ -
	Marathon	Wis. 29	Marathon City	Wausau	Freeway conversion	100	80	2	$ -	$ -	$ 4.8	$ 5.0	$ -	$ -
	Marathon	Wis. 29	Marathon City	Wausau	Freeway conversion	100	80	2	$ -	$ -	$ -	$ -	$ 4.1	$ 5.0
(TOTAL)								**8.2**	**$ 20.4**	**$ 13.3**	**$ 9.6**	**$ 9.4**	**$ 4.1**	**$ 5.0**
La Crosse	La Crosse	I-90, Dresbach Bridge	U.S. 53	U.S. 14/61 in Minnesota	Bridge rehabilitation	100	70	3	$ 65.9	$ 44.8	$ -	$ -	$ -	$ -
	La Crosse	Wis. 35	U.S. 14/16	South Co. Line	Widen 2L>4L	100	50	2	$ 9.8	$ 4.8	$ -	$ -	$ -	$ -
	La Crosse	Wis. 35	Poplar St.	Cty. Hwy. OT	Reconstruction	100	50	3.5	$ 9.3	$ 4.5	$ -	$ -	$ -	$ -
	La Crosse*	U.S. 53, La Crosse Corridor	Wis. 157	South Ave.	Inters + imps (new roadway, widen-recon)	100	80	6.1	$ 44.6	$ 37.7	$ 93.6	$ 90.8	$ -	$ -
	La Crosse	I-90	U.S. 53/35	Theater Road	Widen 4L>6L	100	70	2	$ -	$ -	$ 25.7	$ 19.0	$ -	$ -
	La Crosse	Wis. 16	Landfill Road	Veterans Park	Widen 2L>4L	100	50	2	$ -	$ -	$ 14.5	$ 7.7	$ -	$ -
(TOTAL)								**18.6**	**$ 129.6**	**$ 91.8**	**$ 133.8**	**$ 117.5**	**$ -**	**$ -**
Oshkosh	Winnebago	U.S. 41	Wis. 26	Metro Bound	Widen 4L>6L	100	70	14	$ 71.6	$ 54.3	$ -	$ -	$ -	$ -
	Winnebago	U.S. 45	Cty. Hwy. G	Cty. Hwy. II	Reconstruction	100	50	4.5	$ 18.5	$ 10.0	$ -	$ -	$ -	$ -
	Winnebago	U.S. 41	Cty. Hwy. T		New interchange	100	100	0.5	$ -	$ -	$ 4.6	$ 5.5	$ -	$ -
	Winnebago	U.S. 44	Wisconsin St.	Lift Bridge	Widen 2L>4L	100	70	0.5	$ -	$ -	$ 19.1	$ 17.5	$ -	$ -
	Winnebago	U.S. 45	Jackson	Algoma	Reroute-widen	100	70	0.5	$ -	$ -	$ -	$ -	$ 8.3	$ 8.9
	Winnebago	Wis. 21	U.S. 41	W. External	Upgrade to freeway	100	80	2	$ -	$ -	$ -	$ -	$ 18.5	$ 22.7
	Winnebago	Cty. Hwy. GG	Cty. Hwy. A	Wis. 26	Widen 2L>4L	25	50	3	$ -	$ -	$ -	$ -	$ 12.5	$ 2.4
	Winnebago	West Side arterial	Wis. 91	Wis. 21	New arterial	50	100	4	$ -	$ -	$ -	$ -	$ 11.5	$ 8.8
(TOTAL)								**29**	**$ 90.1**	**$ 64.4**	**$ 23.7**	**$ 23.0**	**$ 50.8**	**$ 42.8**
Fond du Lac	Fond du Lac	Wis. 23	Townline	U.S. 41	Widen 2L>4L	100	50	2	$ -	$ -	$ 11.8	$ 7.7	$ -	$ -
	Fond du Lac	Wis. 23	Cty. Hwy. K	Tower Rd.	Widen 2L>4L	100	50	2	$ -	$ -	$ 11.0	$ 7.2	$ -	$ -
	Fond du Lac	Pioneer St	U.S. 45	Cty. Hwy. OOO	Widen 2L>4L	25	50	2	$ -	$ -	$ 38.6	$ 6.3	$ -	$ -
	Fond du Lac	U.S. 151	9 Grade sep interchanges		Grade-separated interchanges	100	80	7	$ -	$ -	$ -	$ -	$ 15.0	$ 18.4
	Fond du	U.S. 41	Townline Rd	Lost Arrow	Widen 4L>6L	100	70	9	$ -	$ -	$ -	$ -	$ 10.0	$ 10.7

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
	Lac													
(TOTAL)								**22**	**$ -**	**$ -**	**$ 61.4**	**$ 21.2**	**$ 25.0**	**$ 29.1**
Appleton	Outagamie	Cty. Hwy. CE (College Ave)	Fox River		Widen bridge 2L>4L	50	80	0.3	$ 8.2	$ 3.8	$ -	$ -	$ -	$ -
	Outagamie	Wis. 96	Rankin	Cty. Hwy. E	Reconstruction	100	50	1	$ 5.0	$ 2.7	$ -	$ -	$ -	$ -
	Outagamie	Wis. 96	Wis. 76	U.S. 41	Reconstruction	100	50	3.2	$ 7.8	$ 4.4	$ -	$ -	$ -	$ -
	Winnebago	U.S. 41	Wis. 26	Breezewood	Reconst-widen 4L>6L	100	70	15	$ 10.0	$ 8.4	$ -	$ -	$ -	$ -
	Winnebago	U.S. 10	Little Lake Butte des Morts Bridge		New bridge + interchanges	100	100	3	$ -	$ -	$ -	$ -	$ 60.0	$ 93.6
	Winnebago	U.S. 41/10/Wis. 441 Interchange			Reconstruction Interchange	100	70	1		$ -	$ -	$ -	$ 30.0	$ 32.8
	Calumet	U.S. 10	Appleton	UA boundary	Widen 2L>4L	100	50	6.5	$ -	$ -	$ -	$ -	$ 10.0	$ 7.8
	Outagamie	U.S. 41	Wis. 15	Brown Co line	Widen 4L>6L	100	70	6		$ -	$ -	$ -	$ 40.0	$ 43.7
	Outagamie	Wis. 15	Greenville	New London	Widen 2L>4L	100	70	16		$ -	$ -	$ -	$ 10.0	$ 10.9
(TOTAL)								**52**	**$ 31.0**	**$ 19.4**	**$ -**	**$ -**	**$ 150.0**	**$ 188.8**
Sheboygan	Sheboygan	Cty. Hwy. OK	Cty. Hwy. EE	Camelot	Widen 2L>3L		50	1	$ 3.9	$ -	$ -	$ -	$ -	$ -
	Sheboygan	Wis. 23	West Co. Line	Cty. Hwy. C	Reconstruction + Widen 2>4	100	50	7.5	$ 24.0	$ 12.7	$ -	$ -	$ -	$ -
	Sheboygan	I-43	Rowe Rd.		New 1/4 "event" interchange	100	100	0.1	$ 1.4	$ 1.5	$ -	$ -	$ -	$ -
	Sheboygan	Cty. Hwy. O	I-43	Woodland	Widen 2L>3L	25	50	1.3	$ 1.1	$ 0.1	$ -	$ -	$ -	$ -
	Sheboygan	Cty. Hwy. OK	Cty. Hwy. EE	Cty. Hwy. V	Widen 2L>3L		50	1.8	$ -	$ -	$ 6.9	$ -	$ -	$ -
	Sheboygan	S. Taylor Dr	Cty. Hwy. EE	Cty. Hwy. OK	New 4L arterial		50	1.4	$ -	$ -	$ 3.6	$ -	$ -	$ -
	Sheboygan	Wis. 42	Cty. Hwy. Y	Cty. Hwy. A	Widen 2L>4L	100	50	2.8	$ -	$ -	$ -	$ -	$ 6.6	$ 4.6
	Sheboygan	Cty. Hwy. Y	Cty. Hwy. O	Wis. 42	Widen 2L>4L	25	50	3.1	$ -	$ -	$ -	$ -	$ 6.2	$ 1.1
	Sheboygan	I-43	Cty. Hwy. FF		New full interchange	100	100	0.2	$ -	$ -	$ -	$ -	$ 3.0	$ 4.2
	Sheboygan	18th St.	Cty. Hwy. EE	Cty. Hwy. V	New 2L arterial		100	2.2	$ -	$ -	$ -	$ -	$ 2.4	$ -
(TOTAL)								**21.4**	**$ 30.4**	**$ 14.3**	**$ 10.5**	**$ -**	**$ 18.2**	**$ 9.8**
Madison	Dane	I-94	I-39/90	Cty. Hwy. N	Widen 4L>6L	100	50	4.4	$ -	$ -	$ -	$ -	$ -	$ -
	Dane	U.S. 14	Lacy Rd.		New interchange	100	100	0.5	$ 7.5	$ 7.9	$ -	$ -	$ -	$ -
	Dane	U.S. 14	Wis. 138	vic. Rutland	Widen 2L>4L+ interchanges	100	60	5	$ 6.5	$ 4.1	$ -	$ -	$ -	$ -
	Dane	U.S. 18 (Verona	U.S. 14	Cty. Hwy. PD	Widen 4L>8L	100	50	1.6	$ 17.0	$ 9.0	$ -	$ -	$ -	$ -

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
		Rd.)												
	Dane	U.S. 51	Wis. 19	Cty. Hwy. V	Widen 2L>4L	100	50	4.2	$ 59.6	$ 31.5	$ -	$ -	$ -	$ -
	Dane	U.S. 41	Fish Hatchery Rd.		Expansion/ improve interchange	100	70	0.5	$ 6.9	$ 5.0	$ -	$ -	$ -	$ -
	Dane	Cty. Hwy. M	Cross Country	Mineral Point Rd.	Widen 2L>4L + interchange improvement		80	0.5	$ -	$ -	$ 16.2	$ -	$ -	$ -
	Dane	Cty. Hwy. S (Mineral Point)	U.S. 14	Pleasant View	Widen 4L>8L	25	50	2.5	$ -	$ -	$ 10.7	$ 1.6	$ -	$ -
	Dane	Cty. Hwy. S (Mineral Point)	Cty. Hwy. M		Improve interchange	0	50	0.5	$ -	$ -	$ 18.3	$ -	$ -	$ -
	Dane	U.S. 18 (Verona)	Cty. Hwy. PD		Upgrade interchange	100	80	0.5	$ -	$ -	$ 10.0	$ 9.3	$ -	$ -
	Dane	U.S. 18/12	Cty. Hwy. AB		New interchange	100	80	0.5	$ -	$ -	$ -	$ -	$ 10.0	$ 11.1
(TOTAL)								**20.7**	**$ 97.5**	**$ 57.4**	**$ 55.2**	**$ 10.9**	**$ 10.0**	**$ 11.1**
Green Bay	Brown	U.S. 41 (part*)	North county line	South county line	Widen 4L>6L	100	50	12	$ 283.5	$ 149.7	$ -	$ -	$ -	$ -
	Brown	Wis. 29	Cty. Hwy. J	U.S. 41	Freeway conversion	100	80	1.34	$ 27.2	$ 23.0	$ -	$ -	$ -	$ -
	Brown	Wis. 29	Cty. Hwy. J	Cty. Hwy. EB	Freeway conversion	100	80	1	$ 31.5	$ 26.6	$ -	$ -	$ -	$ -
	Brown	Wis. 96	Wrightstown	Fox River	New bridge	100	100	0.5	$ 27.8	$ 29.4	$ -	$ -	$ -	$ -
	Brown	Wis. 54	Oneida	Green Bay	Realignment study	100	100	6	$ 0.6	$ 0.6	$ -	$ -	$ -	$ -
	Brown	Cty. Hwy. GV	Wis. 172	Cty. Hwy. X	New arterial	25	100	2.96	$ 12.2	$ 3.2	$ -	$ -	$ -	$ -
	Brown	Cty. Hwy. SB	Cty. Hwy. X	Wis. 57	New arterial	25	100	2.66	$ -	$ -	$ 10.5	$ 3.1	$ -	$ -
	Brown	Wis. 29	Cty. Hwy. J	Cty. Hwy. U	Conversion to freeway	100	80	6	$ -		$ -	$ -	$ 40.0	$ 44.5
	Brown	Wis. 54	U.S. 41	Wis. 172	Upgrade	100	70	8	$ -	$ -	$ -	$ -	$ 20.0	$ 19.5
	Brown	Cty. Hwy. SB	Wis. 57	Cty. Hwy. EE	New arterial + bridge	25	100	2.4	$ -	$ -	$ -	$ -	$ 60.0	$ 20.9
	Brown	Cty. Hwy. EA	Cty. Hwy. JJ	Cty. Hwy. R	Widen		50	1.3	$ -		$ -	$ -	$ 8.0	$ -
(TOTAL)								**44.16**	**$ 382.7**	**$ 232.4**	**$ 10.5**	**$ 3.1**	**$ 128.0**	**$ 84.9**
SEWRPC	Milw-Rac-Kenosha	I-94	Howard/27th	Illinois border	Widen to 8 Lanes	100	70	32	$1,150.2	$ 867.2	$ -	$ -	$ -	$ -
Greater Milw Area	Milw-Rac-Kenosha	I-94	Cty. Hwy. P Interchange		Upgrade interchange	100	80	0.5	$ 17.1	$ 15.3	$ -	$ -	$ -	$ -
	Racine-Walworth	Burlington Bypass*	Wis. 83	Wis. 11	New arterial	100	100	4.9	$ 15.6	$ 16.5	$ -	$ -	$ -	$ -

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
	Racine	Wis. 32 (part)	Five Mile Rd.	Wis. 31	Widen 2L>4L	100	50	1.3	$ 4.3	$ 2.4	$ -	$ -	$ -	$ -
	Waukesha	Waukesha West Bypass	I-94	Wis. 59	New bypass	50	100	5.1	$ 28.0	$ 15.6	$ -	$ -	$ -	$ -
	Milwaukee	I-94/894 (Zoo Interchange)	Burleigh/ Lincoln	124th/70th	Upgrade/ reconstruct interchange	100	80	3	$ -	$ -	$1,700.0	$1,588.5	$ -	$ -
	Milwaukee	I-894	Hale Interchange		Upgrade Interchange	100	80	0.5	$ -	$ -	$ 181.9	$ 187.0	$ -	$ -
	Milwaukee	I-894	Zoo Interchange	Hale Interchange	Upgrade/widen	100	80	3.5	$ -	$ -	$ 94.3	$ 97.0	$ -	$ -
	Milwaukee	I-894	Hale Interchange	Mitchell Interchange	Upgrade/widen	100	80	4.5	$ -	$ -	$ 147.0	$ 155.7	$ -	$ -
	Milw-Racine	Wis. 38 (part)	Oakwood Rd.	Cty. Hwy. K	Widen 2L>4L	100	50	6.1	$ -	$ -	$ 25.3	$ 15.5	$ -	$ -
	Milwaukee	U.S. 45	Drexel Ave	60th St.	Widen 2L>4L	100	50	4.5	$ -	$ -	$ 26.6	$ 16.3	$ -	$ -
	Milwaukee	Wis. 242 (part)	College Ave.	Drexel Ave.	Widen 4L>6L	100	50	1	$ -	$ -	$ 8.8	$ 5.4	$ -	$ -
	Waukesha	Pilgrim Rd.	U.S. 18	Lisbon Rd.	Widen 2L>4L	25	50	4.8	$ -	$ -	$ 26.4	$ 4.0	$ -	$ -
	Waukesha	Springdale/ Towline Rd. Extent	Cty. Hwy. JJ	Weyer	New arterial	50	100	4.7	$ -	$ -	$ 25.7	$ 15.7	$ -	$ -
	Waukesha	Cty. Hwy. Y	Cty. Hwy. L/Hickory Trail	College/Downing	Widen 2L>4L	0	50	6	$ -	$ -	$ 21.9	$ -	$ -	$ -
	Waukesha	Wis. 164	Howard Lane	Cty. Hwy. Q	Widen 2L>4L	100	50	3.5	$ -	$ -	$ 13.7	$ 8.4	$ -	$ -
	Waukesha	Wis. 190 (part)	Brookfield Rd	Calhoun Rd	Widen 2L>4L	100	50	1	$ -	$ -	$ 8.8	$ 5.4	$ -	$ -
	Waukesha	Wis. 83 (part)	Cty. Hwy. DE	U.S. 18	Widen 2L>4L	100	50	1.8	$ -	$ -	$ 7.0	$ 4.3	$ -	$ -
	Waukesha	Wis. 83 (part)	Mariner Dr.	Wis. 16	Widen 2L>4L	100	50	3.6	$ -	$ -	$ 14.0	$ 8.6	$ -	$ -
	Waukesha	Wis. 83	Bayview Rd.	Cty. Hwy. X	Widen 2L>4L	100	50	4.8	$ -	$ -	$ 19.5	$ 11.9	$ -	$ -
	SEWRPC area	Various Freeways 5 Projects			Widen/ reconstruction	100	50	60	$ -	$ -	$ -	$ -	$1,627.2	$1,118.2
	SEWRPC area	Various Freeways 9 Projects			Widen/ reconstruction	100	50	31.6	$ -	$ -	$ -	$ -	$1,523.2	$1,292.0
	SEWRPC area	Various Freeways 8 Projects			Widen/ reconstruction	100	50	127	$ -	$ -	$ -	$ -	$1,761.1	$1,773.1
	SEWRPC area	Various Arterials			Widen/ reconstruction	80	50	19.3	$ -	$ -	$ -	$ -	$ 119.3	$ 70.3
	SEWRPC area	Various Arterials			Widen/ reconstruction	90	50	27.9	$ -	$ -	$ -	$ -	$ 138.1	$ 105.1
	SEWRPC area	Various Arterials			Widen/ reconstruction	100	50	7.8	$ -	$ -	$ -	$ -	$ 32.6	$ 31.7
Total for SEWRPC Area								**370.7**	**$1,215.2**	**$ 916.9**	**$2,320.9**	**$2,123.7**	**$5,201.5**	**$4,390.2**

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
Sub total for MPOs								**662.86**	**$2,114.1**	**$1,495.4**	**$2,695.5**	**$2,337.8**	**$5,824.3**	**$5,059.2**
Major State Highway Projects (per State Transportation Projects Board, Feb. 2011														
		Major Projects Report Listing												
	Portage-Wood	U.S. 10	Marshfield	Stevens Point	New 4L + 5 bypasses	100	80	31	$ 150.3	$ 127.1	$ -	$ -	$ -	$ -
	Portage-Waupaca	U.S. 10	Stevens Point	Waupaca	Widen 2L>4L	100	70	21	$ 2.9	$ 2.1	$ -	$ -	$ -	$ -
	Kenosha	Wis. 11, Burlington Byp**	Wis. 11 E of B	Wis. 11 W of B	New 4L divided bypass	100	80	11	$ 6.4	$ 5.4	$ 20.0	$ 19.4	$ -	$ -
	Sauk	U.S. 12, Ski HI Connector	I-90/94	Ski High Rd.	New 4L bypass	100	80	13	$ 52.4	$ 44.3	$ 73.6	$ 71.4	$ -	$ -
	Dane	U.S. 12	Sauk City	Middleton	Widen 2L>4L+ upgrade interchanges	100	50	18	$ 1.1	$ 0.6	$ -	$ -	$ -	$ -
	Vernon	U.S. 14	Viroqua	Westby	Widen 2L>4L + 2 bypass	100	50	12.6	$ 32.5	$ 17.2	$ 29.3	$ 17.8	$ -	$ -
	Jefferson-Waukesha	Wis. 16	Oconomowoc Bypass		New 4L expressway bypass	100	80	6.5	$ -	$ -	$ 4.8	$ 4.7	$ -	$ -
	Crawford	U.S. 18	Bridgeport	Prairie du Chien	Widen 2L>4L	100	50	4	$ 4.6	$ 2.4	$ 9.5	$ 5.8	$ -	$ -
	Fond du Lac-Sheboygan	Wis. 23	Fond du Lac	Plymouth	Widen 2L>4L expressway	100	80	19	$ 73.0	$ 61.7	$ 44.9	$ 43.6	$ -	$ -
	Jefferson-Dodge (less Janesville portion)**	Wis. 26	Janesville	Watertown	Widen 2L>4L + 3 bypass	100	80	44.1	$ 206.1	$ 83.0	$ -	$ -	$ -	$ -
	Marathon	I-39 /U.S. 51 Wausau Corridor	Foxglove Rd.	Bridge St., Wausau	Widen 4L>6L + interchange upgrade	100	60	7	$ 8.3	$ 5.3	$ 7.2	$ 5.2	$ -	$ -
	Oconto-Marinette	U.S. 41	Oconto	Peshtigo	Widen 2L>4L divided + bypass	100	80	21.4	$ 8.2	$ 6.9	$ 17.5	$ 17.0	$ -	$ -
	Brown-Winnebago	U.S. 41 (part in Winnebago Co.)	Green Bay	Little Chute	Reconstruction + interchange upgrade	100	60	31	$ 644.0	$ 408.6	$ 123.0	$ 89.5	$ -	$ -
	Eau Claire-Chippewa	U.S. 53, Eau Claire Bypass	Golf Rd. Eau Claire	Wis. 29 Chippewa	New 4L frwy + interchanges	100	100	7.5	$ 15.6	$ 16.5	$ -	$ -	$ -	$ -
	Door-Kewaunee	Wis. 57	Dyckesville	Sturgeon Bay	Widen 2L>4L	100	50	20	$ 0.6	$ 0.3	$ 17.8	$ 10.8	$ -	$ -

MPO area	Wisconsin County	Route or Name	From	To	Action Proposed	% St Hwy Sys	% Non-Overlap w. Other Work Category	Project Length	2011-14 Base Year Cost	2011-14 YOE Cost, $M, Adj for SHS & Non-Overlap	2015-20 Base Year Cost	2015-20 YOE Cost, $M, Adj for SHS & Non-Overlap	2020 + Base Year Cost	2020 + YOE Cost, $M, Adj for Wis. & Non-Overlap
	St. Croix	Wis. 64	Houlton	Richmond	Widen 2L>4L + bypass	100	80	13.1	$ -	$ -	$ 2.6	$ 2.5	$ -	$ -
	Oconto-Marinette	U.S. 141	LeMere Rd., Oconto	6th Rd., Marinette	Widen 2L>4L expressway+3 bypass	100	80	16.4	$ -	$ -	$ -	$ -	$ -	$ -
	Fond du Lac	U.S. 151, Fond du Lac Bypass	U.S. 41 SW of Fond du Lac	Wis. 149 NE of Fond du Lac	New 4L bypass+ interchanges	100	100	7.8	$ 0.7	$ 0.7	$ -	$ -	$ -	$ -
	Fond du Lac	U.S. 151	Waupun	Fond du Lac	Widen 2L>4L	100	50	12.7	$ 0.1	$ 0.1	$ 0.4	$ 0.2	$ -	$ -
(TOTAL)								**317.1**	**$1,206.8**	**$ 782.2**	**$ 350.6**	**$ 287.9**	**$ -**	**$ -**
		Recommended for adding 10-19-2010												
	Dane-Rock	I-39 /90	Illinois border	U.S. 12 E of Madison	Widen 4L>6L	100	50	45	$ -	$ -	$ 715.0	$ 433.6	$ -	$ -
	Winnebago	U.S. 10/Wis. 441	Oneida St., Appleton	Cty. Hwy. CB W of Appleton	Widen 4L>6L + new bridge	100	80	5	$ -	$ -	$ 390.0	$ 378.5	$ -	$ -
	Milwaukee-Racine	Wis. 38	Oakwood Rd., Milw County	Cty. Hwy. K, Racine County	Widen 2L>4L	100	50	9	$ -	$ -	$ 125.0	$ 75.8	$ -	$ -
	Outagamie	Wis. 15	Wis. 76, Greenville	New London	Widen 2L>4L + 1 bypass	100	80	11	$ -	$ -	$ 125.0	$ 121.3	$ -	$ -
(TOTAL)								**70**	**$ -**	**$ -**	**$1,355.0**	**$1,009.2**	**$ -**	**$ -**
		Potential Additional Projects												
	St Croix	Wis. 35, St Croix Bridge	Wis. 35 NE of Houlton	Minn. 36 Bayport	New bridge and bypass	100	100	4	$ -	$ -	$ 300.0	$ 363.9	$ -	$ -
	Milwaukee to Brown	U.S. 41 (Press Release 5/9/11)	I-94 Mitchell Int (Milw)	I-43 (Green Bay)	Upgrade to Interstate 41	100	100	142	$ -	$ -	$1,500.0	$1,500.0		$ -
(TOTAL)								**146**	**$ -**	**$ -**	**$1,800.0**	**$1,863.9**		**$ -**
Total, State Transportation Project Commission								**533.1**	**$1,206.8**	**$ 782.2**	**$3,505.6**	**$3,161.0**	**$ -**	**$ -**
Grand total for State and MPOs				**Grand Total, MPOs and State**				**1196.0**	**$3,320.9**	**$2,277.6**	**$6,201.1**	**$5,498.8**	**$5,824.3**	**$5,059.2**
	***STPC and MPO joint project. Costs and mileage separated. **Reduced for MPO duplication.**													

Other Needs

- Special summaries of the 2011-14 STIP were made to identify all projects in the following general classes:
    - Intersection upgrades.
    - Roundabouts.
    - Signal treatments (but no intersection upgrade)
    - Pedestrian, bike and greenway enhancements.
    - Railroad grade crossing signal upgrades.
- Within each group, projects were listed and average costs per project were estimated.
- Based on the current rate of activity, in the STIP, the same rate, in terms of projects per year were assume going forward, but at higher cost, for 2015-20.

Administrative Costs

- Administrative costs were obtained from WisDOT submittals to the FHWA, as reported in Table SF4 of Highway Statistics. These costs are about 7% to 8% of the highway program, in line with most other states.
- To forecast administrative costs, a growth rate of 2% per year was assumed.

Federal Funds

- Sources of information for federal funds come primarily from FHWA's Highway Statistics series, particularly Table SF3 and SF 4.
- Federal fund totals by funding category FHWA Highway Statistics, Table FA4, various years.
- For SFYs 2009-10 through 2013-14, data for federal funds come from details of the proposed Wisconsin 2011-13 state budget. Federal funds in the State Highway System and federal funds for some other general and administrative categories, system operation and law enforcement/safety are also added in. The specific budget items included are noted in the table below.
- Forecasts of federal funds beyond 2013-14 are made by assuming a 1% per year growth rate for 2014-17, and a more rapid growth, 5% per year, to 2020.

Table T6. State Budget Categories Used For SHS Expenditure Estimates

TRANSPORTATION BUDGET SECTION AND ITEMS SELECTED	TRANSPORTATION BUDGET SECTION AND ITEMS SELECTED
(1) Aids	**(3) State Highway Facilities (Continued)**
(as) Transportation aids to counties, state funds	(eq) Highway maintenance, repair, and traffic operations, state funds
(at) Transportation aids to municipalities, state funds	(er) State−owned lift bridge operations and maintenance, state funds
(ex) Highway safety, local assistance, federal funds	(ev) Highway maintenance, repair, and traffic operations, local funds
(fq) Connecting highways aids, state funds	(ex) Highway maintenance, repair, and traffic operations, federal funds
(fs) Flood damage aids, state funds	(iq) Administration and planning, state funds
(ft) Lift bridge aids, state funds	(ir) Disadvantaged business mobilization assistance, state funds
(2) Local Transportation Assistance	(iv) Administration and planning, local funds
(aq) Accelerated local bridge improvement assistance, state funds	(ix) Administration and planning, federal funds
(av) Accelerated local bridge improvement assistance, local funds	(jh) Utility facilities within highway rights−of−way, state funds
(ax) Accelerated local bridge improvement assistance, federal funds	(jj) Damage claims
(eq) Highway and local bridge improvement assistance, state funds	(js) Telecommunications services, service funds
(ev) Local bridge improvement and traffic marking enhancement assistance, local and transferred funds	**(4) General Transportation Operations**
(ex) Local bridge improvement assistance, federal funds	(aq) Departmental management and operations, state funds
(fb) Local roads for job preservation, state funds	(ar) Minor construction projects, state funds
(fr) Local roads improvement program, state funds	(at) Capital building projects, service funds
(ft) Local roads improvement program; discretionary grants, state funds	(av) Departmental management and operations, local funds
(fv) Local transportation facility improvement assistance, local funds	(ax) Departmental management and operations, federal funds
(fx) Local transportation facility improvement assistance, federal funds	(ch) Gifts and grants
(fz) Local roads for job preservation, federal funds	(dq) Demand management
(jq) Grant to village of Bellevue, state funds	(eq) Data processing services, service funds
(jr) Grant to village of Footville, state funds	(er) Fleet operations, service funds
(kv) Congestion mitigation and air quality improvement, local funds	(es) Other department services, operations, service funds
(kx) Congestion mitigation and air quality improvement, federal funds	(et) Equipment acquisition
(nv) Transportation enhancement activities, local funds	(ew) Operating budget supplements, state funds
(nx) Transportation enhancement activities, federal funds	**(5) Motor Vehicle Services and Enforcement**
(3) State Highway Facilities	(ci) Breath screening instruments, state funds
(bq) Major highway development, state funds	(dg) Escort, security and traffic enforcement services, state funds
(br) Major highway development, service funds	(dh) Traffic academy tuition payments, state funds
(bv) Major highway development, local funds	(di) Chemical testing training and services, state funds
(bx) Major highway development, federal funds	(dk) Public safety radio management, service funds
(ck) West Canal Street reconstruction and extension, service funds	(dL) Public safety radio management, state funds
(cq) State highway rehabilitation, state funds	(dq) Vehicle inspection, traffic enforcement and radio management, state funds
(cr) Southeast Wisconsin freeway rehabilitation, state funds	(dr) Transportation safety, state funds
(ct) Owner controlled insurance program, service funds	(dx) Vehicle inspection and traffic enforcement, federal funds
(cv) State highway rehabilitation, local funds	(dy) Transportation safety, federal funds
(cw) Southeast Wisconsin freeway rehabilitation, local funds	**(6) Debt Services**
(cx) State highway rehabilitation, federal funds	(af) Principal repayment and interest, transit, local roads, major highway and rehabilitation, state funds
(cy) Southeast Wisconsin freeway rehabilitation, federal funds	(aq) Principal repayment and interest, transportation facilities, major highway and rehabilitation, state funds
(dq) Major interstate bridge construction, state funds	(ar) Principal repayment and interest, buildings, state funds
(dv) Major interstate bridge construction, local funds	(au) Principal repayment and interest, Marquette interchange and I-94 north-south corridor reconstruction project, state funds
(dx) Major interstate bridge construction, federal funds	

State and Local Funds

- State funds for the State Highway System are also drawn from the Wisconsin 2011-13 state budget, Department of Transportation section.
- Funds for "state" and "services" are included for the SHS portion of the budget, and for other portions of the DOT budget that are related at the general administration, management and funding of the State Highway System. This includes a portion of administrative resources, and the law enforcement and safety portion of motor vehicle and licensing resources. The specific budget items included are noted in the table above.
- Resources for bonding and debt service (principal and interest payments) are also included.
- A small portion of State Highway System resources from local governments is also included.

Acknowledgements

This report was prepared by **Professor David T. Hartgen**, professor emeritus of transportation studies at University of North Carolina Charlotte and president of The Hartgen Group, under contract to the Wisconsin Policy Research Institute. Professor Hartgen was assisted by **M. Gregory Fields** and **Elizabeth San Jose.** The Hartgen Group gathered and consolidated information, analyzed the data and prepared the report. However, this report is also the product of the support and assistance of numerous individuals and agencies. **George Lightbourn** of the Wisconsin Policy Research Institute ensured a smooth and harmonious research environment. Representatives of the Wisconsin Department of Transportation, led by **Mark Wolfgram** and **Joseph Nestler**, were most cooperative in providing data and expertise to many sections and comments on the draft report. MPO staff from Wisconsin's urbanized areas kindly reviewed material and provided input. We would also like to acknowledge **Professor Edward Beimborn**, Professor Emeritus of Civil Engineering at the University of Wisconsin-Milwaukee, for his input and comments on drafts of this report. Without the assistance of these individuals and organizations, this study could not have been completed. The authors are grateful to all individuals and organizations for their assistance but of course retain full responsibility for the analysis and its interpretation. This study does not necessarily reflect the views of WPRI, the Wisconsin Department of Transportation, or the regional metropolitan planning organizations.

About the Authors

David T. Hartgen is emeritus professor of transportation studies at UNC Charlotte and president of The Hartgen Group. Professor Hartgen is widely known in transportation circles. He established the UNC Charlotte's Center for Interdisciplinary Transportation Studies in 1989 and now conducts research in transportation policy. He is the author of about 355 publications on a wide variety of topics in transportation policy and planning, is U.S. editor of the international academic journal *Transportation,* and is active in professional organizations. He is a frequent media interviewee in local and national publications. Before coming to Charlotte, he directed the statistics and analysis functions of the New York State Department of Transportation and served as a policy analyst at the Federal Highway Administration. He holds engineering degrees from Duke University and Northwestern University. He has taught at SUNY Albany, Union College and Syracuse University, and he lectures widely. He is widely known for his annual assessments of the cost-effectiveness of the 50 state highway systems. His studies of road conditions and his recent national study of congestion reduction also attracted wide national attention.

M. Gregory Fields is a retired military officer with degrees from West Point, Webster University in St. Louis, and UNC Charlotte. He is enrolled in the PhD program in urban regional analysis at UNC Charlotte and has participated in a number of comparative transportation studies including the Fraser Institute's study of Canadian provinces, Reason's recent study of congestion, and Reason's recent study of accessibility and productivity.

Elizabeth San Jose is a research analyst with The Hartgen Group. She has contributed to studies of Charlotte's light rail line, congestion in mid-sized regions, and Highway Trust Fund revenues. She holds a BS in aviation studies from Indiana State University.

Endnotes:

[1] WisDOT, Impacts of Highway Facility Improvements on Travel and Regional Development, TransLinks21 project, Madison, Wis., January 1994.
[2] Wisconsin Department of Transportation, Wisconsin State Highway Plan 2020, Summary Report, Madison Wis., February 2000.
[3] Southeastern Wisconsin Regional Planning Commission, Cost of Reconstructing the SEWRPC regional freeway system, Report No. 47, 2003.
[4] Wisconsin Legislature, Joint Legislative Committee on Transportation Needs and Finance, Final Report, December 2006.
[5] Hartgen D et al.. Comparative Performance of State Highway Systems, 1984-2008, Reason Foundation, September 30, 2010. Available at www.reason.org.
[6] "Needs assessments" are transportation studies that estimate how much money and time it would take to bring a road (or other) system up to a given level of quality or standard. They are regularly done by the federal government, in the biennial reports to Congress, and occasionally by individual states.
[7] WisDOT, State Transportation Improvement Program, 2011-14. January 2011.
[8] Published VMT statistics for Wisconsin show an anomaly for 2008 local travel that has not been resolved. If corrected, VMT trends would likely be higher.
[9] A "vehicle-mile of travel" (VMT), defined as one vehicle traveling one mile, is a common measure of surface traffic activity.
[10] Wisconsin's data files list divided highways separately by direction, so "roadways" are directional sections of pavement and hence total to slightly longer than centerline mileage.
[11] FHWA, Highway Statistics, Table VM 2, 2008
[12] FHWA, Highway Statistics, Table HM 64, 2000 and 2008.
[13] The federal government has dropped the use of words such as "poor" in describing road condition. By prior research and convention, 170 inches/mile of roughness has been generally agreed as the cutoff for "poor" Interstate roads, and 220 inches/mile is the cutoff for "poor" other roads.
[14] Based on "roadway" mileage, which separates divided roads by direction.
[15] "Potentially required pavement treatments" are WisDOTs preliminary estimated pavement work types based on high-level assessment of road condition and traffic data. They are intended to estimate cost and work intensity for planning purposes, and do not necessarily reflect actual treatments developed when engineering design is completed and pavements are repaired.
[16] Southeastern Wisconsin Regional Planning Commission, Freeway Reconstruction Plan for Southeastern Wisconsin, Report No. 47, 2003.
[17] Some states use the federal HERS-ST model to prepare such estimates, and some use their own condition deterioration methods. Wisconsin uses a state-based deterioration model.
[18] The State Transportation Improvement Program (STIP) is a federally-required document listing all projects involving federal funds for the short range (four to six years) time frame. Many states use the STIP to list all projects, including those funded with only state or local funds as well.
[19] Memo from Mark Wolfgram, WisDOT Administrator to George Lightbourn, WPRI, "re: the draft report 'Wisconsin State Highway System: Needs and Resources, 2011-2020,' " April 26, 2011.
[20] USDOT, 2009 National Bridge Inventory for Wisconsin, available at www.fhwa.dot.gov.
[21] Federal bridge repair funds are allocated to the states according to estimated cost to repair deficient bridges.
[22] According to the *Recording* and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, Item 96–Total Project Costs should include "*incidental costs not included in Items 94 [Bridge Improvement Costs] and 95 [Roadway Improvement Costs]*" and "*should include all costs normally associated with the proposed bridge improvement project.*" We assumed that this includes design engineering, right-of-way and potential change order costs, since many WisDOT bridges show total costs that are 10% to 15% higher than the sum of "roadway" and "bridge" costs.
[23] Transportation Research Board, Highway Capacity Manual, National Research Council, Washington, DC, 2000.
[24] Lomax T and Turner T, Urban Mobility Report, 2010, Texas Transportation Institute, Released December 2010, available at www.mobility.tamu.edu.
[25] Daily Beast, "50 Worst Commutes: America's Highways to Hell," March 8, 2011. www.thedailybeast.com .
[26] Highway Capacity Manual, op. cit.
[27] Federal Highway Administration, Highway Performance Monitoring System, Field Manual. Washington, DC, 1994.
[28] Memo from Mark Wolfgram to George Lightbourn, op. cit.

[29] For instance, new routes, bypasses, improved intersection treatments, coordinated traffic signals, ITS monitoring, better transit service, flex time and carpooling, etc.
[30] Yunker KR, "Preliminary draft, Appendix E, Evaluation of alternative freeway system improvements," Feb. 6, 2006. At www.milwaukeerising.net/AppendixE.pdf .
[31] WisDOT, Facilities Design Manual, available at: http://roadwaystandards.dot.wi.gov/standards/fdm/11-44.pdf.
[32] WisDOT FDM, op. cit.
[33] WisDOT FDM, op. cit.
[34] Bonneson J and Pratt MP, Roadway Safety Design Workbook, Texas A&M University, July 2009.
[35] WisDOT FDM; urban road data available at: http://roadwaystandards.dot.wi.gov/standards/fdm/11-20-001att.pdf; rural road data available at: http://roadwaystandards.dot.wi.gov/standards/fdm/11-15-001att.pdf.
[36] Shoulder type codes 1-5, WisDOT Roadway Inventory file.
[37] Zeeger CV et al. Safety effects of cross-section design for two-lane roads. Record 1195, Transportation Research Board, Washington DC 20418, 1988.
[38] Bonneson and Pratt, op. cit.
[39] Wisconsin Department of Transportation, 2011-13 Biennial Budget Request, November 17, 2010, pages 234-243, sum for highway maintenance and repair, traffic operations, lift bridge operations, state, federal and local funds.
[40] WisDOT, Compass Report: Wisconsin State Highway 2009 Maintenance, Traffic and Operations Conditions, available at: https://trust.dot.state.wi.us/extntgtwy/dtid_bho/extranet/compass/reports/2009/Compass%20Report-2009-Final.pdf
[41] National Traffic Operations Center (NTOC), 2007 National Traffic Signal Report Card, Federal Highway Administration, 2010.
[42] Based on $ 192,000 per intersection for replacement of a typical four-leg intersection, per WisDOT correspondence, March 15, 2011.
[43] Wisconsin DOT press release, "Governor Walker announces plans to convert U.S. 41 to an Interstate Highway," press release, May 3, 2011., Madison, Wis.
[44] Memo, Wolfgram to Lightbourn, op. cit.
[45] U.S. Congress, American Reinvestment and Recovery Act, signed Feb. 13, 2009.
[46] Utt, Ronald, Federal highway program shortchanges more than half the states, Heritage Foundation, Web Memo #3228, April 18, 2011. This assessment subtracts out congressional transfers to the Highway Trust Fund from the General Fund. For Wisconsin, the cumulative 1959-2009 "donee/donor ratio" was 0.918, while the more recent 2009 ratio was 1.039.
[47] National Surface Transportation Policy and Revenue Study Commission, Transportation For Tomorrow, December 2007; and National surface Transportation Infrastructure Financing Commission, Paying Our Way, Final Report February 2009.
[48] Orski, K. House Transportation and Infrastructure Committee's "Views and Estimates," Innovation Briefs, March 22, 2011. At www.innobriefs.org.
[49] According to the AASHTO Daily Briefing (April 15, 2011) "*The [2011] obligation limitation on the federal-aid highway program is frozen at its FY 2010 level of $41.107 billion. State transportation departments will have their contract authority balances lowered by $2.5 billion and states that have old unused earmarked highway funds from 1998 and prior years will see those canceled as well to the tune of $630 million.…Total Federal Highway Administration funding drops 2.2% from last fiscal year to this fiscal year, representing Congress' previous decision not to renew $650 million in General Fund extra highway appropriations and $293 million in General Fund highway earmarks made in FY 2010.*"
[50] Federal Highway Administration, Highway Statistics, Table SF3, various years.
[51] Federal Highway Administration, Highway Statistics, Tables MF 1, MF2, MV1 and MV2, 2008.
[52] This summary includes only selected items in the Department of Transportation's budget; these items are identified in the appendix.
[53] Federal Highway Administration, Highway Statistics, 2008, Table SF3.
[54] Memo from Mark Wolfgram to George Lightbourn, op cit, attached revenue forecast.
[55] Memo from Mark Wolfgram to George Lightbourn, op. cit.
[56] Memo from Mark Wolfgram to George Lightbourn, op. cit.
[57] Memo from Mark Wolfgram to George Lightbourn, op. cit.
[58] Memo from Mark Wolfgram to George Lightbourn, op. cit.
[59] Memo from Mark Wolfgram to George Lightbourn, op. cit.