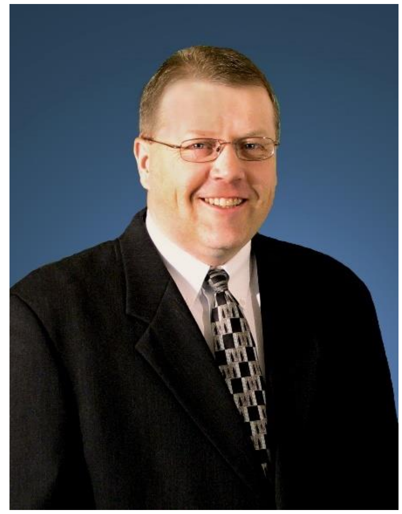
SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
Design ~ Construct ~ Maintain ~ Operate

Transportation Asset Management Plan 2019

A Message from the Secretary



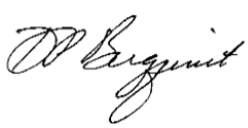
Roads and bridges support so much of our way of life here in South Dakota. As the efficiency and condition of our highways and bridges continue to improve, so does our economy and quality of life. At the South Dakota Department of Transportation, we call this "better lives through better transportation".

Our customers deserve and expect a high-quality transportation system. Asset management has played a key role in developing the state highway system we enjoy and rely on today. Starting in the 1970's, SDDOT developed pavement management processes aimed at long-range network optimization. As bridge management software became available, the SDDOT applied similar rigor to the management of our structures. Over the years, these processes have been fine-tuned to make the most efficient use of our funding.

The Transportation Asset Management Plan (TAMP) details the processes currently used to manage our pavements and structures and describes the condition and outlook for these important assets. More than 30 persons with deep knowledge and experience in our asset management enterprise helped to develop it. The TAMP not only represents our response to federal requirements, but also articulates our dedication to sound asset management principles and commitment of resources.

Sometimes it's hard to see the connection between a well-managed transportation system and a high quality of living and good business climate, but the link can be measured and experienced. At the SDDOT, we're happy to have achieved so much since the 1970's and pledge to do our best to provide an efficient, safe transportation system for the citizens of South Dakota and everyone who travels through our state.

Sincerely,



Darin P. Bergquist

Secretary of Transportation

Acknowledgements

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Chapter 1 Executive Summary

Introduction

The South Dakota Department of Transportation (SDDOT) enjoys a long and productive history with asset management. The SDDOT first developed formal pavement management processes, including objective condition assessment and economic analysis, in the 1970's and led development and application of pavement condition assessment equipment. For the past 25 years, the SDDOT has used long-range network optimization to develop strategies and capital improvement programs for pavement rehabilitation, repair, and reconstruction. As bridge management software has become available, the SDDOT has applied similar rigor to management of structures. As much as any state transportation agency in the nation, the SDDOT has embraced, developed, refined, and used asset management to fulfill its mission and responsibilities to taxpayers and highway users.

The SDDOT 2019 Transportation Asset Management Plan (TAMP) explains processes currently used to manage pavements and structures and describes the present condition and outlook for these important assets. The plan not only represents the SDDOT's response to requirements of the Moving Ahead for Progress in the 21st Century Act (MAP-21) laid out in 23 CFR Part 515 Asset Management Plans, but also articulates the department's dedication to sound asset management principles and commitment of resources toward that end. The TAMP discusses how the plan's strategies integrate with other departmental efforts to achieve the national goals identified in 23 USC 150(b) National Goals and Performance Management Measures. More than thirty persons with deep knowledge and experience in the SDDOT's asset management enterprise collaborated to develop the plan.

Inventory and Condition

The SDDOT manages approximately 8,847 roadway miles of highway and 1,800 bridges and large culverts on the state highway system. State highways are classified by functional class and funding category. Approximately 4,779 roadway miles and 969 structures comprise the Interstate and non-Interstate National Highway System.

The department monitors the inventory and condition of pavement assets through annual automated and manual surveys in both directions of travel on the entire state highway system and on non-state-owned NHS segments. Automated measurements include the International Roughness Index, rutting (on asphalt pavements), faulting (on jointed concrete pavements), and asphalt concrete cracking percent. Manual surveys collect a comprehensive set of distress ratings for several distinct families of flexible, jointed concrete, and continuously reinforced concrete pavements. Pavement management decisions are based on ratings of individual distress types and on a calculated composite Surface Condition Index (SCI). Condition data is also collected to satisfy federally mandated reporting requirements.

The SDDOT maintains structure inventory and condition information in the National Bridge Inventory. Inspections conforming to National Bridge Inspection Standards are performed at 1-, 2-, or 4-year intervals, depending on the structure type and condition. The department has historically tracked federally-defined sufficiency rating and structural deficiency. Recently, the department adopted ratings mandated by 23 CFR Part 490 National Performance Management Measures, including overall bridge condition and percentage of bridge deck area in good, poor, and structurally deficient condition, to manage bridge and large culvert assets.

Asset Management Practices

Effective asset management relies on sound analysis of current and predicted asset condition. Since the mid-1990's, the SDDOT has used life cycle planning, life cycle cost analysis, and benefit-cost analysis for network- and project-level asset management.

Pavement management employs historically based performance models that predict future condition of each pavement distress measured on more than twenty distinct pavement families. Incremental benefit-cost analysis determines the combination of feasible reconstruction, rehabilitation, and preventative maintenance treatments and timings that will use anticipated funding to provide the best overall pavement condition on the highway network over the 20-year analysis period. The recommended investment strategy, supplemented by safety improvement projects, forms the foundation of the recommended Statewide Transportation Improvement Program (STIP). Later, at the project level, life cycle cost analysis determines the most cost-effective design alternatives.

The SDDOT manages structures similarly, using AASHTOWare™ Bridge Management (BrM) and Pontis software. Models predict current and future condition and needs at both the network and project level to identify timely and cost-effective preservation, rehabilitation, and replacement treatments. Life cycle benefit-cost analysis, along with staff review of field recommendations, traffic capacity needs, logical project grouping, and expected impact on key performance measures, generates a recommended program of structure improvement projects for the STIP. The department is currently transitioning from Pontis to BrM software. During this transition both software are being used to complete the process.

Tradeoff analysis determines the proportions of total available funding to be allocated to pavements and structures. The SDDOT's Trade-Off Tool estimates the benefits—in terms of asset condition, safety impacts, level of service, and maintenance costs—that can be realized by feasible funding splits and recommends an optimal investment allocation.

Results of these analyses, along with recommendations from field offices and on-site project inspections, feed development of an eight-year developmental STIP and a four-year construction STIP. Basic scopes of proposed projects are developed to ensure that additional features such as lighting and sidewalks are included in cost estimates. A final asset management analysis, using updated information, generates a prioritized list of candidate projects for review by SDDOT managers.

The tentative STIP is submitted to the Transportation Commission, Metropolitan Planning Organizations, and Tribal governments. After revisions based on these meetings, the tentative STIP is distributed for statewide public comment. The Transportation Commission recommends final changes and then endorses the STIP for final approval by the Federal Highway Administration and the Federal Transit Administration. The approved STIP takes effect at the beginning of the federal fiscal year.

Objectives and Targets, Performance Gap Assessment

To help accomplish its mission "to efficiently provide a safe and effective public transportation system", the SDDOT has long set targets for pavement and structure condition in consideration of customer needs and expectations, analysis of asset condition, and anticipated funding levels.

The SDDOT bases targets for overall pavement condition on the Surface Condition Index, calculated as a composite of roughness, rutting, faulting, and distress indices on a scale of 0 to 5. The 10-year target goal and minimum value for the statewide highway network are 3.90 and 3.55, respectively. With currently anticipated funding, SDDOT can exceed the minimum value but cannot achieve the target value. The gap analysis for individual funding categories (Table 1.1) shows that the average SCI of pavements in every funding category are expected to decline significantly from current values.

Although most categories of roadways exceed their target goals now, none are expected to after ten years. All the categories are expected to remain above their target minimum, however.

Table 1.1: Pavement Performance Gap Analysis by Funding Category

Category	Measure	Minimum Target	Goal Target	Current Level	10-Year Projected Level
State Highway System	SCI	3.55	3.90	4.19	3.72
Interstate	SCI	3.80	4.20	4.27	3.95
Major Arterial	SCI	3.70	4.00	4.23	3.81
Minor Arterial	SCI	3.20	3.80	4.22	3.64
State Secondary	SCI	3.00	3.60	3.97	3.38
State Urban	SCI	3.60	4.10	4.01	3.70
State Municipal	SCI	3.55	3.9	3.82	3.68

An additional gap analysis, shown in Table 1.2, is conducted on pavements on the Interstate and non-Interstate NHS based on the performance targets as mandated by 23 CFR Part 490 National Performance Management Measures. This analysis shows the federal pavement performance measure target levels can be achieved with the anticipated funding.

Table 1.2: Pavement Performance Gap Analysis by Mandated Performance Measures

Category	Measure	Current Level	2-Year Level	4-Year Level	2-Year Target	4-Year Target
Interstate	% in Good Condition	73.2	N/A	80.5	N/A	≥ 62.6
Interstate	% in Poor Condition	0.0	N/A	0.0	N/A	≤ 2.4
Non-Interstate NHS	% in Good Condition	53.2	68.5	74.9	≥ 41.5	≥ 41.5
Non-Interstate NHS	% in Poor Condition	0.8	0.8	0.8	≤ 1.5	≤ 1.5

The SDDOT rates structure condition according to the good, fair, and poor ratings required for National Bridge Inventory reporting. As shown in Table 1.3, 97.4% of structures on the state highway system are now in the good or fair categories, exceeding the 95% target goal. With planned levels of investment, 96.7% of structures are expected to be in the good or fair condition ten years from now.

Table 1.3: Structure Performance Gap Analysis

Category	Measure	Goal Target	Current Level	10-Year Projected Level
State Network Structures	% of Structures in Good or Fair Condition	>95%	97.4%	96.7%

A second gap analysis is conducted on NHS structures based on the performance targets as mandated by 23 CFR Part 490 National Performance Management Measures and is shown in Table 1.4. This analysis shows the target levels can be achieved with the anticipated funding.

Table 1.4: Structure Condition Distribution

Category	Measure	Current Level	2-Year Level	4-Year Level	2-Year Target	4-Year Target
National Highway System (NHS)	Structures in good condition as a percentage of deck area	27.6	25.0	24.0	≥ 22	≥ 20
National Highway System (NHS)	Structures in poor condition as a percentage of deck area	2.8	3.0	2.65	≤ 5	≤ 5
National Highway System (NHS)	Structures considered structurally deficient as a percentage of deck area	2.8	3.0	2.65	<10% for 3 consecutive years	

Clusters of pavements and structures built—and consequently reaching the end of their lives—at the same time can limit the SDDOT's ability to consistently meet state or federal targets. The department intentionally extends the service life of some assets to avoid funding demand peaks arising from structures built during the Interstate era and pavements rehabilitated under the 2009 American Recovery and Reinvestment Act, for example.

Growth and Demand

Asset management must respond to growth in the state's population and economy and resulting demand for traffic capacity and travel reliability. South Dakota's population, which has grown steadily at a modest rate of 0.4 percent per year, reached 870,000 in 2017. As population continues to migrate to urban centers, especially Sioux Falls, Rapid City, and Sioux City, more than half of rural counties are losing population. In urban areas, diverse economies include finance, real estate, retail and wholesale trade, government services, manufacturing, education, and other services. In rural areas, agriculture, forestry, fishing, and hunting dominate.

Traffic characteristics mirror the state's population distribution and economy. Interstate highways I-29 and I-90, which carry high proportions of through traffic, carry the largest volumes of passenger vehicles and trucks and will continue to in the future. Other highways on the National Highway System serve as major travel corridors in the state. Little recurring congestion exists anywhere in the state highway network. Data from the Regional Integrated Transportation Information System rated reliability for Interstate traffic, non-Interstate NHS traffic, and the Interstate truck reliability index at 100%, 93.7%, and 1.16 respectively in 2018. Main causes of non-recurring congestion are winter weather and special events, such as the Sturgis Motorcycle Rally. The SDDOT is formally moving to Transportation Systems Management and Operations to manage traffic and expedite commercial vehicle movements in and through the state.

Among the economic sectors generating freight traffic, agriculture is growing the fastest. Genetic crop improvements have increased yields, expanded tillable acreage, and shifted crop types, significantly multiplying overall production. Livestock movements are also important. Initial shipping—to farm, local grain elevator, processing facility, or railhead—is always by truck on local and state highways. The SDDOT uses major corridor studies, planning studies for Metropolitan Planning Organizations and non-metropolitan cities and counties, and its freight and rail plans to identify critical locations, such as intermodal freight facilities, that will experience significant growth and need transportation investment.

Risk Management

Unforeseen events or uncontrollable factors can disrupt the SDDOT's ability to maintain pavement and structural assets and meet the needs of highway users. Failure to anticipate and plan for risks can jeopardize asset condition, safety, mobility, economic vitality, the department's reputation, and funding.

The SDDOT has assigned a risk rating based on the likelihood of occurrence and the severity of consequences for each of 22 potential risks encompassing financial threats, regulations, traffic demand, organizational capability, technology, and geological impacts. Possible mitigation strategies—treating, tolerating, terminating or eliminating risk, transferring risk, and taking advantage of the opportunity—are identified for each risk. The eight risks rated "extreme" or "high" (Table 1.5) are considered major and receive detailed discussion in Chapter 8.

Table 1.5: Major Risks

Risk Description	Likelihood	Consequence Severity	Risk Rating	Mitigation Strategy
Business System Technology	Almost Certain	Major	Extreme	Treat, Take Advantage
Federal Funding Uncertainty	Likely	Major	Extreme	Treat, Tolerate, Transfer
State Funding Shortfall	Remote	Major	High	Treat
Traffic Demand Growth	Possible	Moderate	High	Treat, Transfer
Culture Changes	Remote	Major	High	Treat, Take Advantage
Extreme Weather and Climate Change	Likely	Moderate	High	Treat
Consultant, Contractor, and Supplier Workforce Retention and Recruitment	Likely	Moderate	High	Treat
ROW Acquisition	Likely	Moderate	High	Tolerate

Finally, the SDDOT specially monitors the condition of thirteen facilities that have been repeatedly damaged by emergency events, as required by 23 CFR Part 667 Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events. These facilities are prone to natural disasters such as flooding and landslides.

Financial Plan and Investment Strategies

Highway projects in South Dakota are funded from two primary sources—the State Highway Fund and federal funding. The State Highway Fund is supported by the state motor fuel tax, an excise tax on vehicle purchases, commercial vehicle registration and permitting fees, and miscellaneous revenues. About a quarter of the $300M total is used to match federal highway funding, and the remainder is used for highway maintenance and other operational expenses.

The SDDOT receives approximately $300M per year in federal funding, mainly apportioned into the National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STBG), and the Highway Safety Improvement Program (HSIP). Federal funds must be used for design, preservation, rehabilitation, safety improvements, new construction, or reconstruction. They may not be used for non-transportation purposes or routine maintenance operations. The SDDOT relies heavily on federal funding for construction, reconstruction, and rehabilitation of pavement and structural assets, as 70% of the construction budget is federally funded. Some federal funds are also allocated to local programs for counties, Tribes, cities, towns, townships, and recreational trails.

The SDDOT has prioritized maintaining existing assets in a state of good repair when new construction is not needed. Determining the amount of investment for rehabilitation, preservation, and maintenance of assets over their entire useful life is the basis for the SDDOT's overall investment strategy. Using pavement and bridge management tools, the SDDOT can predict the average condition and distribution of condition over the complete state highway network or within any funding category for any assumed funding level. The SDDOT's Trade-Off Tool evaluates the effect of potential funding scenarios to recommend year-by-year distributions among funding categories that will produce the greatest benefit in network condition and life.

Using these asset management tools has allowed the SDDOT to substantially improve pavement and structure conditions, but these conditions may not be sustainable in the future. State and federal funds are expected to grow slowly in future years and may not keep pace with inflation in highway construction costs, which have more than doubled in the past twenty years. Uncertainty in the federal Highway Trust Fund further threatens the SDDOT's future ability to sustain asset condition and function and support progress toward achieving the national goals in accordance with 23 USC 150(b) National Goals and Performance Management Measures.

The replacement values of pavement and structures on the entire state highway system are estimated to be nearly $15B and $2B respectively. In their current condition, their present values are approximately $10B and $1.8B respectively. Federal law requires the SDDOT to identify the funding needed to maintain the current value of pavement and structure assets on the National Highway System. Over the next 10 years, an average annual investment of $210M, $39M more than the current $171M annual investment, is needed to maintain the value of pavements on the NHS. Maintaining the current value of NHS structures will require an annual investment of $29M, $11M more than the current annual investment of $18M.

Summary

The SDDOT 2019 Transportation Asset Management Plan describes the SDDOT's experience, commitment, processes, and intentions regarding management of pavement and structures. Further, it identifies key issues, including challenges to maintaining current levels of condition of the state highway network and of highways on the National Highway System.

The plan will be updated as required by federal rules and as needed to dynamically and effectively manage these valuable and important assets.

Chapter 2 Introduction

The South Dakota Department of Transportation's (SDDOT) mission is "to efficiently provide a safe and effective public transportation system". This commitment is reemphasized in the department's strategic plan and the Statewide Long-Range Transportation Plan (SLRTP). The strategic plan and SLRTP outline the department's mission, vision, core values, strategic objectives, and short-term and long-term goals. Innovation, high ethical standards, transparency, efficient and accountable use of public resources, and ensuring safety are expected of all employees.

Asset management plays a significant role in achieving the department's mission. For decades, the SDDOT has included asset management practices in many decision-making processes such as development of the Statewide Transportation Improvement Plan (STIP). Over the years, the department has adopted and continues to improve many asset management methods and strategies. The use of benefit-cost ratios, life cycle cost analysis, and tradeoff analysis, among other tactics, will continue to guide the department's management of assets.

As part of the National Highway Performance Program (NHPP), the Moving Ahead for Progress in the 21st Century Act (MAP–21) established a requirement for states to develop and implement a risk-based asset management plan to improve or preserve the condition and performance of the National Highway System (NHS). The department views this requirement as an opportunity to review established practices, improve them where needed, and add transparency to the process.

The SDDOT Transportation Asset Management Plan (TAMP) was developed over several years by committees of department technical experts. More than 30 SDDOT staff members, guided by the department's Asset Management Engineer and in partnership with the Federal Highway Administration (FHWA) Division Office, contributed to the writing. The plan addresses pavements and structures on the NHS including both Interstate and non-Interstate NHS highways and other state-owned non-NHS highways. Figure 2.1 depicts the state highway system covered in the TAMP.

The TAMP documents current and historic processes. Asset management of pavement and structures has been conducted by the department since the 1970's and has continuously improved and evolved over the years. The plan also includes the new requirements of federal performance measures and targets. The plan is organized into chapters that describe:

- data collection practices
- current condition of pavements and structures
- processes of analyzing the data
- asset management objectives and condition goals
- identification of performance gaps
- risk management analysis
- financial planning processes
- investment strategies

At the first TAMP Committee meeting in August 2013 the committee members decided to participate in National Highway Institute's training on "Developing an Asset Management Plan" and "Transportation Asset Management Overview". These courses were conducted in December of 2013 and established the outline and initial chapters of the TAMP. Each chapter was developed by a subcommittee of approximately 15 people, drawn from all three divisions of the department, with a wide range of knowledge and expertise

As the TAMP developed, the committees continuously discussed "who is the audience" and what content would be beneficial to that audience. The federal requirement to develop a TAMP was only part of the conversation. The group also discussed how to demonstrate the department's dedication to asset management principles.

When the draft rules for the TAMP were presented in the Code of Federal Regulations (CFR) in February of 2015, the committees suspended work on the TAMP to prepare comments to the draft rules and to evaluate the existing content versus the content required in the draft rules. The draft rules included many requirements not presented in the original training classes. Waiting for the final rules prevented rework.

Following the publication of the final rule on October 24, 2016, the committees reconvened to evaluate the chapter drafts and make necessary modifications based on the final rules. The Gantt chart projecting TAMP completion by the April 30, 2018 deadline was adjusted to accommodate the additional work required. Several chapters were revised to satisfy the new requirements.

Following development and submittal of the initial TAMP, the department worked toward collecting and analyzing the data needed to update the TAMP for the June 30, 2019 submittal. Each subcommittee worked through reviewing and updating each chapter to meet the additional requirements of the second submittal. All the data in this version has been updated to the most currently available data and the federal performance measures and targets have been added.

The TAMP is a collaboration of many dedicated and resourceful individuals within the department who take great pride in providing a quality transportation network to the people of South Dakota.

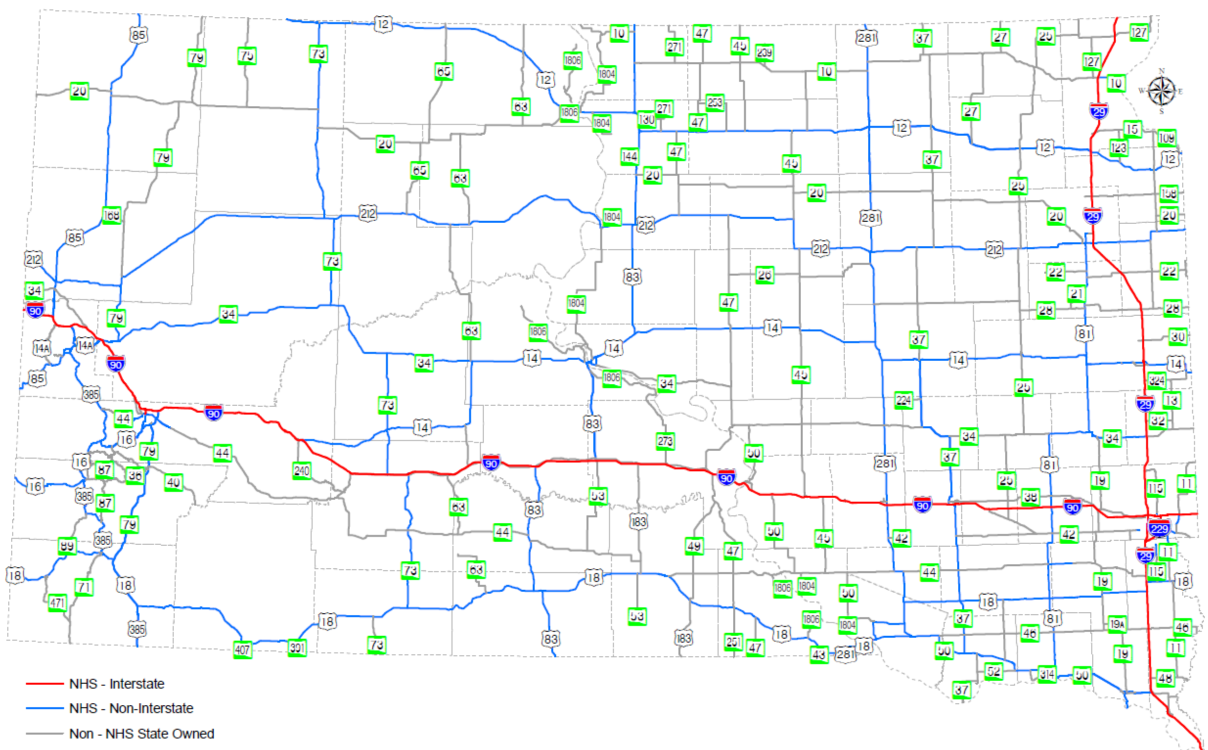


Figure 2.1: State Highway System

Chapter 3 Inventory and Condition

South Dakota has more than 82,000 public roadway miles and 5,000 vehicular structures. The SDDOT manages approximately 8,847 roadway miles of higher-functioning highways and 1,800 structures. Roadway miles are the number of miles of each roadway including both directions of divided or separated roadways. The level of investment on each state-owned highway and structure is based primarily on the condition and function of each highway section and structure. To manage these highways and structures, the SDDOT defines the state-owned highway system in more detail by identifying funding categories for each subset of roadway functional classification.

South Dakota State Highway System

The state highway system in South Dakota is categorized into functional classes based on the functionality and type of service each road provides the traveling public. See Table 3.1 and Figure 3.1. The SDDOT coordinates with city, county, and federal government agencies, tribal governments, and other local entities to determine mutually-agreeable designations for these roads.

The functional classification designation also determines federal funding eligibility for highways.

Table 3.1: Functional Classifications

Classification	Type of Service
Interstate	Urban and Rural
Expressways	Urban and Rural
Principal Arterial	Urban and Rural
Minor Arterial	Urban and Rural
Major Collector	Urban and Rural
Minor Collector*	Rural
Local Roads*	Urban and Rural

**Not generally eligible for federal funding*

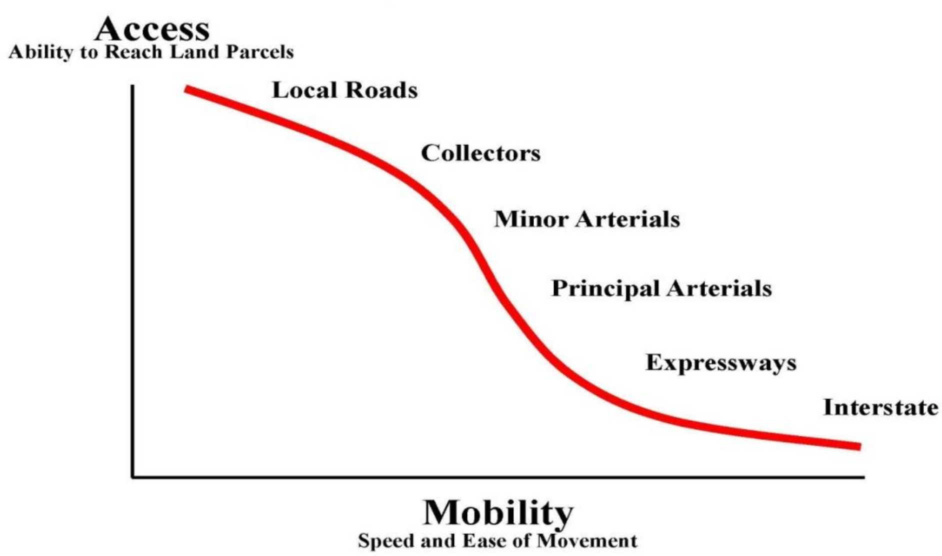


Figure 3.1: Functionality of Roads and Streets

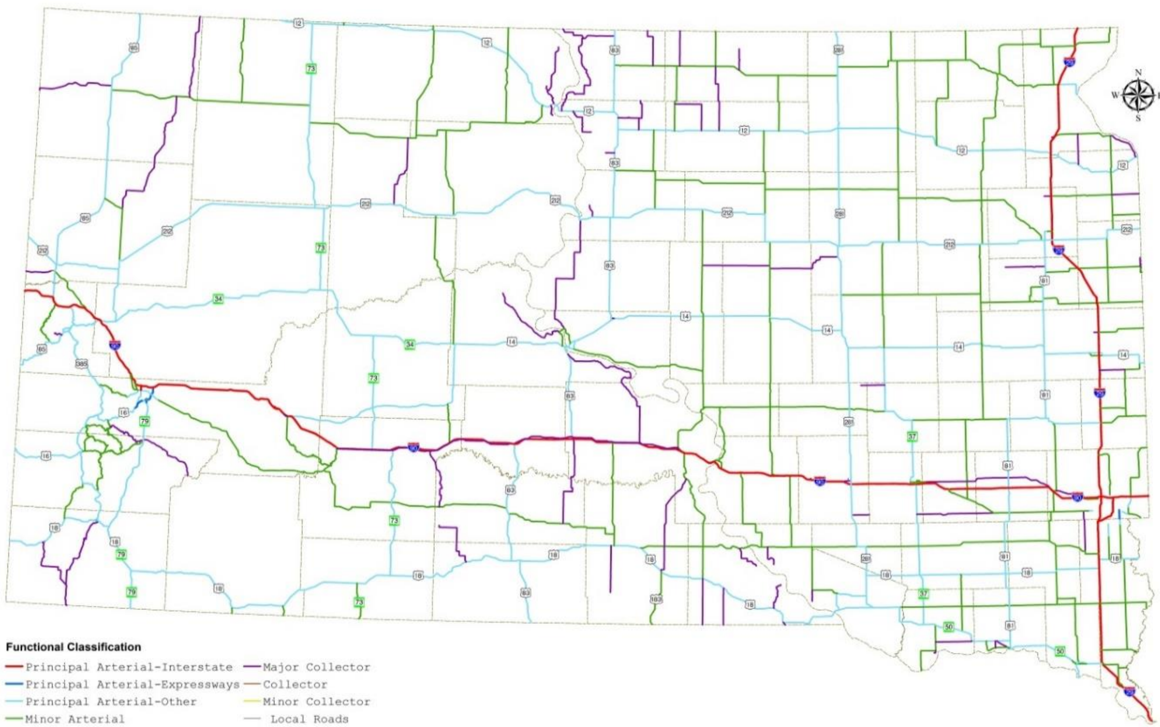


Figure 3.2: South Dakota Functional Classification Map

State highways are also designated as part of either the National Highway System (NHS) or non-NHS. The FHWA defines the NHS as roadways important to the nation's economy, defense, and mobility. A small portion of the NHS (Non-State-Owned NHS) is owned, operated, and maintained by entities other than the SDDOT. The quantities of each are shown in Table 3.2 and Table 3.3. The locations of each are shown in Figure 3.3 through 3.6.

NHS and non-NHS roadway miles in South Dakota include:

Table 3.2: South Dakota National Highway System Roadway Mileage

National Highway System Mileage	Roadway Miles
Interstate (NHS)	1,358
State Highway System (NHS)	3,378
Non-State-Owned (NHS)	43
TOTAL	**4,779**

Table 3.3: South Dakota State Highway System Roadway Mileage

State Highway System Mileage	Roadway Miles
Interstate (NHS)	1,358
State Highway System (NHS)	3,378
State Highway System (Non-NHS)	4,111
TOTAL	**8,847**

Does not include non-state-owned NHS

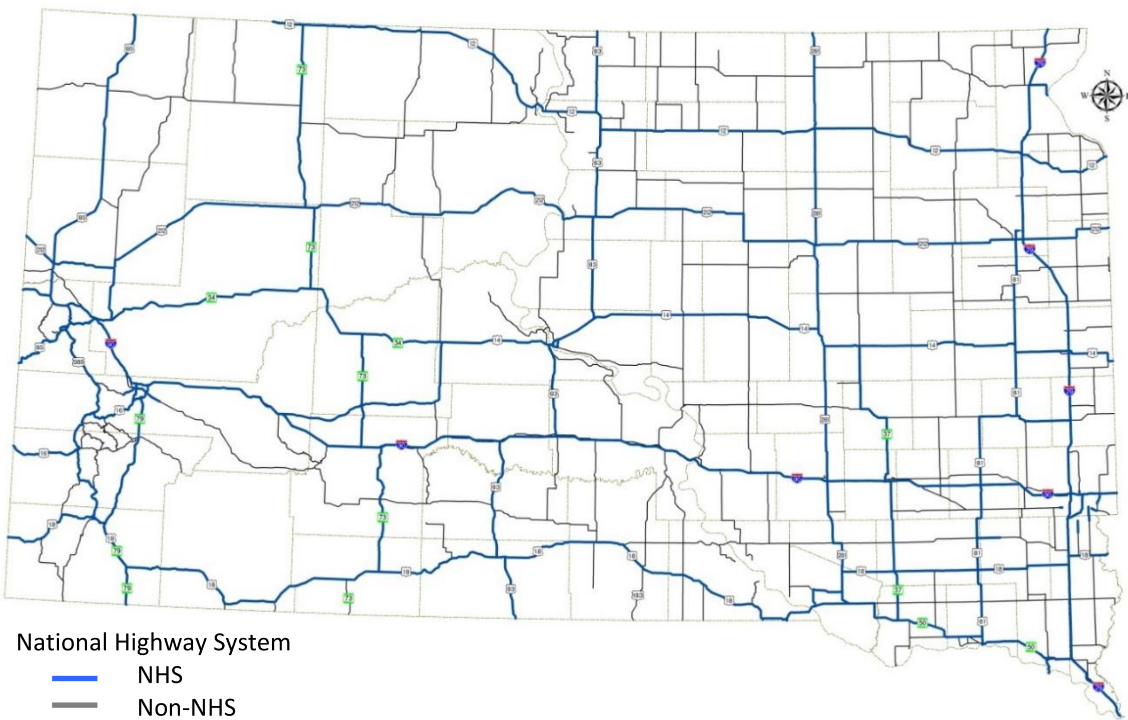


Figure 3.3: State-Owned NHS Routes Map

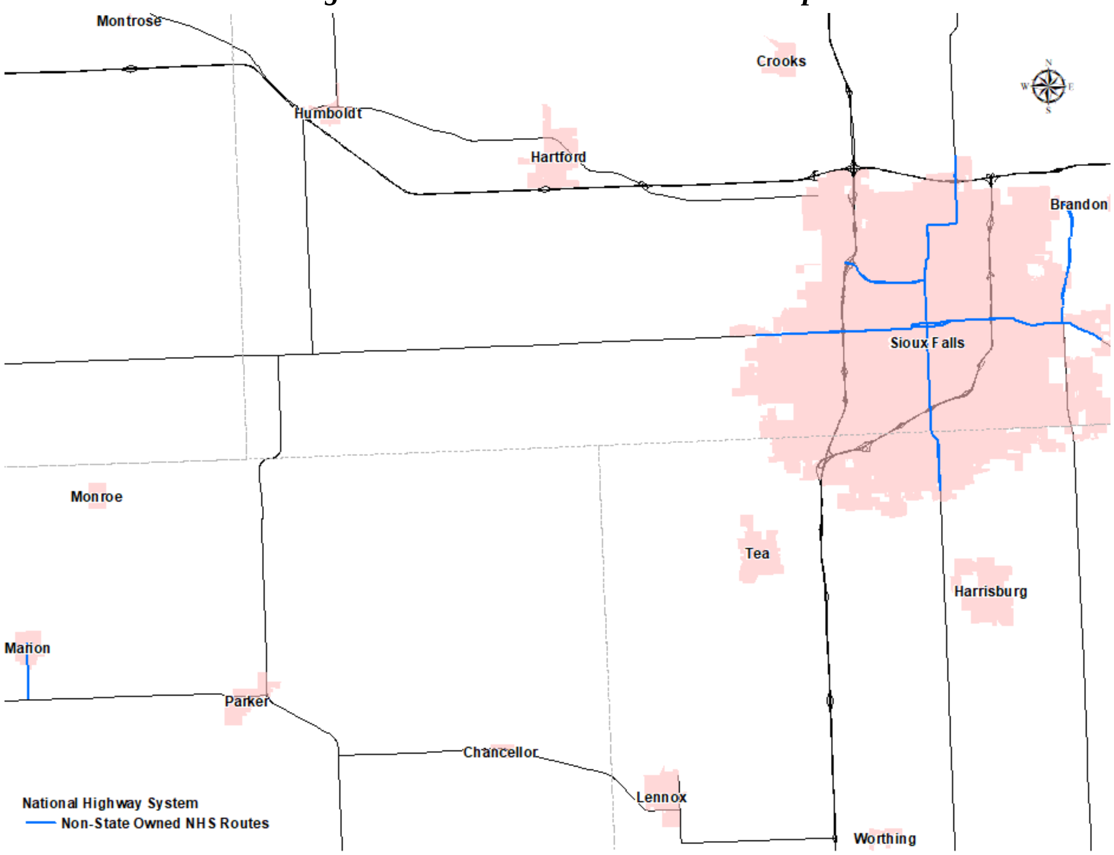


Figure 3.4: Non-State-Owned NHS Routes Map – Sioux Falls

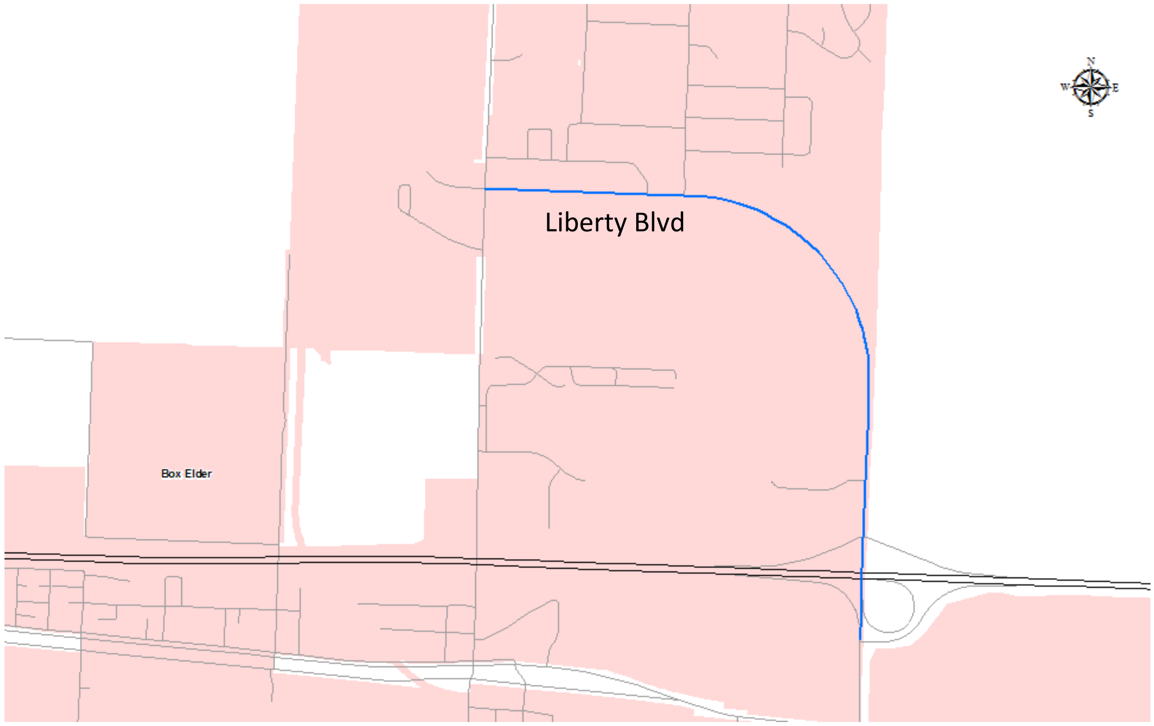


Figure 3.5: Non-State-Owned NHS Routes Map – Rapid City Area Metropolitan Planning Organization

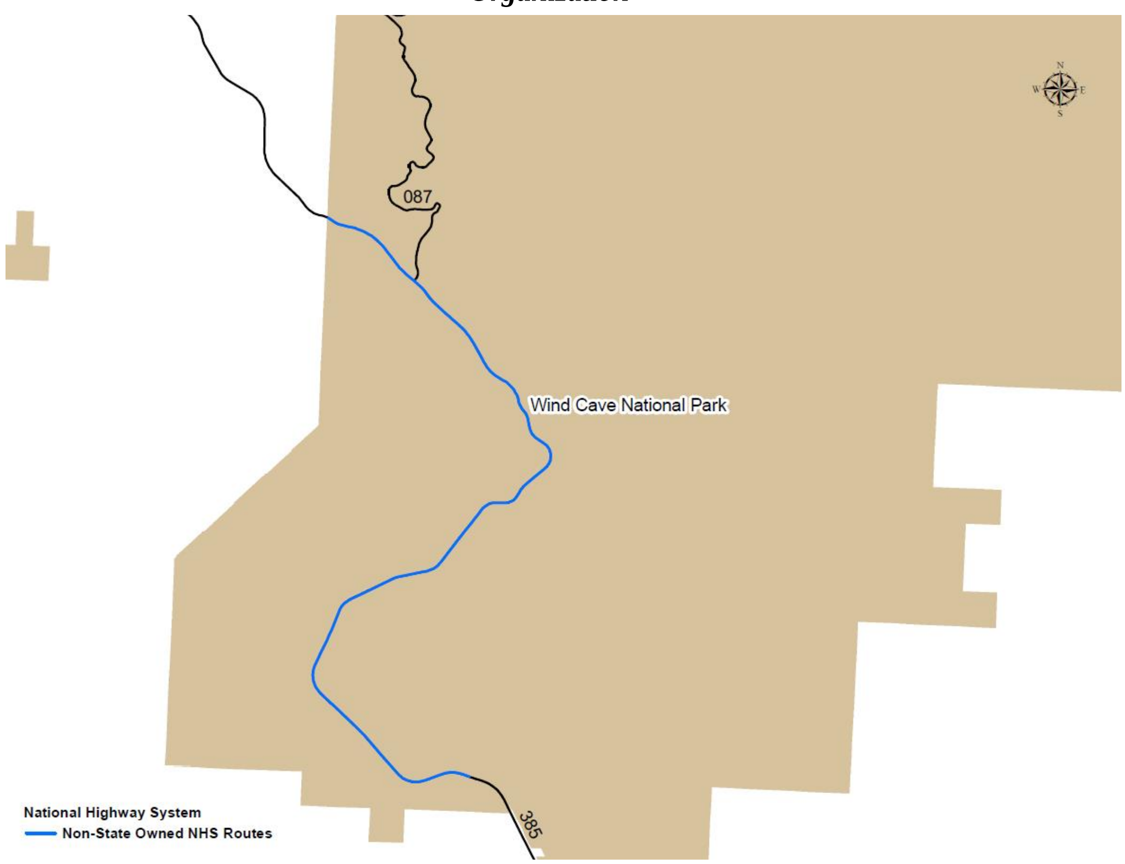


Figure 3.6 Non-State-Owned NHS Routes – US385 through Wind Cave National Park

Funding Categories

To manage the state highway system, the SDDOT uses six funding categories based primarily on functional classifications:

- **Interstate:** The route has a federal designation of National Highway System – Interstate or a federal functional classification of rural principal arterial – Interstate or urban principal arterial – Interstate.
- **Major Arterial:** The route has a federal designation as a National Highway System – non-Interstate route and/or has a federal functional classification of rural principal arterial – expressway or rural principal arterial – other and/or is on South Dakota's Preferential Truck Network and is not classified as urban or municipal.
- **Minor Arterial:** The route has a federal functional classification of rural minor arterial or the route has a federal designation of National Highway System – connector route and has a federal functional classification lower than rural minor arterial and is not classified as urban or municipal.
- **State Urban**: The route has an urban federal functional classification, is not classified as principal arterial – Interstate, and is located in cities with a population greater than 5,000.
- **State Municipal:** The route has a rural federal functional classification, is not classified as principal arterial – Interstate, and passes through a community with a population between 450 and 5,000.
- **State Secondary:** All remaining routes on the state system with the federal functional classification as a collector.

Table 3.4 shows the roadway miles designated in each funding category and Figure 3.7 shows their location throughout the state. The department has set surface condition goals for each category and funding is allocated between categories to achieve the goals. Objectives and targets are detailed in Chapter 5.

Table 3.4: Funding Category Roadway Mileage

Funding Categories	NHS Mileage	NHS non-Federal Aid Mileage	Non-NHS Mileage	Total
Interstate	1358	0	0	**1358**
Major Arterial	3108	6	13	**3127**
Minor Arterial	9	0	2887	**2896**
State Secondary	0	0	1082	**1082**
State Urban	176	0	52	**228**
State Municipal	77	0	79	**156**
Total	**4728**	**6**	**4113**	**8847**

Does not include non-state-owned NHS

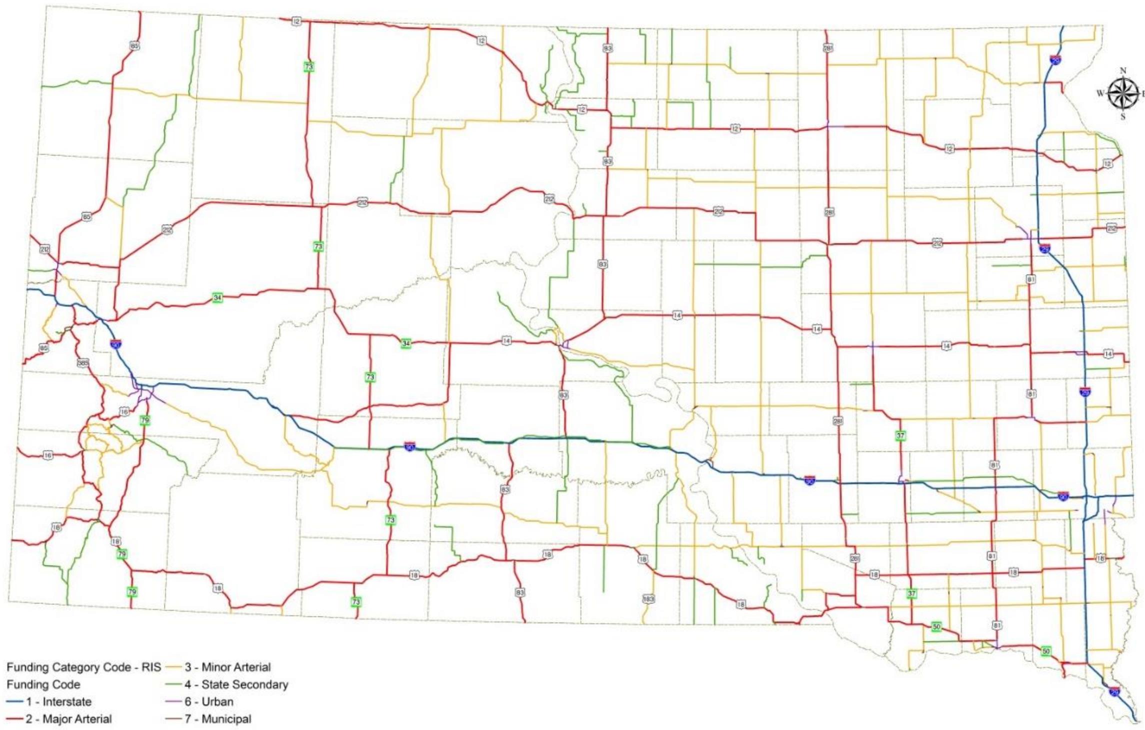


Figure 3.7: Funding Categories Map

Pavement Inventory

The SDDOT has collected state highway roadway data for decades. In the late 1960s, a linear referencing system known as the Mileage Reference Marker (MRM) system was created. The MRM system is still used to associate roadway inventory information with geographic location. The first mainframe database for storing roadway information was created in the 1970s and was known as the Roadway Environment System (RES).

Beginning in the fall of 2008, the SDDOT upgraded to a PC-based application, the Roadway Information System (RIS). Currently, RIS has multiple subsystems for the state highway system inventory including mileage reference marker, roadway features, intersection inventory, traffic inventory, GIS data extract, and RIS validation. RIS data is continually updated throughout the year, with the majority of updates occurring from October through December.

The state highway system comprises 6,881 roadway miles of asphalt concrete pavement, 1,889 roadway miles of Portland cement concrete (PCC) pavement, and 66 miles of gravel surface. Figure 3.8 and Figure 3.9 show the distribution of ages for concrete and asphalt pavements. Concrete pavements typically undergo significant rehabilitation at an age of approximately 40 years. Asphalt pavements undergo significant rehabilitation at approximately 16 years. While age is a factor, many other factors are considered. Additional discussion on life-cycle planning is provided in Chapter 4.

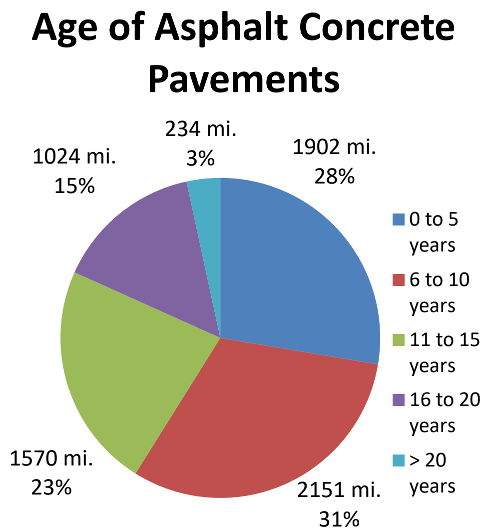


Figure 3.8: Asphalt Pavement Ages

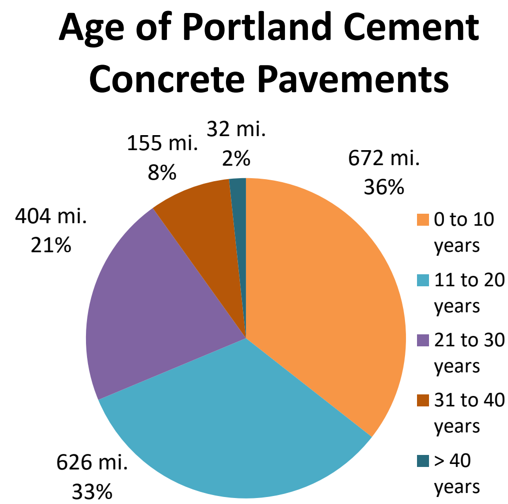


Figure 3.9: PCC Pavement Ages

Pavement Condition Data Collection

Pavement condition data is collected by the SDDOT on 100 percent of the NHS including the 43 miles of non-state-owned NHS and more than 85 percent of the remaining state highway system annually by automated and manual methods. Data is not collected on pavements under construction. The SDDOT has entered into formal agreements with each Metropolitan Planning Organization (MPO) that identify the responsibilities of each party regarding data collection and target setting for non-state-owned NHS segments.

Every year, manual visual inspections are performed to collect three sets of distresses. On asphalt concrete (AC) pavements, transverse cracking, fatigue cracking, patching and patch deterioration, and block cracking information is gathered. On jointed Portland cement concrete pavements (JCP) durability-cracking/alkali silica reactivity, joint spalling, corner cracking, and joint seal damage information is gathered. Continuous reinforced concrete pavement (CRCP) has durability-cracking and alkali silica reactivity, punch-outs, and block cracking collected. More detailed information on the data collection procedures and rating systems can be found in the Pavement Management Visual Distress Survey Manual linked in Appendix B. In addition, the state-of-the-art vehicle pictured in Figure 3.10 collects digital images of roadway surfaces and adjacent roadsides along with automated measurements of International Roughness Index (IRI), faulting, and rutting.

Figure 3.10: Road and Pavement Data Collection Vehicle

This specially equipped road and pavement data collection vehicle travels nearly every mile of the state highway system each year measuring pavement profile, roughness, and recording roadway and pavement images.

For pavement management purposes, the state highway system is divided into pavement management system segments based on highway terminal breaks, pavement types, previous STIP project limits, funding categories, SDDOT region boundaries, state-significance designations, roadway widths, surfacing or resurfacing year, and the year of grading. Currently over 3,800 segments are designated on the state highway system that range in length from 26 feet to 22 miles. Visual condition data is collected at 0.25-mile intervals and automated condition data is summarized and stored at 0.01-mile intervals except faulting where the location and extent of each fault is stored. The individual condition ratings within each segment are combined using a modified weighted average so that each pavement management system segment receives one overall rating for each distress type.

Surface Condition Index (SCI)

The Surface Condition Index (SCI) indicates the overall health of the pavement using a range of zero to five. SCI is calculated from the overall distress ratings for each segment as described in SDDOT's Enhanced Pavement Management System Synopsis linked in Appendix B. The SCI value for each segment of pavement is generalized further into four categories as shown in Figure 3.11. In 2018, the state highway system network had an average SCI rating of 4.19 or Good Road Condition.

Figure 3.11: Example Road Conditions – 2018 Data

Figure 3.12 through Figure 3.17 show the historical average SCI for each funding category. Figure 3.18 shows the state-wide condition distribution and Figure 3.19 shows their locations throughout the state.

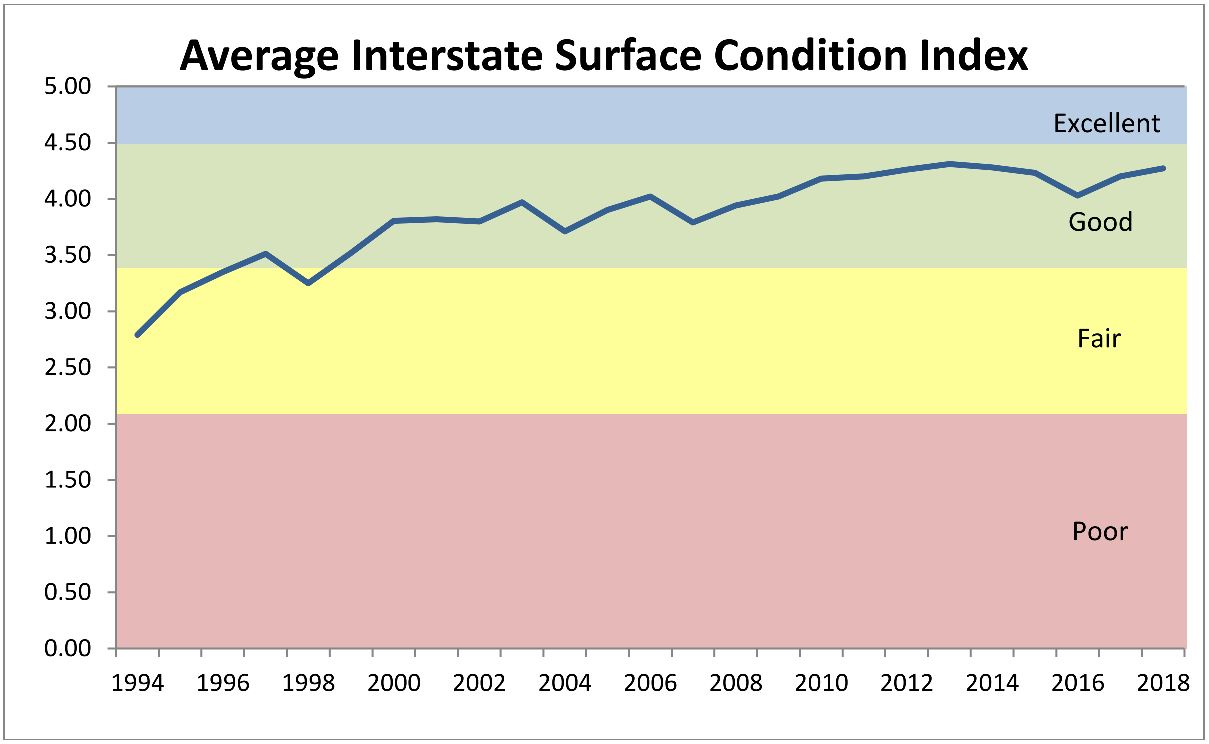


Figure 3.12: Historical Surface Condition Index Ratings, Interstate

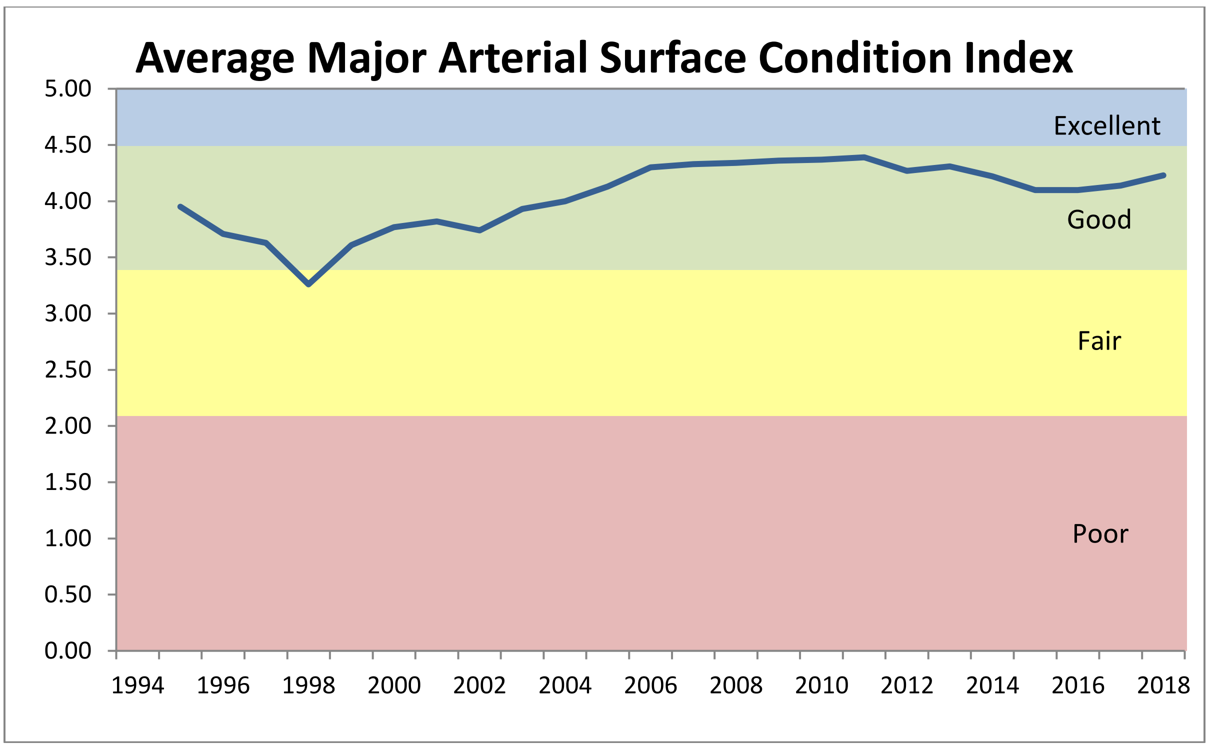


Figure 3.13: Historical Surface Condition Ratings, Major Arterial

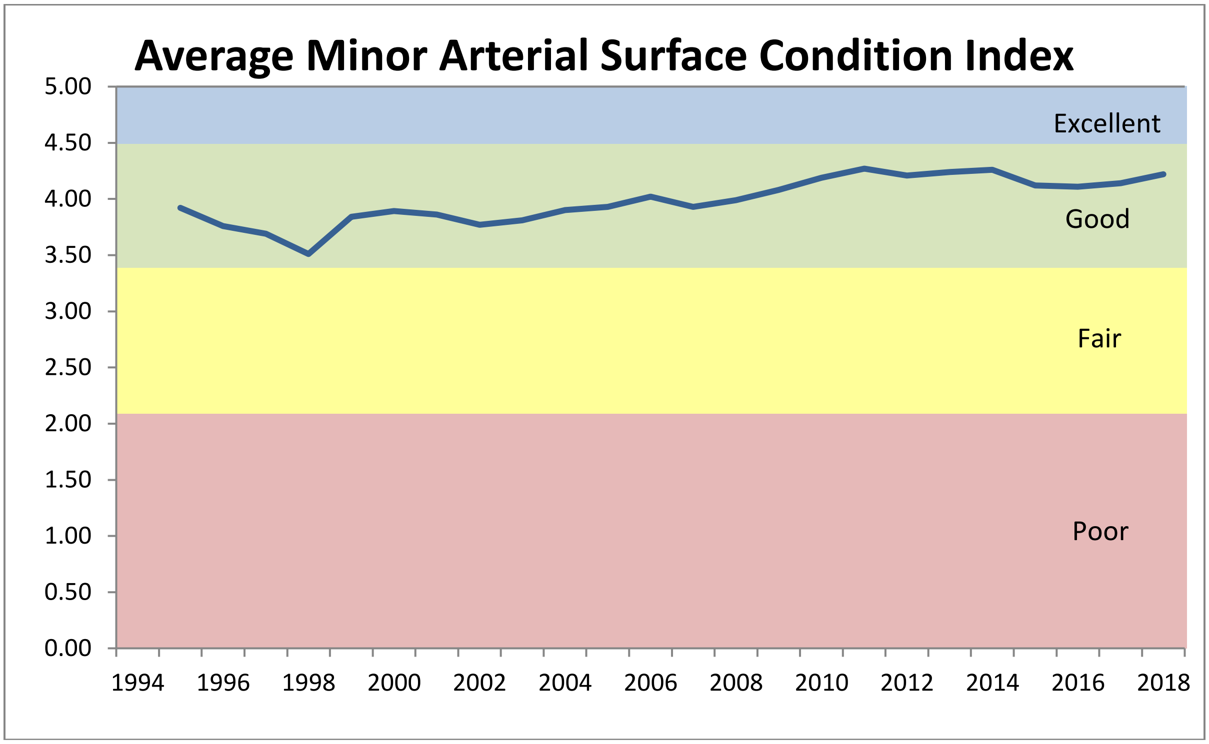


Figure 3.14: Historical Surface Condition Index Ratings, Minor Arterial

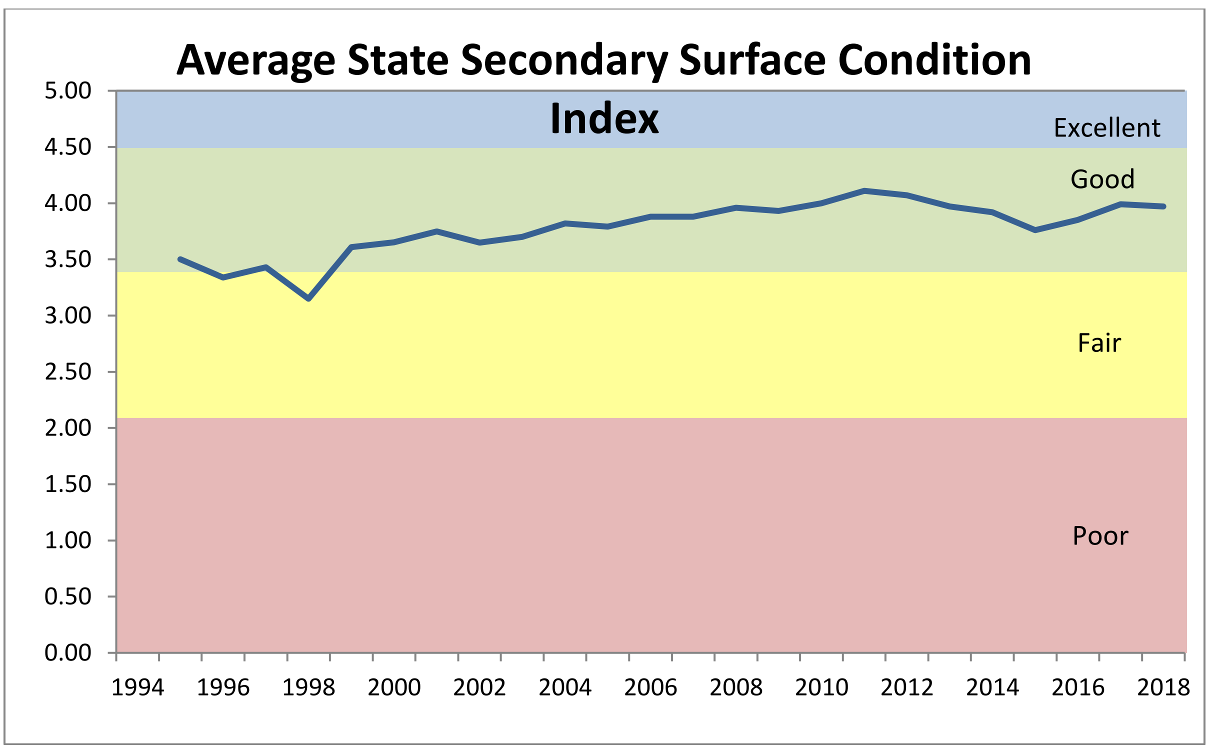


Figure 3.15: Historical Surface Condition Index Ratings, State Secondary

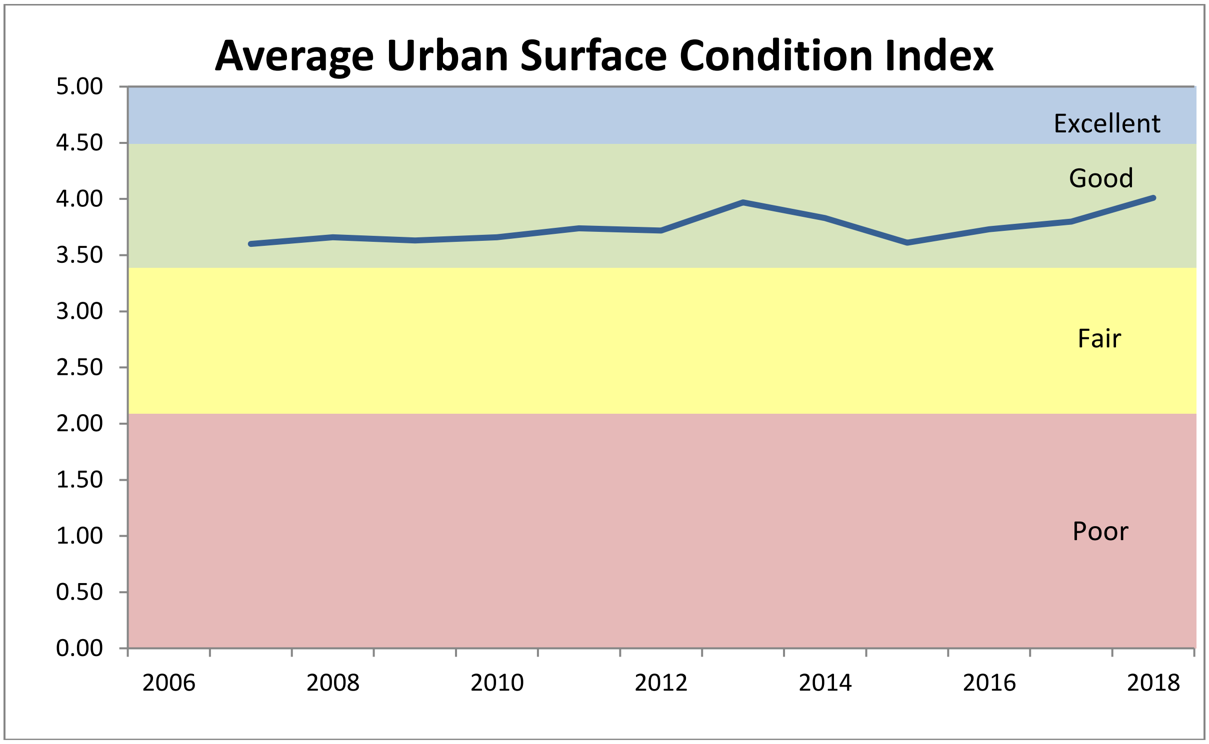


Figure 3.16: Historical Surface Condition Index Ratings, State Urban

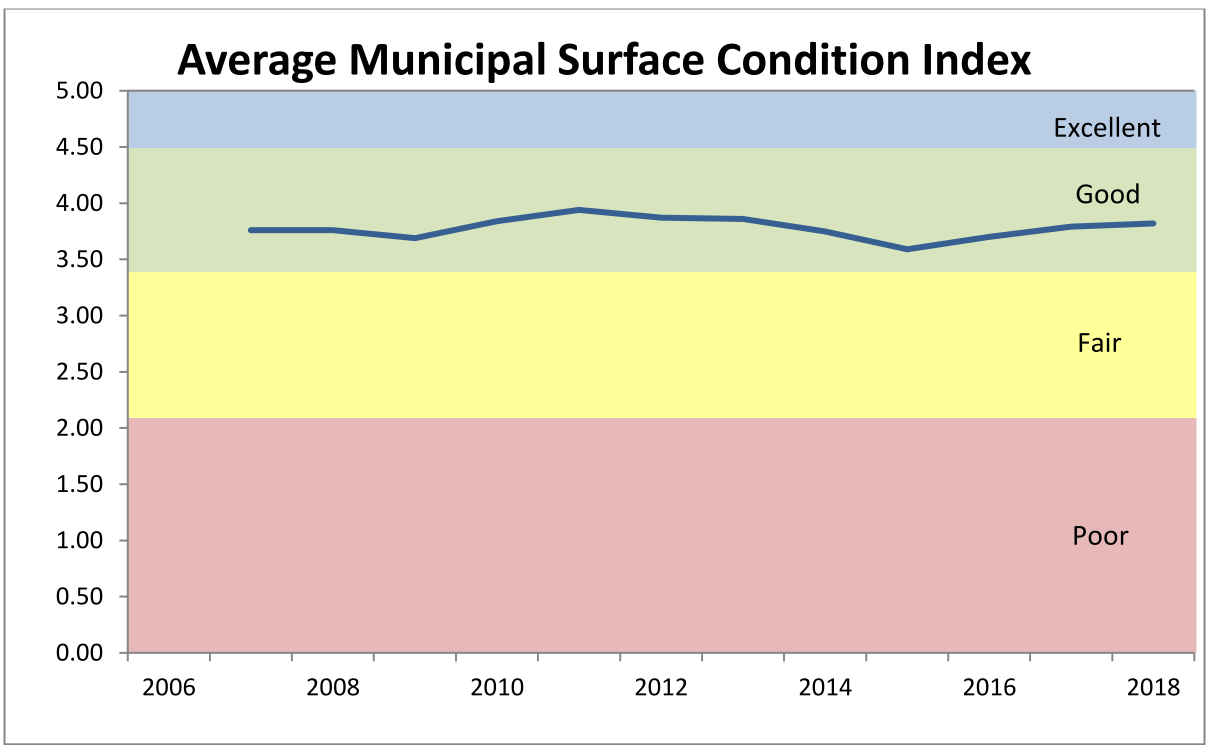


Figure 3.17: Historical Surface Condition Index Ratings, State Municipal

Figure 3.18 shows the historical distribution of SCI categories on the state highway system.

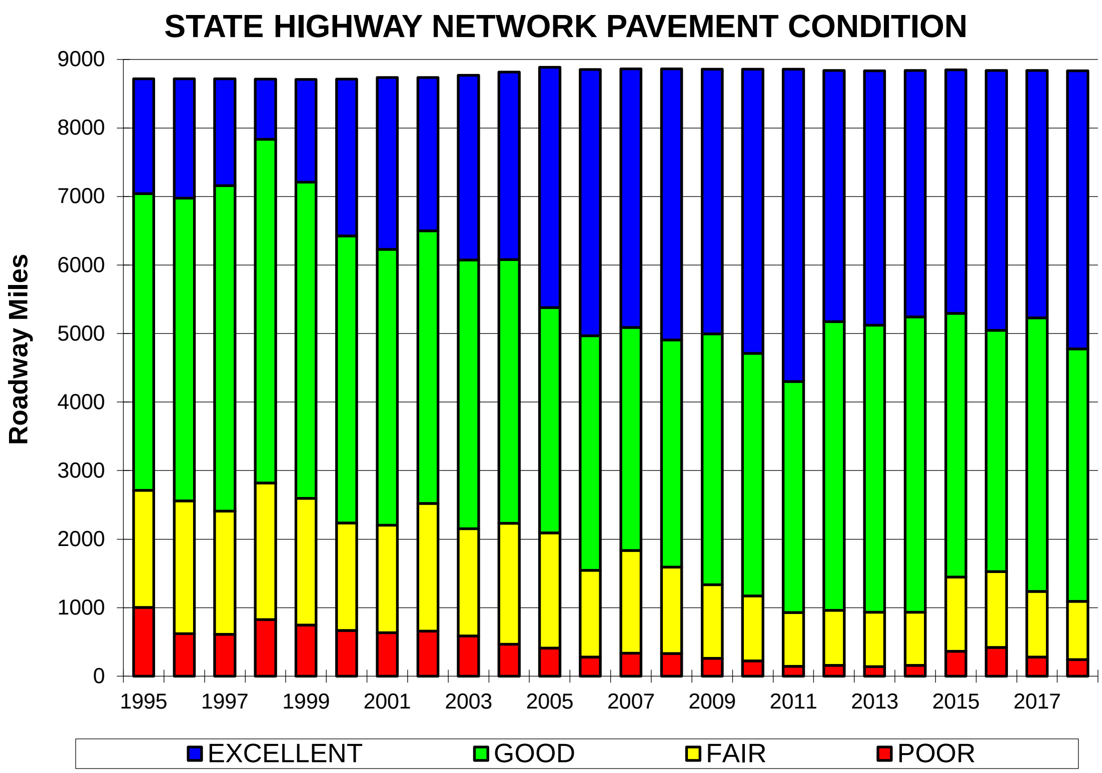


Figure 3.18: Historical Statewide Pavement Condition

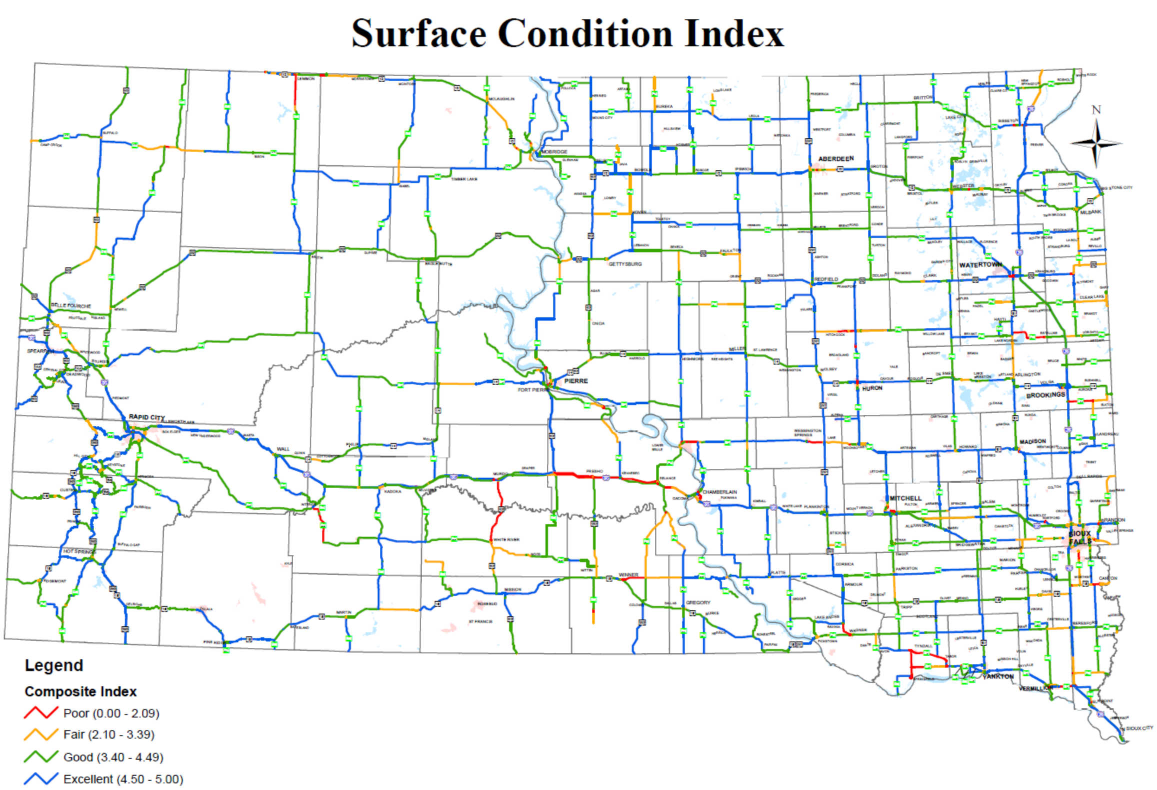


Figure 3.19: 2018 Surface Condition Index Map

Federal Pavement Performance Measures

The passage of Moving Ahead for Progress in the 21st Century Act (MAP-21), the Fixing America's Surface Transportation Act (FAST Act), and the subsequent federal rules created a requirement for states to evaluate and report the condition of their pavements according to a prescribed rating system. This rating system uses some but not all the same distresses the department has been using for years to manage pavements. However, some of the collection, analysis, and calculation methods prescribed in the federal system deviate from the department's established system.

The department's pavement management practices described in this chapter and in subsequent chapters have matured over decades of use. These established procedures are the primary basis for decisions regarding pavement improvements. However, the federally mandated system of performance measures can have a substantial impact on federal funding and the available uses of that funding. For those reasons, the federally mandated system is described here as required by federal law and is considered by the department in pavement management decisions.

The federal system uses rutting, faulting, IRI, and cracking percentage to categorize tenth-mile segments into good, fair, and poor overall conditions. The measure is reported for the Interstate and non-Interstate NHS in percentage of lane miles in good and poor condition. 2018 is the first year these measures were collected and reported.

Table 3.5 Federal Pavement Performance Measures

Category	% Good	% Poor
Interstate	73.2	0
Non-Interstate NHS	53.2	0.8

Includes non-state-owned NHS

Structure Inventory

The SDDOT has collected and maintained inventory and condition information on National Bridge Inventory (NBI) structures since 1971. An NBI structure is defined as a bridge or culvert that has an opening greater than 20 feet, is open to the public, and carries vehicular traffic as per 23 CFR Part 650 Bridges, Structures, and Hydraulics. Within the TAMP, NBI structures including bridges and culverts are referred to as "structures". Since 1998, the SDDOT has used the AASHTOWare™ software product Bridge Management System (BrM), and its former version known as Pontis, for managing structure data including inventory and inspection data and programming improvements.

The SDDOT manages approximately 1,800 structures on the state highway system. As required by 23 CFR Part 650, subpart C, National Bridge Inspection Standards (NBIS), the SDDOT must inspect or cause to be inspected all structures on public roads located fully within the state boundaries except for structures owned by federal agencies. Structures located at the borders that cross state lines are managed by agreements between the two states that identify which state is responsible for the inspection and how maintenance will be coordinated. Inspection data is shared between the two states.

Table 3.6: Number of State-Owned NBI Structures and Their Inspection Frequencies

Frequency	Bridges	Culverts	Total
12 months	7	0	7
24 months	1212	234	1446
48 months	30	312	342
Total	**1249**	**546**	**1795**

All SDDOT-managed structures are inspected by SDDOT bridge inspectors, with most structures in the state inspected every two years. South Dakota received approval from the FHWA to inspect some low-risk, low traffic structures every four years. These structures include box culverts, continuous concrete, prestressed concrete girder, and concrete frame bridges that have gone through multiple inspection cycles prior to putting them on an extended cycle. As of 2018, 342 structures are eligible for four-year inspections. Seven structures require a 12-month inspection frequency, including some of the major structures over the Missouri River and any NBI structure with a condition rating of three or less.

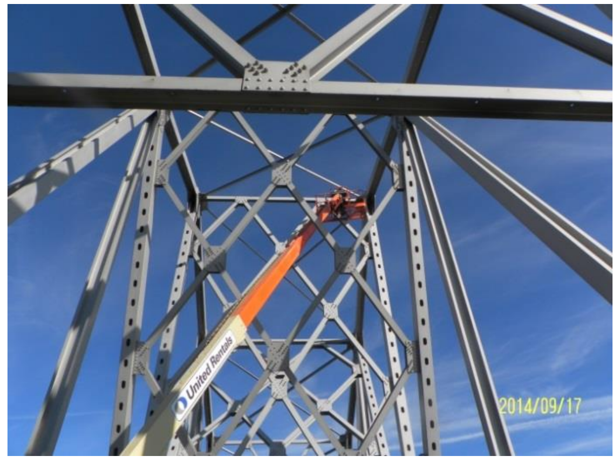


Figure 3.20: Structure Inspections

Details of the structure inventory are shown in Table 3.7 and Table 3.8.

Table 3.7: SDDOT-Managed Structures

Structure	Bridges	Bridge Deck Area (sq. ft.)	Culverts	Culvert Deck Area (sq. ft.)	Total NBI Structures
State-Owned NHS	707	6,319,344	251	408,732	958
State-Owned Non-NHS	542	4,362,363	295	303,514	837
Total State-Owned	**1249**	**10,681,707**	**546**	**712,246**	**1795**

Table 3.8: NHS Structures

Structure	Bridges	Bridge Deck Area (sq. ft.)	Culverts	Culvert Deck Area (sq. ft.)	Total NBI Structures
State-Owned NHS	707	6,319,344	251	408,732	958
Non-State-Owned NHS	10	262,181	1	1804	11
Total NHS	**717**	**6,581,525**	**252**	**410,536**	**969**

Historically, a 50-year service life was anticipated for structures, but new structures are anticipated to have a 75-year service life. Figure 3.21 and Figure 3.22 show the age distribution for state-owned and NHS structures.

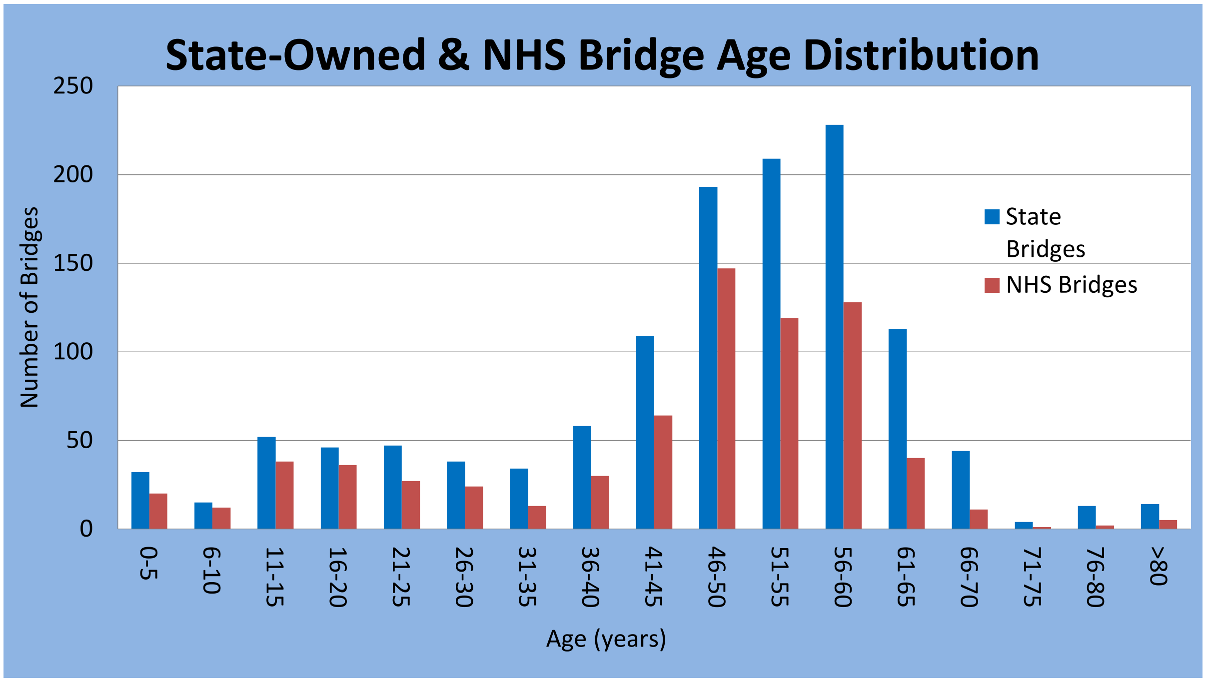


Figure 3.21: Structure Age Distribution

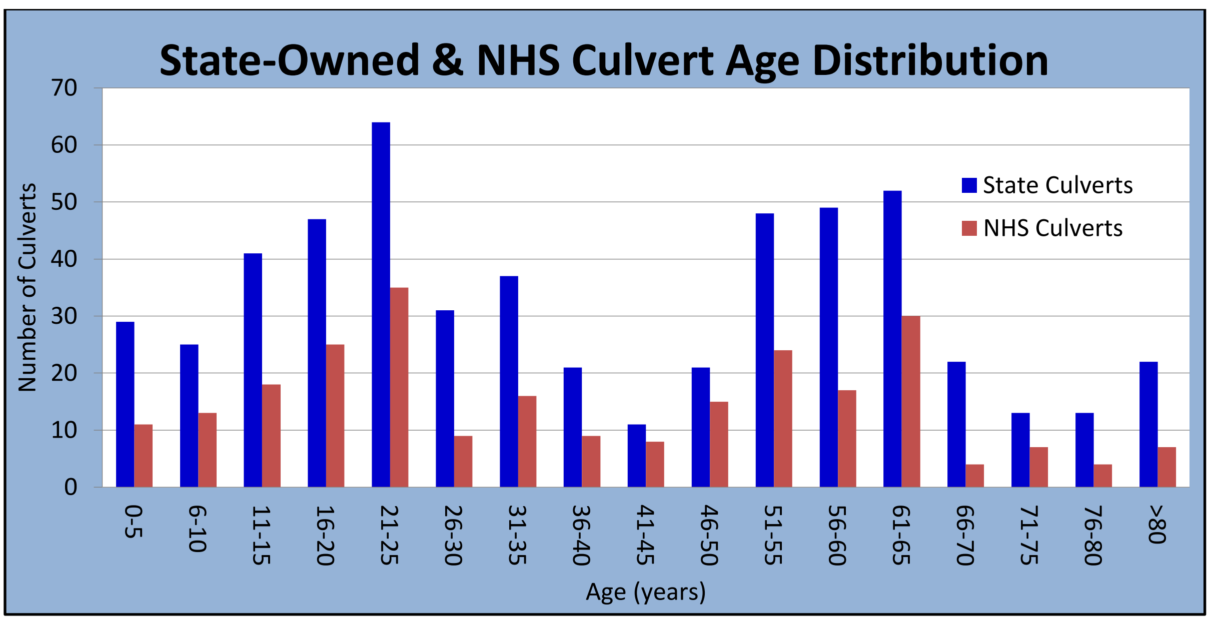


Figure 3.22: Culvert Age Distribution

Structure Condition

The inspection process produces up to 116 points of data per structure. This information is used to calculate two condition-related indexes. Structural deficiency and an overall condition are used in SDDOT's structure management process.

Sufficiency Rating

Federal sufficiency rating, as defined by the FHWA, is a historic index that ranges from zero (worst) to one hundred (best) that is based on: structural adequacy and safety (55%), essentiality to public use (15%), and serviceability and functional obsolescence (30%). The rating is an overall reflection of structure's sufficiency based on the weighted parameters. In the past, federal sufficiency rating was used for structure management and is shown in Figure 3.23 to provide historical perspective.

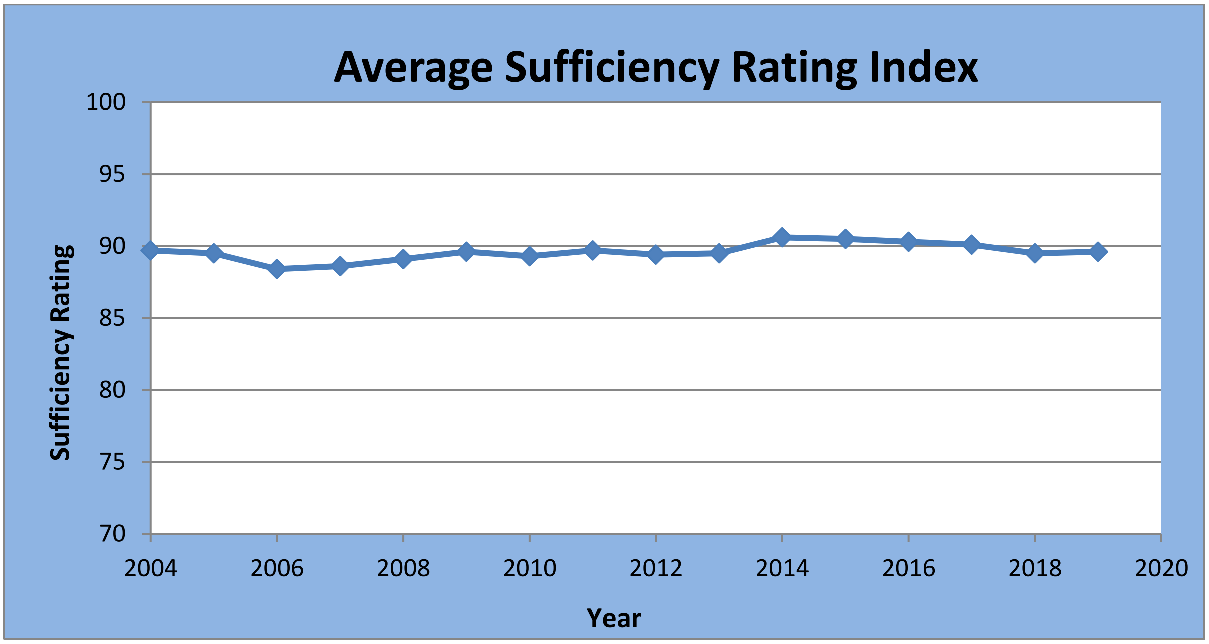


Figure 3.23: State Structure Historical Sufficiency Rating – All State Structures

Structural Deficiency

From 23 CFR Part 490.411 National Performance Management Measures, "Beginning with calendar year 2018 and thereafter, a structure will be classified as structurally deficient when one of NBI Items 58-Deck, 59-Superstructure, 60-Substructure, or 62-Culverts, is rated 4 or less on a scale of zero to nine." Prior to 2018, structurally deficiency was also identified when NBI Items, 67-Structural Evaluation or 71-Waterway Adequacy, were two or less. Historical data prior to 2018 referenced in this document uses the pre-2018 method of calculating structural deficiency. The new definition applies to all data from 2018 to the present.

Table 3.9 lists the numbers of structurally deficient state-owned structures.

Table 3.9: Structurally Deficient Structures – State-Owned

Structure	Bridges	NBI Culverts	Total NBI Structures	Deck Area (sq. ft.)	% of State-Owned Deck Area
State-Owned NHS	12	5	17	198,544	1.7%
State-Owned Non-NHS	24	6	30	145,885	1.3%
Total State-Owned	**36**	**11**	**47**	**344,429**	**3.0%**

Table 3.10 lists the numbers of structurally deficient structures on the NHS.

Table 3.10: Structurally Deficient Structures – NHS

Structure	Bridges	NBI Culverts	Total NBI Structures	Deck Area (sq. ft.)	% of NHS Deck Area
State-Owned NHS	12	5	17	198,544	2.8%
Non-State-Owned NHS	0	0	0	0	0.0%
Total NHS	12	5	17	198,544	2.8%

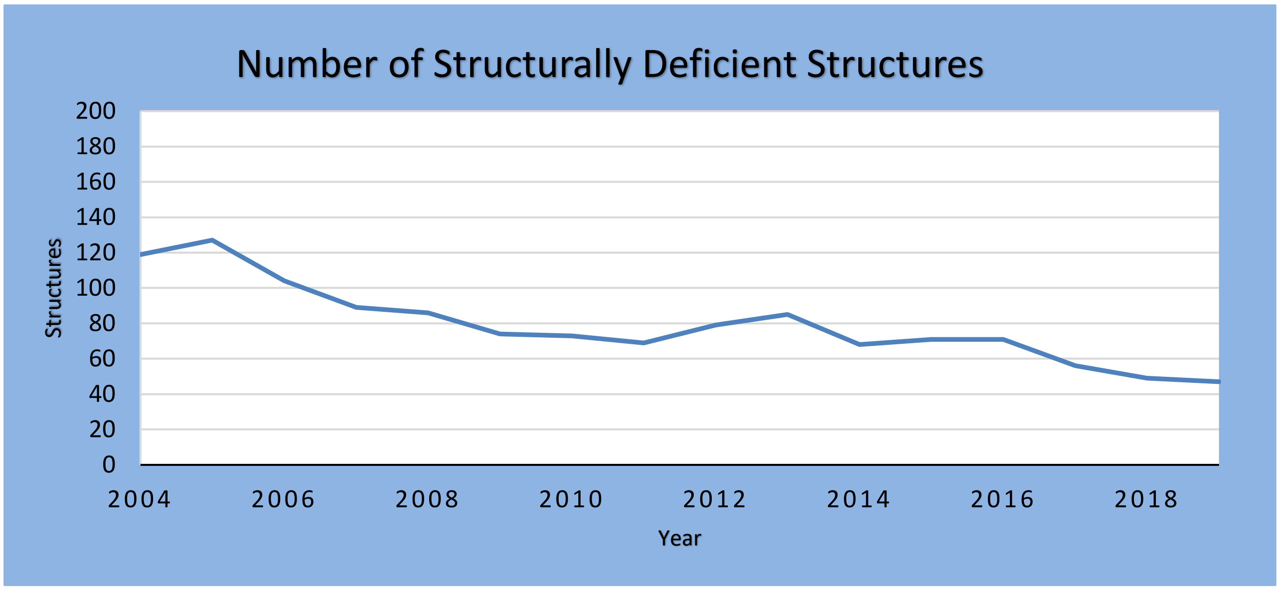


Figure 3.24: Historical Structurally Deficient NBI Structures – All State-Owned Structures

Bridge Condition

Bridge Condition is a measure of the overall condition of the structure. It is based on NBI items 58-Deck, 59-Superstructure, 60-Substructure, or in the case of a culvert structure, 62-Culverts. During the inspections, each item is rated on a scale of zero to nine. The lowest of the inspection ratings is used to categorize the structure as good, fair, or poor condition.

The department uses the percentage of structures in the good and fair categories to gauge the overall condition of the structure inventory. The available historical data for this measure is shown in Table 3.12. This is a new measure so little historical data is currently available.

Table 3.11: Bridge Condition

Lowest Item Rating	Bridge Condition
7, 8, 9	Good
5, 6	Fair
0, 1, 2, 3, 4	Poor

Table 3.12: Percentage of State-Owned Bridges in Good or Fair Condition

Year	Good or Fair
2015	96.1%
2016	96.3%
2017	96.9%
2018	97.3%
2019	97.4%

Federal Structure Performance Measures

Federal rules require states to report structure condition with prescribed measures. These measures are similar to the established procedures the department has recently adopted, except they pertain only to structures on the NHS and are calculated by percentage of bridge deck area rather than the number or percentage of structures. Due to the potential impacts these three measures—percent good, percent poor, and percent structurally deficient—have on federal funding and the use of that funding, they are considered in structure management decisions.

Table 3.13: Overall Condition of NHS Structures by Percentage of Deck Area

Year	Good	Poor		Structurally Deficient
2015	28.0%	3.3%		3.3%
2016	25.8%	3.3%		3.5%
2017	25.8%	1.5%		1.5%
2018	27.2%	1.3%		1.3%
2019	27.6%	2.8%		2.8%

Includes non-state-owned NHS

In accordance with 23 CFR Part 490.411 National Performance Management Measures, NBI culverts are included in the deck areas shown.

Chapter 4 Asset Management Practices

Asset management plays a significant role in achieving the department's mission "to efficiently provide a safe and effective public transportation system". Over the years, the department has implemented many methods and strategies to improve how assets are managed. The use of benefit-cost ratios, life cycle planning, life cycle cost analysis, and tradeoff analysis, continue to guide the department's decision-making processes.

The Life Cycle of an Asset

Transportation infrastructure deteriorates due to use, environment, and in some cases chemical processes. As assets deteriorate, the department plans and executes maintenance, repair, and rehabilitation activities (Figure 4.1) to maintain a condition suitable for the traveling public. At the end of the life cycle, the asset is removed or replaced, and the process repeats.

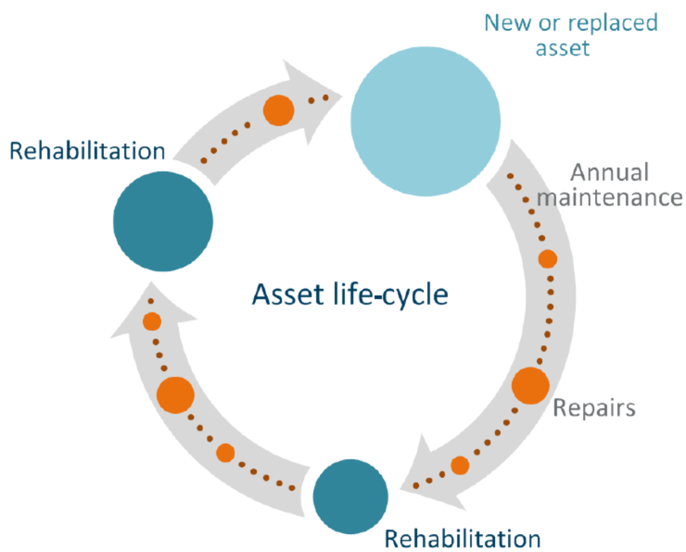


Figure 4.1: Typical Life Cycle of Physical Assets

Life Cycle Planning and Life Cycle Cost Analysis

The timing and order of maintenance, repair, and rehabilitation activities are critical to economically managing an asset throughout its life cycle. Each activity has a different cost and impact on prolonging the life of the asset. Over the years the department has developed methods to assess different combinations and the timing of activities to minimize the cost and maximize the benefits of prolonged service life, increased safety, or reduced congestion. This process is defined in federal legislation as life cycle planning (LCP).

The department uses life cycle cost analysis (LCCA) to assess different construction and rehabilitation alternatives by considering all significant costs, in today's dollars, expected over the life of each alternative. This analysis allows the department to evaluate each feasible alternative over a specified analysis period and determine which alternative provides the best economic value.

LCCA also helps an agency determine whether it can afford the total costs associated with a project, including initial construction and future maintenance and rehabilitation. Operating costs, such as snow removal and deicing, are not considered as they are assumed to be equal in each alternative. However, when the department constructs a new facility, the state commits to the initial construction costs and all future expense of maintaining and operating it. Over the life of an asset, future expenses can be much greater than the initial cost and must be considered when making these decisions.

The use of equivalent dollars enables the department to compare funding requirements spread across different time periods. In LCCA, all costs are brought to a baseline year when the project will be constructed. The example shown in Figure 4.2 compares one project option with a high initial cost and low maintenance and rehabilitation costs to another with lower initial cost but higher maintenance and rehabilitation costs. In this comparison, the project option with the higher initial cost has a lower life-cycle cost in today's dollars.

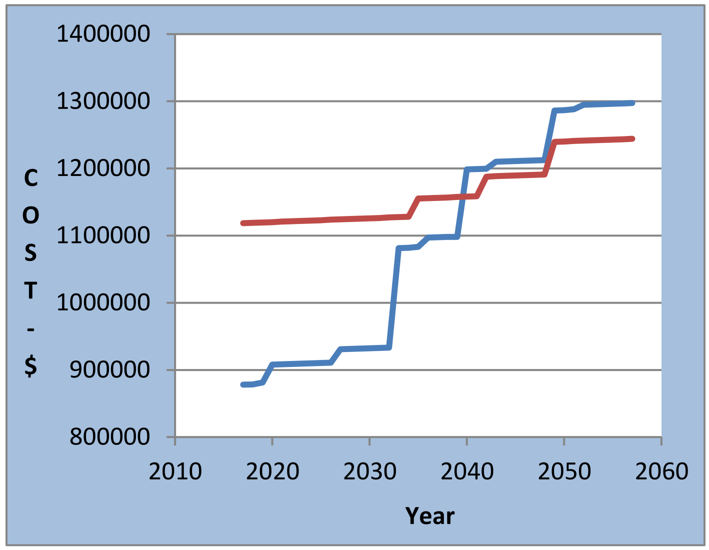


Figure 4.2: Example of Costs Over the Life of Two Different Pavement Options

Benefit-Cost Analysis

Benefit-cost (B/C) analysis compares the benefit of a completed project to the costs associated with constructing it. Benefits can be condition improvements, safety improvements, reduced travel time, effect on life cycle cost, economic impact, or other considerations. Benefits are often converted to a monetary value so a ratio of the benefit to cost can be calculated. This ratio then becomes a measure to compare projects and project options.

SDDOT uses LCCA and B/C to support informed and realistic investment decisions at both the network and project levels.

Pavement Management

The SDDOT manages a vast network of highway pavements spanning a wide range of age, condition, traffic level, material, and surface type. To provide the best roads possible with available funding, the department must schedule the right treatments at the right time on each of the thousands of pavement segments throughout the 8,847 roadway miles of the state highway system.

SDDOT uses Deighton Total Infrastructure Management System (dTIMS) software for a pavement management system. dTIMS is a product of Deighton Associates Limited. The pavement management system uses the current condition information collected as described in Chapter 3, performance prediction curves, triggers, resets, and treatment unit cost information to predict future conditions of each segment of highway and identify the type and timing of treatments that will most economically sustain their condition. Treatment unit cost information is evaluated annually and is shown in Appendix C. The system analyzes millions of possible combinations of feasible treatments to find the sequence of treatments throughout the life cycle that most economically provide the best overall pavement condition with available funding.

The best combination of treatments does not fix all the worst pavements first. For the best long-term benefit, preservation treatments such as chip seals and overlays need to be applied to roads still in good condition, as illustrated in Figure 4.3. The pavement management system recommends a mix of preservation, rehabilitation, and reconstruction projects.

The mix of treatments is predicated on:

- identifying and perpetuating good pavement through preservation and rehabilitation
- identifying and replacing poor pavement when preserving or rehabilitating is no longer economically or operationally feasible

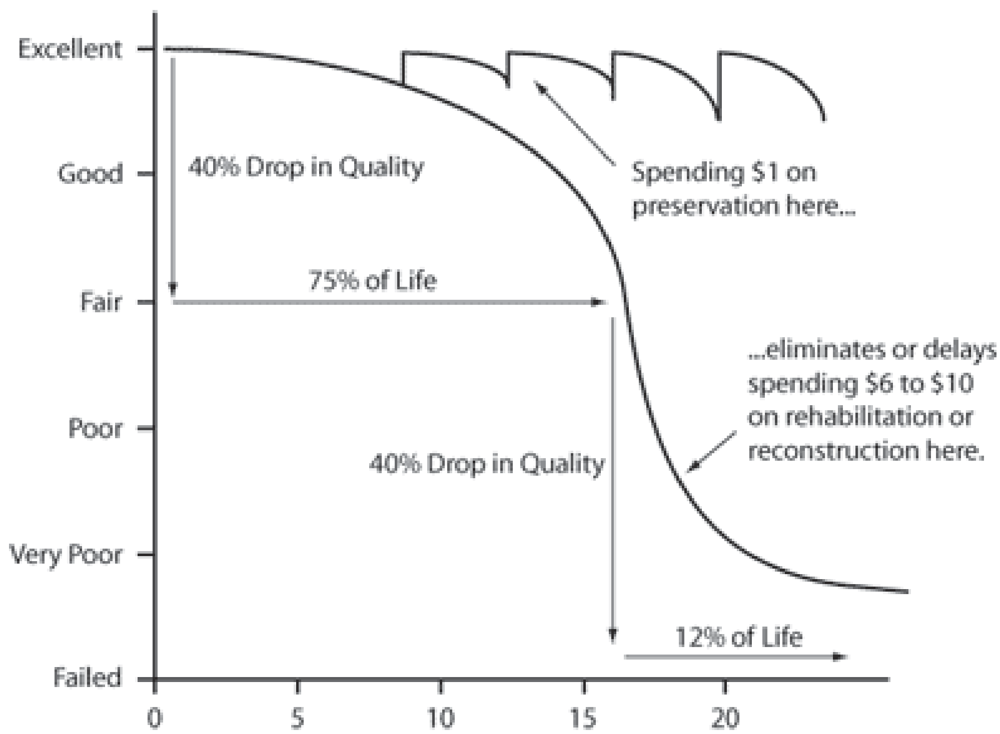


Figure 4.3: Generalized Benefit of Maintaining Assets in Good Condition

Network-Level Analysis: Pavements

The pavement management system uses LCP to perform a network-level Incremental Benefit-Cost (IBC) analysis on all pavements on the state highway system. This method compares treatment strategies and prioritizes pavement maintenance, preservation, rehabilitation, and reconstruction treatments on the same terms.

The pavement management system uses a set of performance prediction curves and triggers to identify viable treatments and timing for consideration in the LCP and IBC analyses. Triggers are logical criteria that enable a treatment option to be selected for analysis. Trigger criteria may include pavement type, values of condition indices, age of grade, age of pavement, geographic location, roadway width, NHS designation, and traffic. A complete listing of the triggers is available in the SDDOT's Enhanced Pavement Management System Synopsis linked in Appendix B.

Performance curves predict the future condition of a segment. Because each pavement type deteriorates in a unique manner and rate, performance curves have been developed for each condition index and pavement type. Additional curves have also been developed to predict future condition indices after the application of certain maintenance treatments.

In 2018, the SDDOT used 158 different performance curves, one for each type of pavement or combination of pavements in service throughout the state. Figure 4.4 shows a sample performance curve.

A treatment strategy is generated for a specific pavement management system segment. Treatment strategies may include one or more treatments over the analysis period and are determined using present and forecasted condition, age, and geometric data. A 50-year analysis captures the full pavement life cycle regardless of pavement type. After this analysis, several economic strategies over a 20-year period are generated. Hundreds of economic alternatives are possible for each of more than 3,800 pavement management system segments on the state highway system. (See Figure 4.5 for the process flow chart). Strategies may range from "do nothing" to full reconstruction.

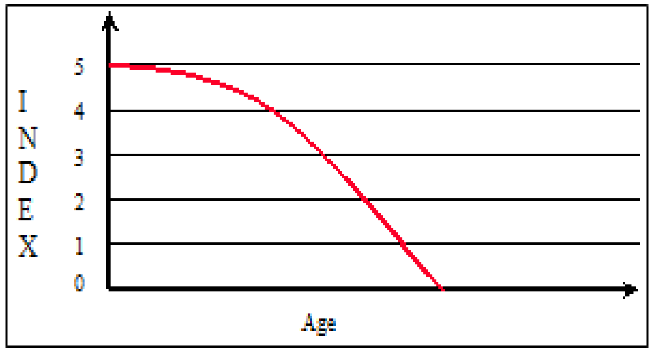


Figure 4.4: Sample Performance Curve

After the pavement management system determines all the possible strategies for each segment of road on the South Dakota state highway system, the benefits and costs associated with all feasible strategies are compared to determine the most cost-effective solutions for the preservation of the system. Benefits and costs of each strategy are calculated as a B/C ratio, where the benefit is a combination of the additional life and increase in pavement condition associated with the application of the treatment strategy. The B/C ratio becomes the basis for the comparison between treatment strategies.

A budget is introduced to constrain the analysis. The pavement management system then compares the B/C ratios of all treatment strategies across all segments within the limits of the budget. This process continues until all strategies have been evaluated or the budget limit is met. The pavement management system maximizes the benefits to the entire state system using available funding. This is known as optimization. The strategies selected at the end of the optimization process become the recommended treatments from the pavement management system and then proceed through the STIP development process explained later in this chapter.

Other Sources of Paving Projects

Every year, the SDDOT spends a portion of its highway funding on safety improvement projects aimed at reducing the number and severity of crashes. These projects can include low cost improvements such as improved signing and pavement markings or more costly improvements such as shoulder widening or full grading.

In the past, locations for safety improvements were selected by identifying "black spots" where multiple crashes had occurred. The SDDOT now combines this analysis with a process that identifies roadway features statistically correlated with crashes. The process uses crash modification factors from the Highway Safety Manual to estimate a reduction in crashes based on the possible improvements. A benefit-cost ratio based on the anticipated reduction in crashes and the estimated cost of improvements at each potential improvement location is used to prioritize safety improvement projects. Other sources of projects such as corridor studies and capacity improvements are described in Chapter 7.

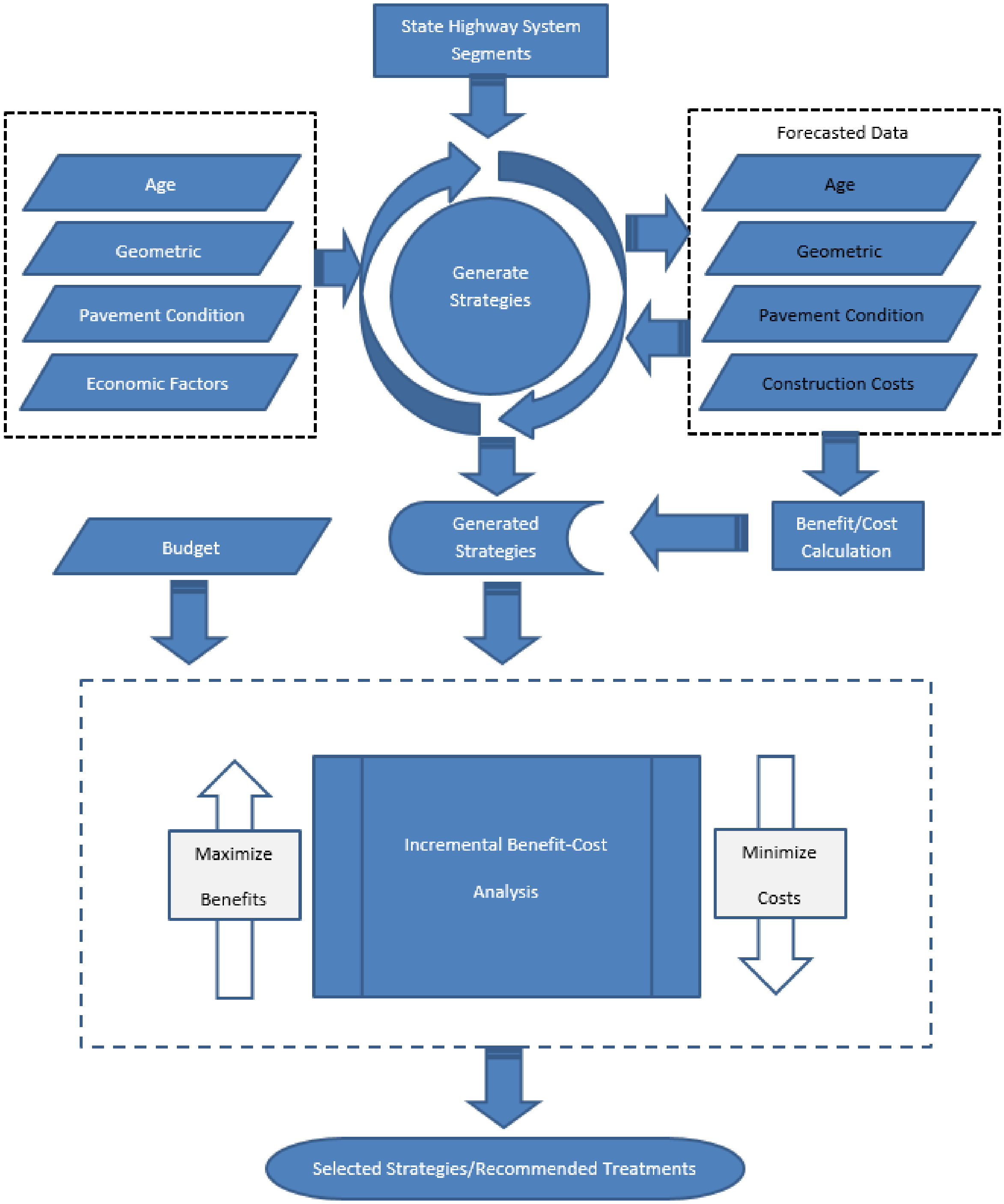


Figure 4.5: Process for Pavement Treatment Optimization

Project-Level Pavement Selection

At the project level, SDDOT uses LCCA to select the most cost-effective pavement type. The project-level LCCA considers all significant costs over a 40-year analysis period, as depicted in Figure 4.6.

The project-level LCCA compares the present and future costs of each alternative in terms of net present worth, as illustrated in Figure 4.7. In this example, Alternative 1 (Pavement A) is the most economical, at approximately $53,700 per mile less, in present dollars, than Alternative B over the 40-year analysis period.

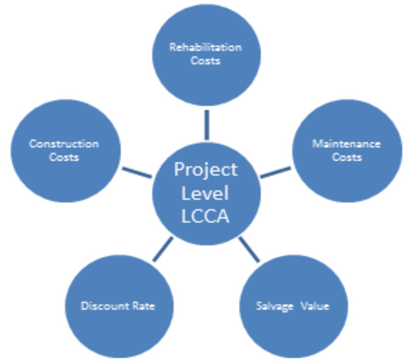


Figure 4.6: Costs and Economic Factors Considered in Project-Level LCCA

LIFE-CYCLE COST ESTIMATING WORKSHEET

Initial Analysis Year	2017	Project Id:	
Analysis Period	40	County:	
Annual Discount Rate, %		PCEMS	

				Alternative 1		Alternative 2	
				Project Description: Pavement A		Project Description: Pavement B	
Initial Costs							
Item	*Item Description*	*Analysis Year*	*Calendar Year*	*Estimated Cost*	*Present Worth*	*Estimated Cost*	*Present Worth*
1	Pavement A	0	2017	$877,568	$877,568		
2	Pavement B	0	2017			$1,117,923	$1,117,923
3							
	Total Present Worth of Initial Costs			$877,568	$877,568	$1,117,923	$1,117,923
Perodic Costs							
Item	*Item Description*	*Analysis Year*	*Calendar Year*	*Estimated Cost*	*Present Worth*	*Estimated Cost*	*Present Worth*
1	Crack Seal	2	2019	$2,500	$2,292		
2	Chip Seal	3	2020	$30,000	$26,342		
3	Chip Seal	10	2027	$30,000	$19,448		
4	Mill & Overlay	16	2033	$295,000	$147,441		
5	Crack Seal	18	2035	$2,500	$1,146		
6	Chip Seal	19	2036	$30,000	$13,166		
7	Chip Seal	26	2043	$30,000	$9,720		
8	Mill & Overlay	32	2049	$295,000	$73,691		
9	Crack Seal	34	2051	$2,500	$573		
10	Chip Seal	35	2052	$30,000	$6,580		
11							
12	Minor Joint & Spall Repair	18	2035			$58,000	$26,581
13	Shoulder Mill & Overlay	25	2042			$85,000	$28,760
14	Major Joint & Spall Repair	32	2049			$192,000	$47,961
15							
	Total Present Worth of Periodic Costs				$300,398		$103,302

Annual Costs		*First Yr. of Ann.*		*Last Yr. of Ann. Costs*		Alternative 1		Alternative 2	
Item	*Item Description*	*Analysis Yr.*	*Cal Yr*	*Analysis Yr*	*Cal Yr*	*Estimated Annual Cost*	*Present Worth*	*Estimated Annual Cost*	*Present Worth*
1	Maint Activity for Pavement A	1	2018	40	2057	$1,020	$18,959		
2	Maint Activity for Pavement B	1	2018	40	2057			$1,203	$22,360
	Total Present Worth of Annual Costs						$18,959		$22,360

Replacement/Salvage Value				Alternative 1		Alternative 2	
Item	*Item Description*	*Analysis Year*	*Calendar Year*	*Estimated Value*	*Present Worth*	*Estimated Value*	*Present Worth*
1	Pavement A	40	2057	$156,071	$27,562		
2	Pavement B	40	2057			$116,286	$20,536
	Total Present Worth of Replacement/Salvage Value				$27,562		$20,536

TOTAL LCC	Alternative 1	Alternative 2
Present Worth LCC	$1,169,362	$1,223,050
Equivalent Uniform Annual LCC	$62,913	$65,802
Lowest LCC Alternative	**Alternative 1**	
PW Cost Difference From Lowest LCC Alternative	***$0***	***$53,687***
% Difference From Lowest LCC Alternative	***0***	***5***

Figure 4.7: Life-Cycle Cost Estimation Worksheet

Quality Management of Pavement Management Practices

Quality management is essential to the success of the pavement management practices. Starting with the inspection processes and equipment, the SDDOT takes extra steps to ensure the data is as accurate as possible. In addition to routine calibration and certification of equipment, data from both the manual and automated collection processes is reviewed by multiple personnel to ensure accuracy and consistency. The SDDOT Quality Management Plan for Network Level Pavement Condition Data Collection details the processes and is linked in Appendix B. On-site inspections to review the proposed project list also ensure that pavement condition indexes are accurate.

All factors used in the mathematical formulas of the pavement management system software and LCCA analysis are reviewed and adjusted on a regular basis. The pavement performance curves were initially developed in the mid-1990s on data from an expert panel. Since then, performance curves have been recalculated from historical data to ensure their accuracy. The SDDOT recently completed research to verify the accuracy of the existing curves and develop tools used to update them regularly. The costs of improvements are reviewed and adjusted annually based on current trends in bid prices. In addition, discount rates are reviewed and adjusted annually to represent current economic conditions.

As described later in this chapter, the many steps of review and adjustment to the projects in the STIP serve as checks and balances for the entire process. Differences between the project list proposed from the pavement management system and the final STIP help identify potential adjustments in trigger logic and other factors in the pavement management process.

Significant projects in the STIP are subjected to an initial scope analysis soon after they are added to the developmental STIP (years 5-8). This serves as another check of the recommendations from the pavement management system. The scope is refined later in the process as the project enters the construction STIP (years 1-4) and serves as the final check prior to design.

Structure Management

The SDDOT manages a relatively large network of structures that span a wide range of age, condition, traffic level, and construction type. To provide the best structures possible within the available funding, the department must schedule the right treatments at the right time on each structure.

Structure management in South Dakota has traditionally focused on keeping structures in good condition by performing timely preservation activities. Since the mid-1970s, significant efforts have been made to protect concrete bridge decks from chlorides and deck joints have been sealed or eliminated to prevent water and chloride damage to substructure units. B/C ratios are used to determine when rehabilitation or replacement of a structure is most feasible. Network-wide treatments may include deck sealing, ride improvements, and replacement based on budget constraints.

Network-Level Analysis: Structures

Prior to MAP-21, SDDOT used AASHTOWare™ Pontis for bridge management activities. All NBI bridge inventory and inspection data was used and stored in Pontis. SDDOT had approximately twenty years of CORE Element data collected that was used with expert elicitation to develop deterioration models for the element data. Pontis was used to create potential candidates for projects using the deterioration models to develop a long-term least cost solution. Other sources of project candidates included inspector work recommendations, manual analysis of the data, and best practices as established by the Office of Bridge Design. Analysis of data would include, for example, looking at all the structurally deficient structures and structures that were close to becoming structurally deficient to identify candidate projects. All projects submitted to the STIP development process were created from these sources.

When MAP-21 was passed, CORE element inspection data was replaced with AASHTO Elements. There was no direct mapping of the historic data of CORE elements to AASHTO elements. SDDOT started collecting this new element data in May of 2015. About the same time work began on transitioning from Pontis to AASHTOWare™ Bridge Management (BrM) software. Implementation of the new software requires collecting the inspection data under the new criteria as well as development of new deterioration models. With the 48-month inspection frequency on a sizeable portion of the SDDOT inventory, most structures have now completed one cycle of element-based inspection. To create new element deterioration models, at least two inspection data points are needed. The structures on 24-month inspection frequency will now have at least two inspection data points which will allow development of reasonable deterioration models for the new AASHTO elements. Further implementation of BrM features is planned as follows:

- Forecasting deterioration – SDDOT is participating in a pooled fund study with other states in the region. This study is anticipated to be completed in 2022.
- Determining B/C – Current practices will be supplemented with BrM analysis by 2021.
- Identifying budget needs and determining investment strategies – Current practices will be enhanced with BrM functionality by 2024.

During the transition to BrM, previous runs from Pontis are used to develop network level projections. Individual needs are identified by inspector work recommendations, manual analysis of the current data, and best practices as established by the Office of Bridge Design. Bridge Office staff review these needs and group them into logical project alternatives by similar types of work, geographic location, and other projects in the vicinity. The refined list of projects is then submitted to participate in the STIP development process.

BrM incorporates MAP-21 inspection and management requirements, incorporates structure inventory and inspection data collected in accordance with NBI standards, and provides powerful tools for analyzing structure preservation (also referred to as maintenance, repair and rehabilitation) and improvement needs, and for planning the sequence of work. BrM models predict needs and analyze work both at the network level, in which needs and work are summarized across sets of structures, and at the structure level, where needs are analyzed structure by structure. Structure improvement options are shown in Figure 4.8.

Figure 4.8: Structure Improvements

Preservation is the most economical way to keep existing structures in operation at their current level of service, except when the structure is posted for a reduced load capacity due to deterioration of structure components. Preservation modeling avoids the question of what the required level of service should be or even whether the structure should remain open. Instead, it assumes that deterioration must be detected and remedied at minimal long-term cost before operations are affected.

Functional improvement modeling addresses functional shortcomings, identifies instances where adequate standards are not met, develops strategies to meet them, and prioritizes and sequences such improvements. The modeling approach addresses these functions separately then combines and coordinates recommendations for each structure in the context of the overall network.

When considering replacement versus preservation, the condition, age, structure type, feasibility of potential preservation alternatives, and economics are considered. Potential work type unit cost information is evaluated annually and is shown in Appendix D. As the life-cycle preservation cost increases, the replacement option becomes a more viable option.

An important feature of BrM is the capability to develop a network-wide least-cost investment strategy to maintain structures in a serviceable condition. This strategy considers how quickly different elements of structures will deteriorate given the application of different maintenance and repair actions. BrM contains an optimization model that considers both preservation and functional needs. The preservation needs portion considers the costs of performing different types of repairs on elements in different conditions and determines whether it is more cost-effective to conduct a particular type of maintenance, repair, or rehabilitation action or wait and "do nothing". It also compares existing functionality to the minimum necessary for vertical and horizontal clearance, width, load capacity, and waterway adequacy.

The result of the model is a set of optimal actions to be taken on each type of structure element in every environment and in all possible conditions. A myriad of action sequences may include a variety of steps from "do nothing" to full reconstruction. Model results are then applied to the structures in the inventory to determine what actions should be taken now and in each year of the 10 to 20-year planning period. The model also considers estimated cost and calculates the benefit-cost ratio of each action. The benefit of each action depends on the type of action, including improved safety, reduced travel time, and the effect on life-cycle cost of performing an action now versus a future year. The benefit-cost ratio of each action is used to determine the most economical actions. The available budget is applied to the model and a list of needs prioritized by benefit-cost is developed.

Project-Level Structure Improvement Selection

When a structure has been identified for replacement, rehabilitation, or preservation, and alternatives for that improvement are available, LCCA and other factors are used to determine the most cost-effective alternative. The project-level LCCA for a structure considers all significant costs over a 75-year analysis period. When replacement is the most economical improvement, LCCA is also used to determine the type of the new structure.

Other Sources of Structure Projects

In addition to the sources of structure projects previously described, situations arise where a grading project changes the horizontal or vertical alignment requiring replacement of a structure that otherwise would not need work. Other situations where traffic exceeds capacity may cause a structure in otherwise good or fair condition to be replaced or widened. Safety needs may compel a structure to be replaced or widened. Extreme events, such as a vehicle impact or flood damage, can create a need that otherwise would not be identified in BrM.

Quality Management of Structure Management Practices

Quality management is a significant part of the structure management process. Starting with the inspection process, the SDDOT takes several precautions to ensure that data is as accurate and consistent across the state as possible. To ensure inspectors are knowledgeable and receive sufficient training, SDDOT bridge inspectors must complete the qualification requirements described in NBIS (23 CFR Part 650.309 Bridges, Structures, and Hydraulics). To ensure accuracy and completeness, inspection information is reviewed by two individuals prior to entry into the BrM system. Quality assurance inspections are also performed annually to ensure accuracy, consistency across the state, and conformance with federal and state regulations.

As described later in this chapter, the many steps of review and adjustment to the projects in the STIP serve as checks and balances for the entire process. Differences between the project developed by the current processes and the final STIP help identify potential adjustments needed in current practices and will assist in implementation of the BrM software.

Pavement and Structure Tradeoff Analysis

Like all other state agencies, the SDDOT has a limited budget that is insufficient to maintain every asset in excellent condition. One of the difficult questions the department must answer is: what is an acceptable condition level for each asset category and is it achievable within the existing budget? Tradeoffs between assets must be considered because shifting funding to improve the condition or performance of one asset removes funding from another. The SDDOT uses an internally developed software called the Trade-Off Tool to help make these funding decisions.

The Trade-Off Tool collects information from multiple asset management systems like the pavement management system and BrM/Pontis. The information collected from these systems is used to generate graphs like Figure 4.9, which show predicted condition levels at various potential funding levels for pavements, structures, culverts, buildings, and equipment. Projections are also calculated for crash rate, crash costs, equipment repair costs, level of service, and pavement maintenance costs. Within the tool, funding may be moved from asset to asset, demonstrating the effect of funding changes on conditions and achievement of performance targets. The tool also estimates the impact on other future costs like maintenance. This information is the basis for determining the most appropriate funding levels for each asset type.

The determined funding levels are used in the final analysis of the pavement management system and BrM/Pontis processes described earlier in this chapter. However, these funding levels are considered starting points, as many other factors are considered during the STIP development process. How the tradeoff analysis influences STIP development is described in more detail in Chapter 10.

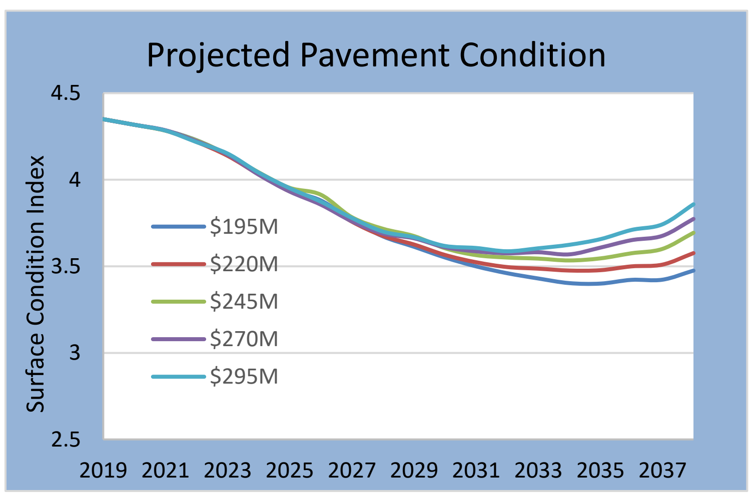


Figure 4.9: Example Projected Pavement Condition and Proposed Funding Levels

Development of the STIP

The four-year construction STIP is updated annually through the year-long process shown in Figure 4.10. The department also creates a developmental STIP that covers projects in years five through eight. Each year, both the construction and developmental STIP are subject to review and public involvement starting with the lists of proposed projects from the pavement and bridge management systems.

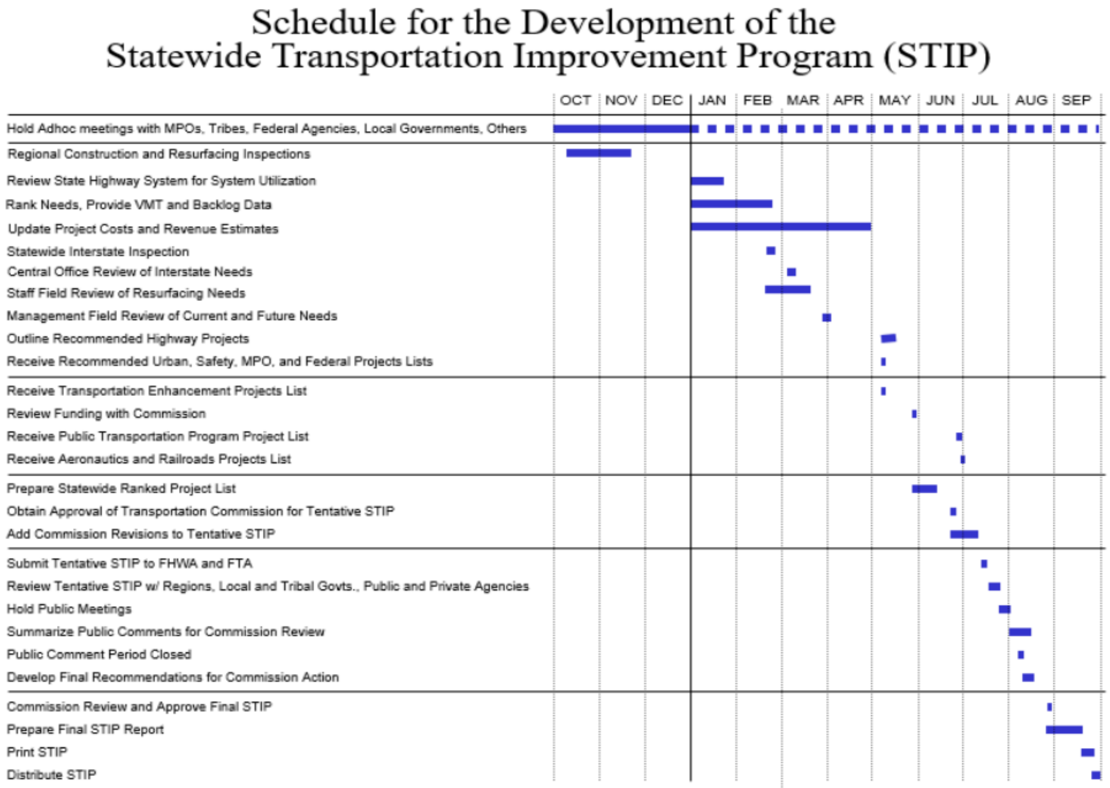


Figure 4.10: STIP Development Timeline

At the same time the pavement management system and BrM/Pontis processes are developing a list of proposed projects, each Region and Area Office of the SDDOT is developing its own prioritized list of projects. A comparison is made between the lists and differences are discussed during on-site inspections at proposed project locations. The on-site inspection and discussion also serve as quality control measures for the process. Following the onsite inspections, the pavement management system is updated with the most current distress data, traffic counts, pavement information, and cost estimates for all existing and new potential projects. Basic scopes of the proposed projects are also developed to ensure that culvert, lighting, sidewalk, or other asset needs are included in the project's cost estimate.

Following the update to all the background information, the pavement management system and BrM/Pontis routines are run again. The new prioritized project list is then reviewed by SDDOT Central Office staff and necessary revisions are made. Proposed projects are prioritized based on potential reductions in congestion, safety improvements, and economic benefit to the community. At this time, the Region, Area, and Central Office managers meet and review the proposed STIP project by project. When all the recommendations from this meeting are incorporated, the proposed STIP is formally called the tentative STIP. The tentative STIP is submitted to the Transportation Commission to be sanctioned for public review and comment. The Transportation Commission can also make recommendations that are incorporated into the tentative STIP.

The tentative STIP is presented to the MPOs and tribal governments for their input. This is accomplished through project coordination meetings held in several locations throughout the state. The STIP is revised again based on the outcome of these meetings.

The tentative STIP is then disseminated for public comment. Four public meetings are held throughout the state and the information is also posted online. Advertising for these public meetings is extensive in daily and regional newspapers. Notices are also sent to special organizations and people that have expressed interest. At the public meetings, the tentative STIP is presented and questions and comments are accepted.

Input is compiled and presented to the Transportation Commission for review. The STIP is then modified based on the public feedback and resubmitted to the Transportation Commission for consideration and approval. Recommendations from the Transportation Commission are incorporated and the STIP is then presented to the FHWA and Federal Transit Administration (FTA) for final approval. Once approved by both the FHWA and FTA, this STIP then becomes the official working document at the beginning of the federal fiscal year. Figure 4.11 shows additional detail of the STIP development process.

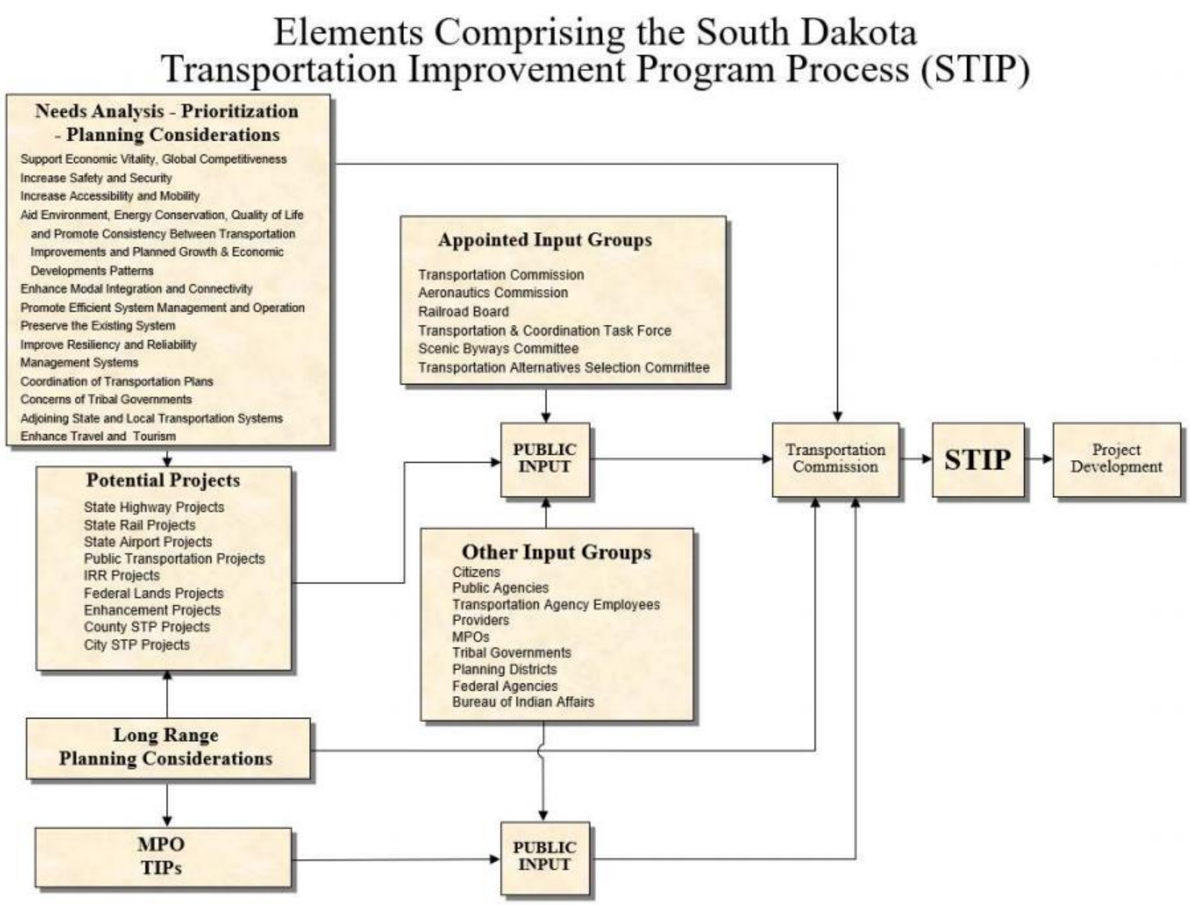


Figure 4.11: STIP Process Flow Chart

Chapter 5 Objectives and Targets

State-owned pavements and structures in South Dakota have been formally managed by performance-based data for decades. Through strong management systems for pavements and structures, SDDOT has been able to set targets and invest properly in both asset categories.

Objectives

The mission of the SDDOT is "to efficiently provide a safe and effective public transportation system". With that mission in mind the SDDOT identified the performance measures described in Chapter 3. Condition targets are set for pavements and structures to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practical cost. Clearly defined targets provide the basis for effective asset management. Condition targets are established primarily through customer satisfaction surveys, analysis of condition projections at anticipated funding levels, and the public input from STIP feedback.

Because pavements and structures consume the largest portion of the annual investment on the state transportation system, defining measures and targets that can be accurately determined, provide clear understanding of the overall asset condition, and relate to customer satisfaction surveys is critical.

Pavements

In South Dakota, pavement condition is summarized by the Surface Condition Index (SCI). The index is not comparable nationally since many states measure and report condition and pavement distresses differently. Due to the variability in data collection and analysis, providing comparable data among the states is challenging.

The FHWA requires states to report the IRI, rutting, faulting, and cracking percentage on pavements. Although these measurements are useful in reporting individual pavement distresses, SDDOT recognizes limitations in fully determining the existing and future condition of a pavement based on federal measures alone and instead focuses pavement investment based on state measures and targets.

State Pavement Performance Measures

Through use of the pavement management system, future pavement conditions are evaluated based on multiple investment levels. Through review of the annual maintenance costs, life cycle cost, and customer satisfaction surveys, a minimum threshold and a goal SCI are set. The analysis includes the entire state highway system and each funding category at current condition, 10-year, and 20-year projections. SDDOT chooses to use the 10-year projections of SCI as the target timeframe due to unknown future funding, environmental impacts, new treatment alternatives, and traffic changes. The goal and minimum target value used for the state network were set at 3.90 and 3.55 SCI respectively.

Considering anticipated budgets and future pavement condition, SDDOT predicts that the state network goal will not be met but the minimum pavement condition levels can be maintained through the 10-year target timeframe. Figure 5.1 details the historic and projected pavement condition at the current funding level through 2028.

Pavement analysis is completed on a funding category basis with each funding category having a minimum and goal condition target. The historical and projected pavement condition trends along with the minimum and goal targets for all funding categories can be found in Figures 5.2 through 5.7.

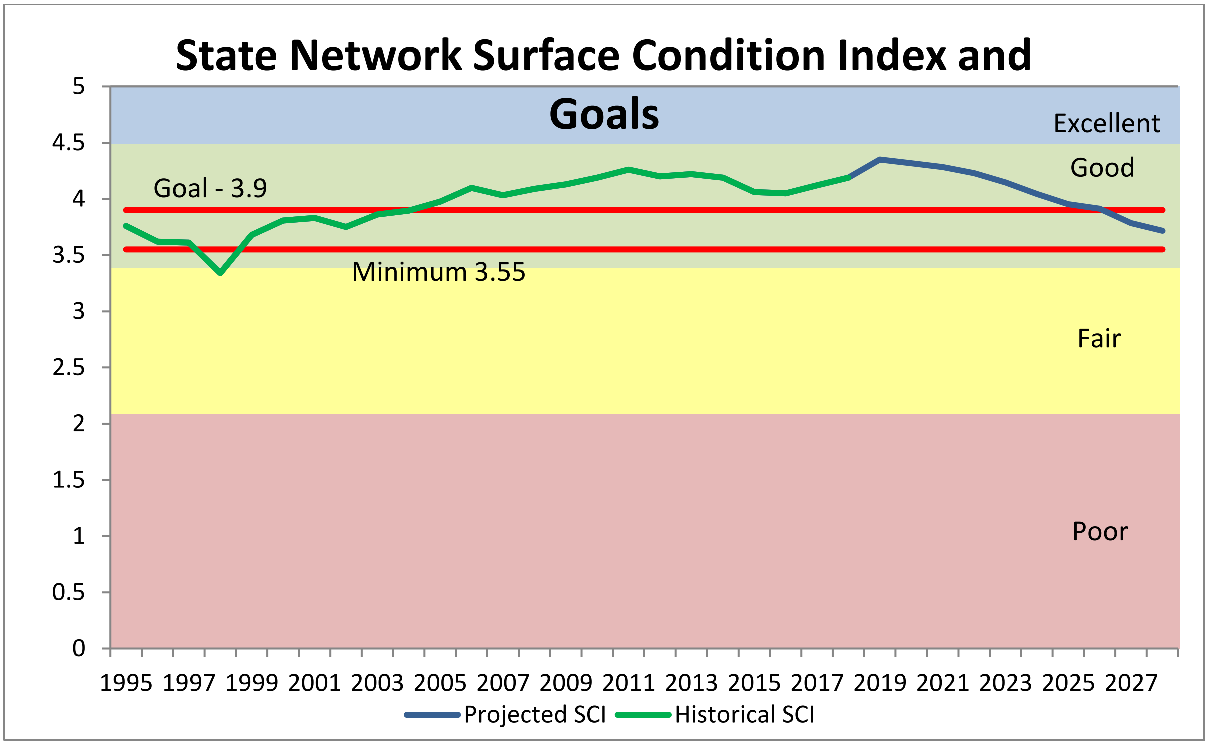


Figure 5.1: Historic and Projected State Network Pavement Condition

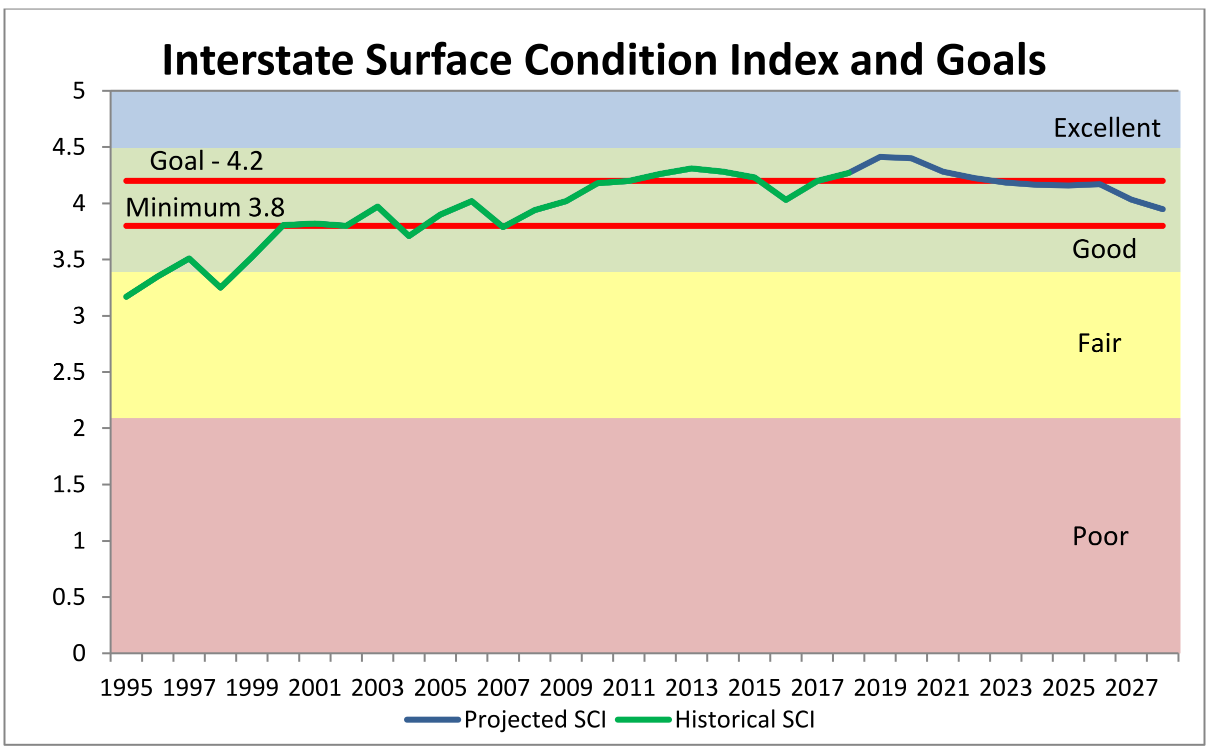


Figure 5.2: Historic and Projected Interstate Pavement Condition

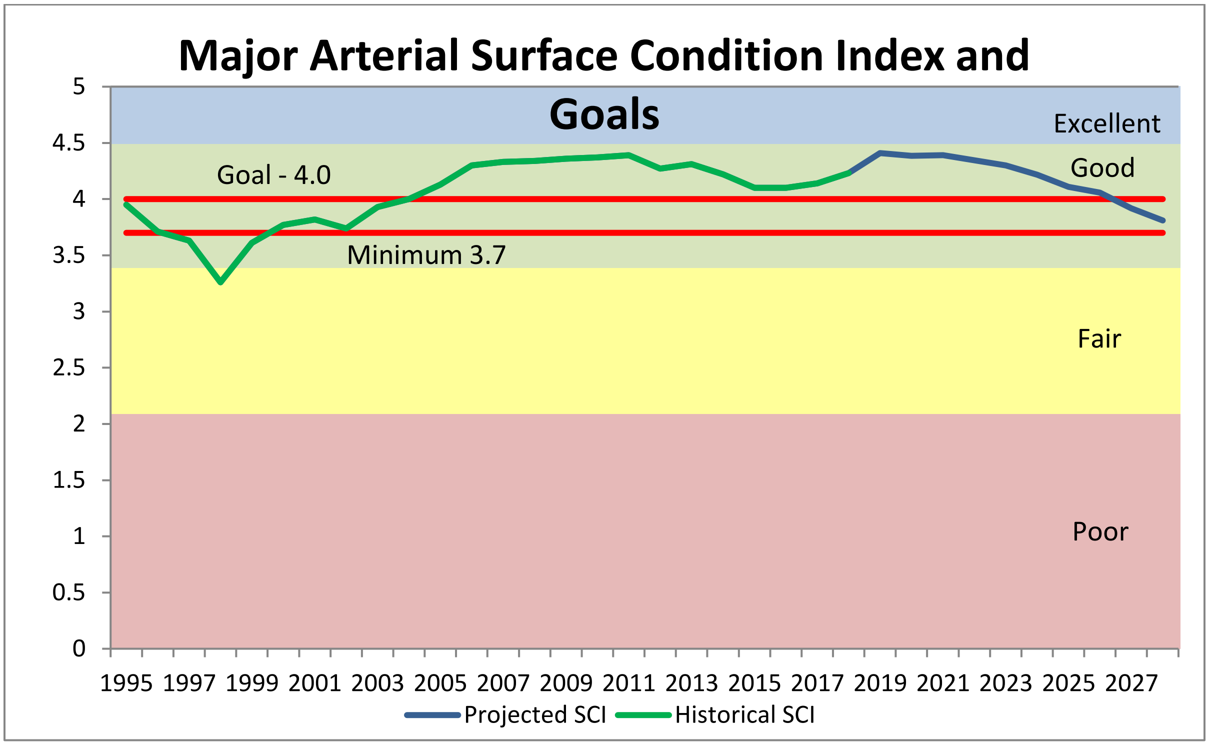


Figure 5.3: Historic and Projected Major Arterial Pavement Condition

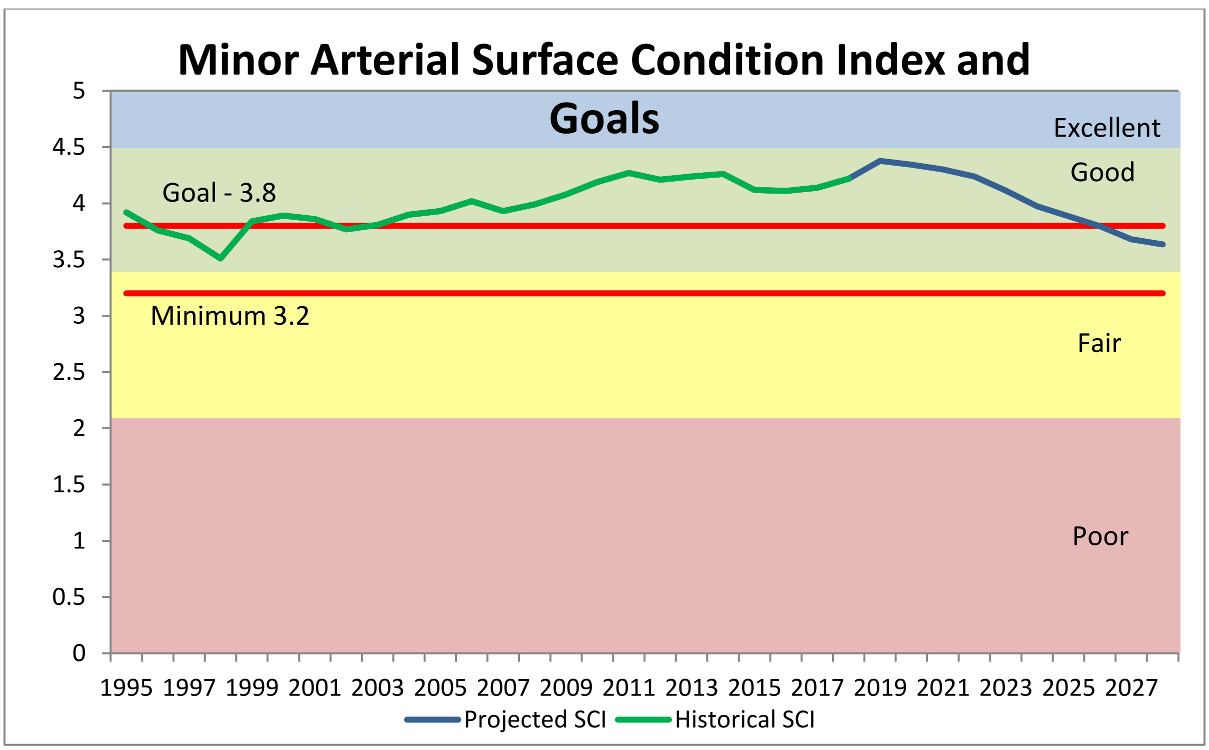


Figure 5.4: Historic and Projected Minor Arterial Pavement Condition

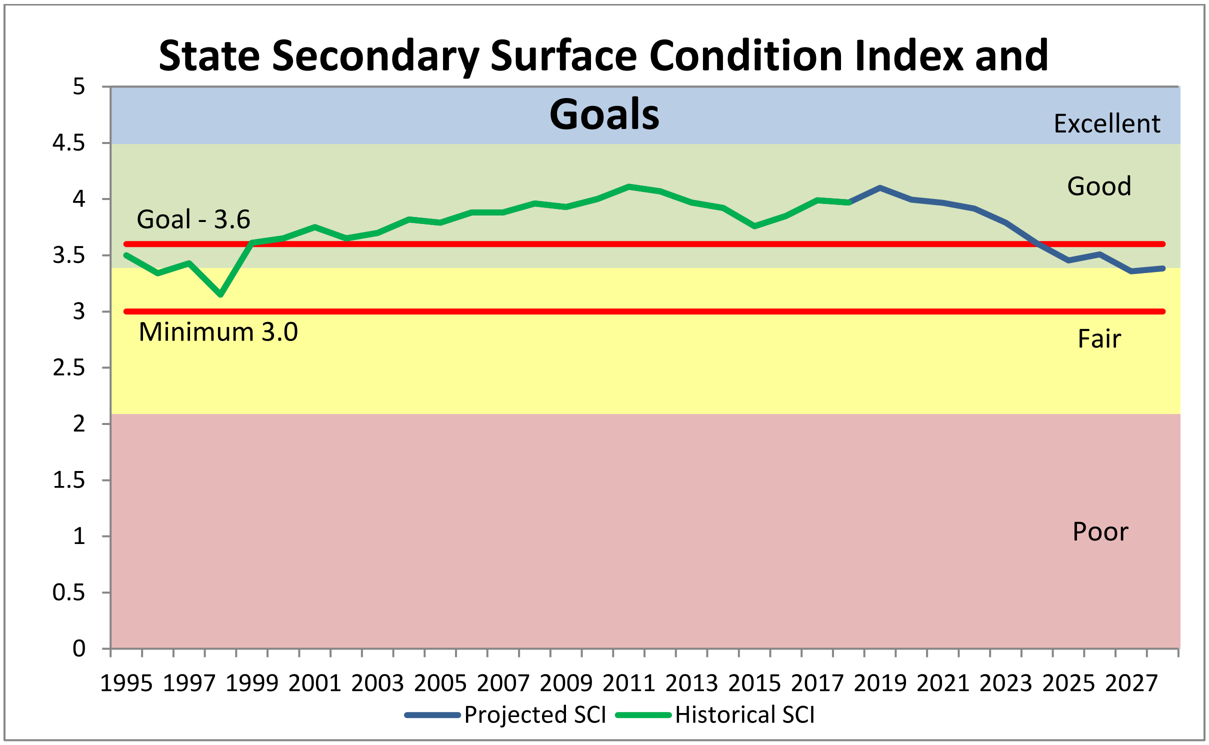


Figure 5.5: Historic and Projected State Secondary Pavement Condition

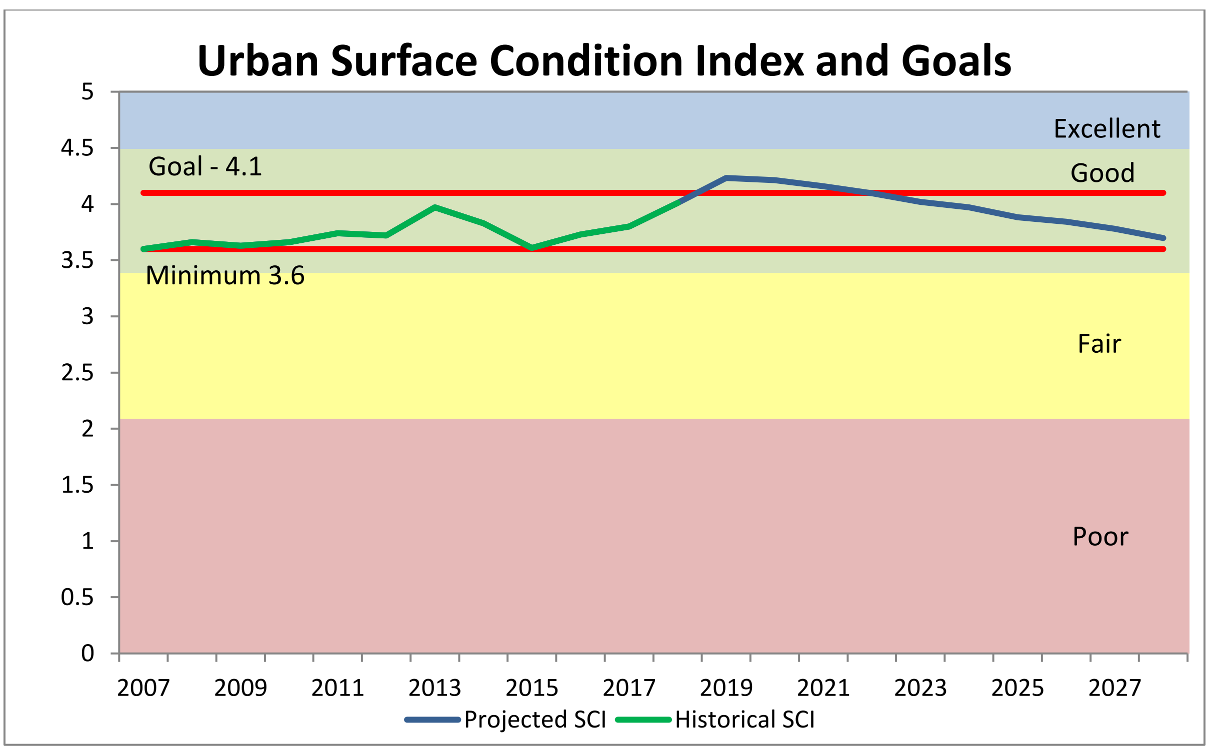


Figure 5.6: Historic and Projected Urban Pavement Condition

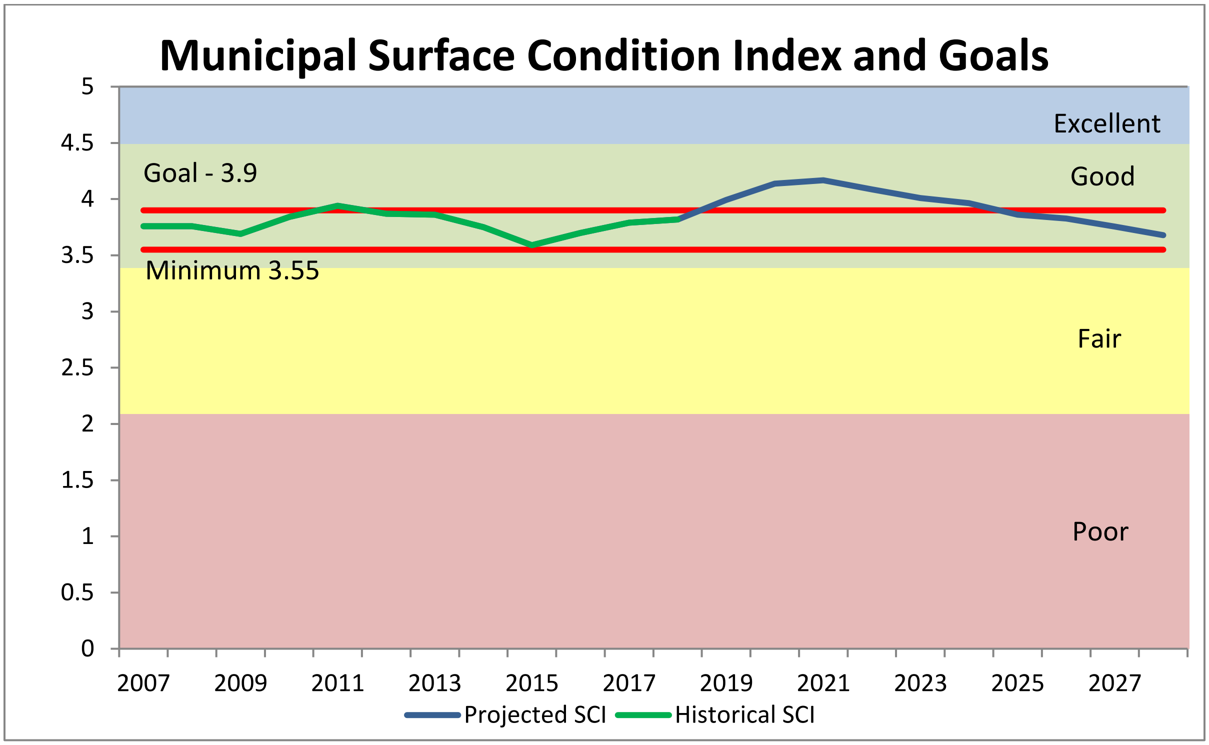


Figure 5.7: Historic and Projected Municipal Pavement Condition

Federal Pavement Performance Measures

23 CFR Part 490 National Performance Management Measures requires different performance measures than those traditionally used by SDDOT for pavement asset management decision making. The existing and projected pavement condition calculated as per the prescribed method are shown in Table 5.1 and Table 5.2.

Table 5.1: Percentage of Interstate Pavements in Good and Poor Condition

Year	% Good	% Good Target	% Poor	% Poor Target
2018	73.2		0.0	
2022 – projected	80.5	≥ 62.6	0.0	≤ 2.4

Table 5.2: Percentage of non-Interstate NHS Pavements in Good and Poor Condition

Year	% Good	% Good Target	% Poor	% Poor Target
2018	53.2		0.8	
2020 - projected	68.5	≥ 41.5	0.8	≤ 1.5
2022 - projected	74.9	≥ 41.5	0.8	≤ 1.5

Includes non-state-owned NHS

Some portions of the NHS are owned and managed by entities other than the SDDOT (Non-State Highway System NHS). SDDOT collects the condition data on these portions and coordinates with the owners to set the federal performance measure targets. This process is performed each time targets are set.

Structures

Structure condition on South Dakota's highway system is evaluated by a good, fair, or poor condition rating in accordance with Federal National Bridge Inventory reporting requirements. SDDOT uses AASHTOWare™ Bridge Management (BrM) and Pontis to determine the existing condition, anticipated condition, and recommended improvements for each structure.

To provide more consistent measurement for bridge condition reporting nationally, MAP-21 requires states to perform and report bridge element-level inspections and data in conformance with the latest Manual for Bridge Element Inspection developed by The American Association of State Highway and Transportation Officials (AASHTO) and FHWA.

MAP-21 also included a requirement that no more than 10% of the total bridge deck area on the NHS may be classified as structurally deficient for three consecutive years. States that exceed the 10% threshold must invest additional federal funding toward structures on the NHS.

Although structures and pavements have substantially different design lives, SDDOT chooses to use a 10-year time horizon for structure condition and budget projections. The 10-year projection is used to determine investment strategies and predict condition of both pavements and structures because much of the same rationale applies to both assets. These factors include but are not limited to: long term funding uncertainties, weather impacts, advances in construction materials technology, and traffic changes. Historical and projected trends of all state-owned NBI structures in good or fair condition are shown in Figure 5.8.

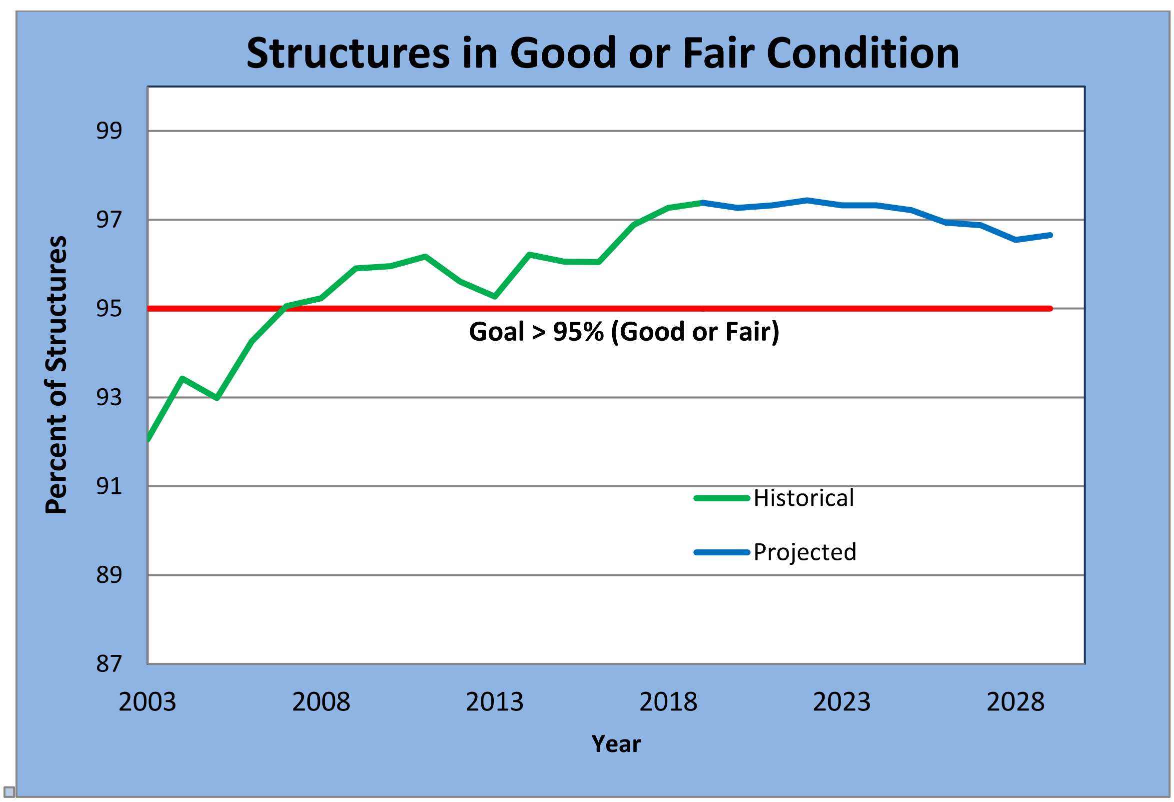


Figure 5.8: Percentage of State-Owned Structures in Good or Fair Condition

Federal Structure Performance Measures

23 CFR Part 490 National Performance Management Measures requires measures similar to the department's current practices except they are calculated for good and poor condition by bridge deck area and only for the structures on the NHS. These metrics, projections, and targets are shown in Table 6.10.

Table 6.10: Percentage of NHS Bridge Deck Area in Good and Poor Condition

Year	% Good	% Good Target	% Poor or Structurally Deficient	% Poor Target
2019	27.6		2.8	
2021 - Projected	25.0	> 22.0	3.0	< 5.0
2023 - Projected	24.0	> 20.0	2.7	< 5.0

Includes non-state-owned NHS

Chapter 6 Performance Gap Assessment

"Performance gap means the gaps between the current asset condition and state DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets." (23 CFR Part 515.5 Asset Management Plans)

Gap analysis identifies differences between current and desired asset conditions. This knowledge is used to prioritize and take appropriate actions with available funding. Funding may need to be reallocated to meet department condition performance targets. If current or projected performance falls short of the targets, there is a performance gap. If predicted performance exceeds the target there is a projected performance surplus. Currently, gap analysis is clouded by volatile federal funding uncertainty, with substantial risk that performance gaps are incorrect if the federal funding does not match forecasted amounts.

Pavements – State Performance Measures Gap Analysis

As described in Chapter 5, SDDOT has set minimum and goal condition targets for each funding category. Condition targets are set for pavements and structures to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practical cost. Table 6.1 summarizes current and projected gaps or surpluses for each of these targets.

Table 6.1: Pavement Gap Analysis by State Performance Measures

Category	Measure	Minimum Target	Goal Target	Current Level	10-Year Level	Gap Analysis
State Highway System	SCI	3.55	3.9	4.19	3.72	The current condition exceeds the goal target. 10-year projections indicate potential to meet the minimum target but not maintain the goal.
Interstate	SCI	3.8	4.2	4.27	3.95	The current condition exceeds the goal target. 10-year projections indicate potential to meet the minimum target but not maintain the goal.
Major Arterial	SCI	3.7	4	4.23	3.81	The current condition exceeds the goal target. 10-year projections indicate potential to meet the minimum target but not maintain the goal.
Minor Arterial	SCI	3.2	3.8	4.22	3.64	The current condition exceeds the goal target. 10-year projections indicate potential to meet the minimum target but not maintain the goal.
State Secondary	SCI	3.0	3.6	3.97	3.38	The current condition exceeds the goal target. 10-year projections indicate potential to meet the minimum target but not maintain the goal.
State Urban	SCI	3.6	4.1	4.01	3.70	The current condition does not meet the goal target but does exceed the minimum target. 10-year projections indicate potential to meet the minimum target but not achieve the goal.
State Municipal	SCI	3.55	3.9	3.82	3.68	The current condition does not meet the goal target but does exceed the minimum target. 10-year projections indicate potential to meet the minimum target but not achieve the goal.

Additional detail on current and projected pavement conditions in relation to state performance targets can be seen in Chapter 5 (Figure 5.1 through Figure 5.7).

Pavements - Federal Performance Measure Gap Analysis

23 CFR Part 490 National Performance Management Measures requires additional performance measures to those currently used by SDDOT for asset management decision-making. Table 6.2 shows the best estimate for existing and projected pavement condition as calculated from IRI, rutting, faulting, and cracking percent, the 2-year and 4-year targets, and the gap analysis.

Table 6.2: Pavement Gap Analysis by Federal Performance Measures

Category	Measure	Current Level	2-Year Level	4-Year Level	2-Year Target	4-Year Target	Gap Analysis
Interstate	% in Good Condition	73.2	N/A	80.5	N/A	≥ 62.6	The 4-year projection indicates potential to meet the target.
Interstate	% in Poor Condition	0.0	N/A	0.0	N/A	≤ 2.4	The 4-year projection indicates potential to meet the target.
Non-Interstate NHS	% in Good Condition	53.2	68.5	74.9	≥ 41.5	≥ 41.5	The 2-Year and 4-year projections indicate potential to meet the targets.
Non-Interstate NHS	% in Poor Condition	0.8	0.8	0.8	≤ 1.5	≤ 1.5	The 2-Year and 4-year projections indicate potential to meet the targets.

Includes non-state-owned NHS

Structures – State Performance Measure Gap Analysis

As described in Chapter 5, SDDOT has set condition targets for all structures on the state highway system based on good, fair, and poor condition ratings in accordance with Federal National Bridge Inventory reporting requirements. Table 6.3 shows the current and projected gaps or surpluses for this target.

Table 6.3: Structure Gap Analysis by State Performance Measures

Category	Measure	Goal Target	Current Level	10-Year Projected Level	Gap Analysis
State-Owned Structures	% of Structures in Good or Fair Condition	>95%	97.4%	96.7%	Both the current and 10-year projected conditions exceed the goal target.

Additional detail on current and projected structure conditions in relation to the state performance measures can be seen in Chapter 5 (Figure 5.8).

Structures – Federal Performance Measure Gap Analysis

23 CFR Part 490 National Performance Management Measures requires additional performance measures to those currently used by SDDOT for asset management decision-making. Table 6.4 lists existing and projected structure condition calculated by bridge deck area for NHS structures, the 2-year and 4-year targets, and the gap analysis.

Table 6.4: NHS Structure Gap Analysis by Federal Performance Measures

Category	Measure	Current Level	2-Year Level	4-Year Level	2-Year Target	4-Year Target	Gap Analysis
National Highway System (NHS)	Structures in good condition as a percentage of deck area	27.6	25.0	24.0	≥ 22	≥ 20	The 2-Year and 4-year projections indicate potential to meet the targets.
National Highway System (NHS)	Structures in poor condition as a percentage of deck area	2.8	3.0	2.65	≤ 5	≤ 5	The 2-Year and 4-year projections indicate potential to meet the targets.
National Highway System (NHS)	Structures considered structurally deficient as a percentage of deck area	2.8	3.0	2.65	<10% for 3 consecutive years		The 2-Year and 4-year projections indicate potential to meet the targets.

Includes non-state-owned NHS

Other Sources of Potential Gaps

Significant Influx of Surfacing

Significant amounts of pavement construction and rehabilitation can introduce a spike in future needs and a correlating funding gap. Analysis of future needs predicts a spike in miles of pavements requiring rehabilitation starting in 2024, attributable to 2009 American Recovery and Reinvestment Act funding used on “shovel ready” projects. This additional funding surfaced and resurfaced many miles of pavement above the average yearly amount. Many of these pavements will require rehabilitation starting in 2024. As the pavements age, the timing of their rehabilitation will be refined further as condition deteriorates and the accuracy of the analysis improves. The department will continue to monitor this spike and evaluate options to reduce and address it.

Clustering of Structure Age

A significant portion of the NBI structures on the state system were built during the Interstate era and are now between 40 and 65 years old (Figure 6.1). When these structures were built, the service life was estimated at 50 years. SDDOT lacks the resources to reconstruct as many structures as were built in the initial Interstate construction era. For example, 78 structures were built in 1963. During the past 10 years, an average of 10.4 new structures have been built per year. Because a substantial number of structures are nearing the end of their service life, current structure condition levels may not be sustainable beyond the 10-year projections. The department is working to smooth the spike in potential structure replacement needs by rehabilitating structures to extend their service life and will continue to monitor structure condition and plan accordingly.

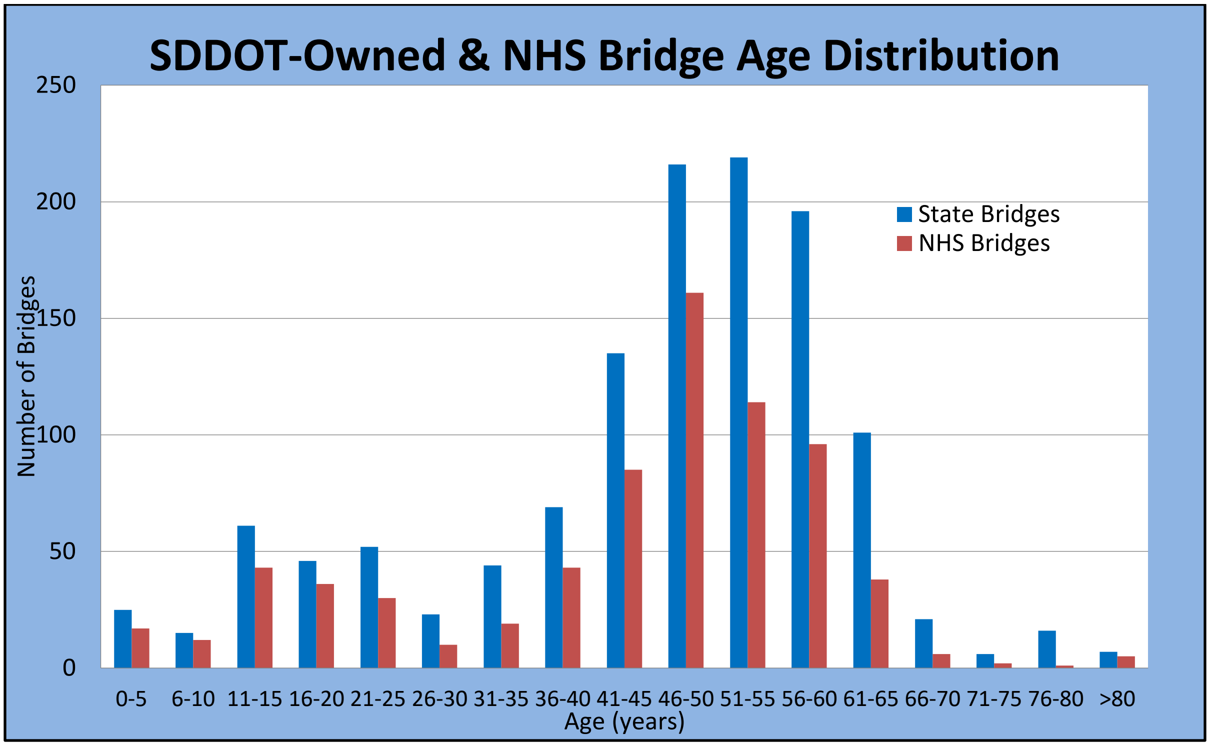


Figure 6.1: State Highway Structure Age Distribution

Megaprojects

Some major structures with significant replacement costs are nearing the end of their service life. The estimated cost of the scheduled Missouri River bridge replacements between Pierre and Fort Pierre and between Platte and Winner are $46.4M and $97.6M respectively. Large projects like these take a significant percentage of the construction budget in the years they are constructed, leaving fewer resources available for other projects. The SDDOT's 2016 Major Bridge Investment Study includes a systematic long-range improvement plan to prioritize and manage these major structure projects. A link to this study is provided in Appendix B.

Chapter 7 Growth and Demand

Having an asset management system that is responsive to growth and demand requires customer-centered data-driven decisions. Customer needs, identified with good data, should dictate how transportation assets are managed. A customer focus requires balancing asset capacity needs, supporting economic development, improving performance, preserving asset condition, and promoting adequate regional connectivity, social equity, and mobility. As South Dakota changes, asset management strategies and alternatives need to evolve and adapt to support beneficial transportation system changes by focusing on the functions the assets provide as well as the condition of the assets. Data-driven decisions based solely on asset condition is an oversimplified approach to management.

Fundamental questions for the SDDOT to answer in achieving an appropriate balance of customer needs are, "How should the future transportation system function in moving people and freight to reduce travel time and improve the cost and ease of movement? What economic sectors most depend on good highways and rail transportation?" A key consideration in implementing the answers to these questions is determining if the economy and the transportation funding structure can sustain the assets that fulfill those purposes. The department's responses to these questions define and shape the department's asset management decisions, alternatives, and strategies.

In South Dakota, urban congestion is almost non-existent below a level of service of C, as defined in Table 7.1. Lower levels of service occur at only a few locations. Even at service level C, travel speed is restricted but restrictions are not significant. One of the main reasons traffic congestion is minimal is South Dakota's population has grown slowly over the last 40 years, at about 0.4 percent per year, with the 2018 population totaling 882,000 people. Rural migration continues to the urban employment centers, as farms and ranches increase in size, equipment gets larger, and farms become more efficient and mechanized which requires a smaller labor force.

As a result, South Dakota has become more urban. Almost 57 percent of the population is now urban. The two largest cities, Sioux Falls and Rapid City, have captured much of the growth from rural migration because of their employment opportunities. North Sioux City also is experiencing stable growth. Other smaller cities across South Dakota are also growing but not as rapidly. Urban growth and traffic focus impacts on transportation assets in key economic and retail corridors, tourist locations, at intersections, and at other locations serving developing corridors.

Forecasting Traffic Growth

The SDDOT collects traffic volume, classification, and vehicle weight data at both short-term and permanent count locations across the state. The short-term counts are seasonally adjusted using factors derived from data collected at the permanent count locations.

Twenty-year traffic projections use growth factors for the Interstate and non-Interstate NHS, arterial, collector, and local roads. They are calculated using historic annual average daily traffic, county employment forecasts, county personal income growth forecasts, county population growth forecasts, vehicle registration forecasts, and licensed driver forecasts. Figure 7.1 through Figure 7.4 show statewide current and future traffic forecasts.

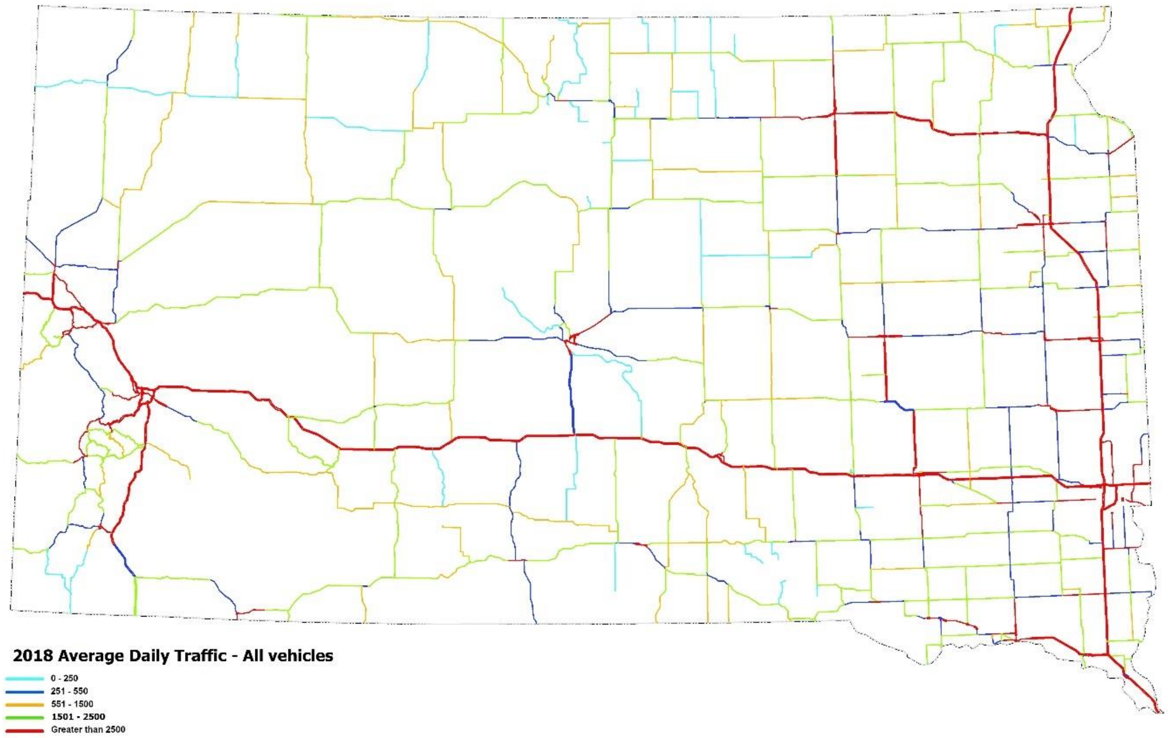


Figure 7.1: 2018 Daily Car and Truck Traffic

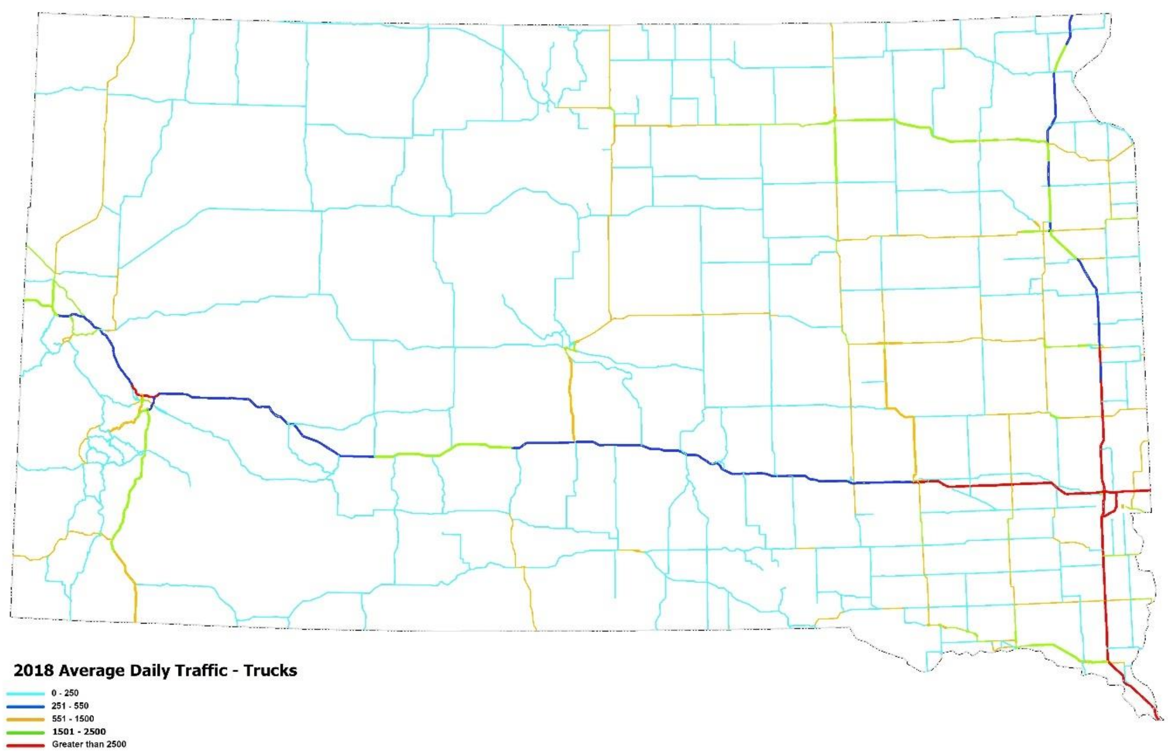


Figure 7.2: 2018 Daily Truck Traffic

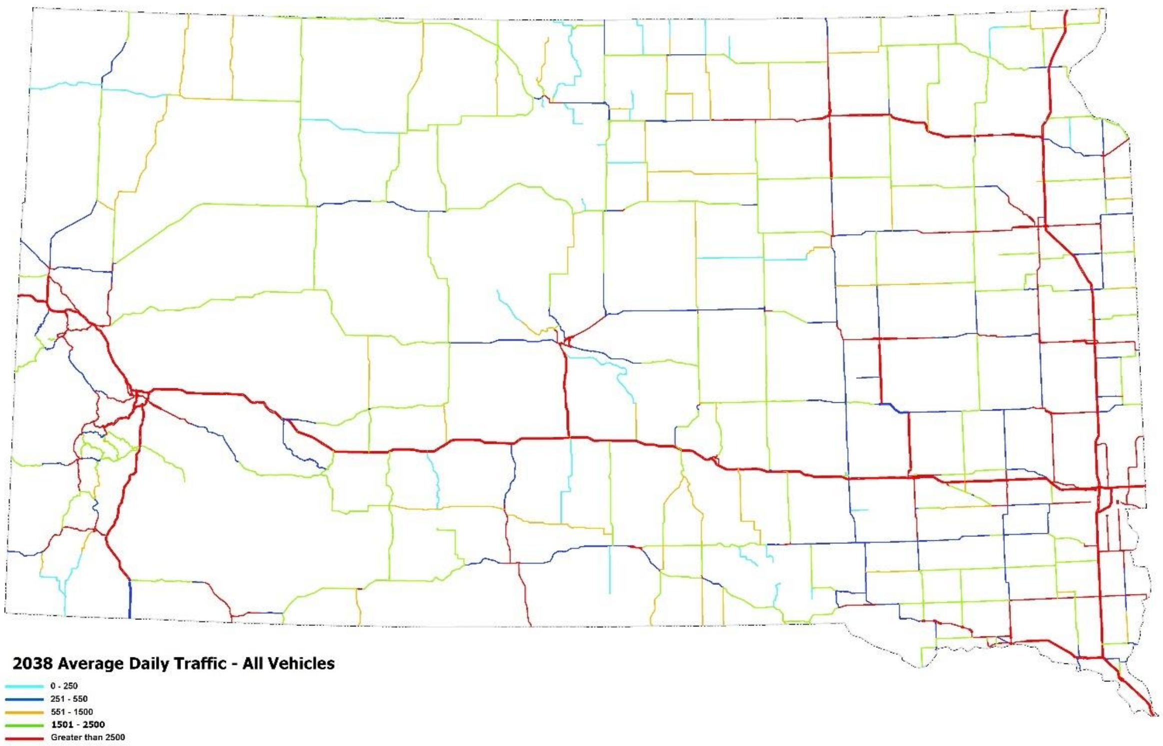


Figure 7.3: Forecast Daily Car and Truck Traffic, 2038

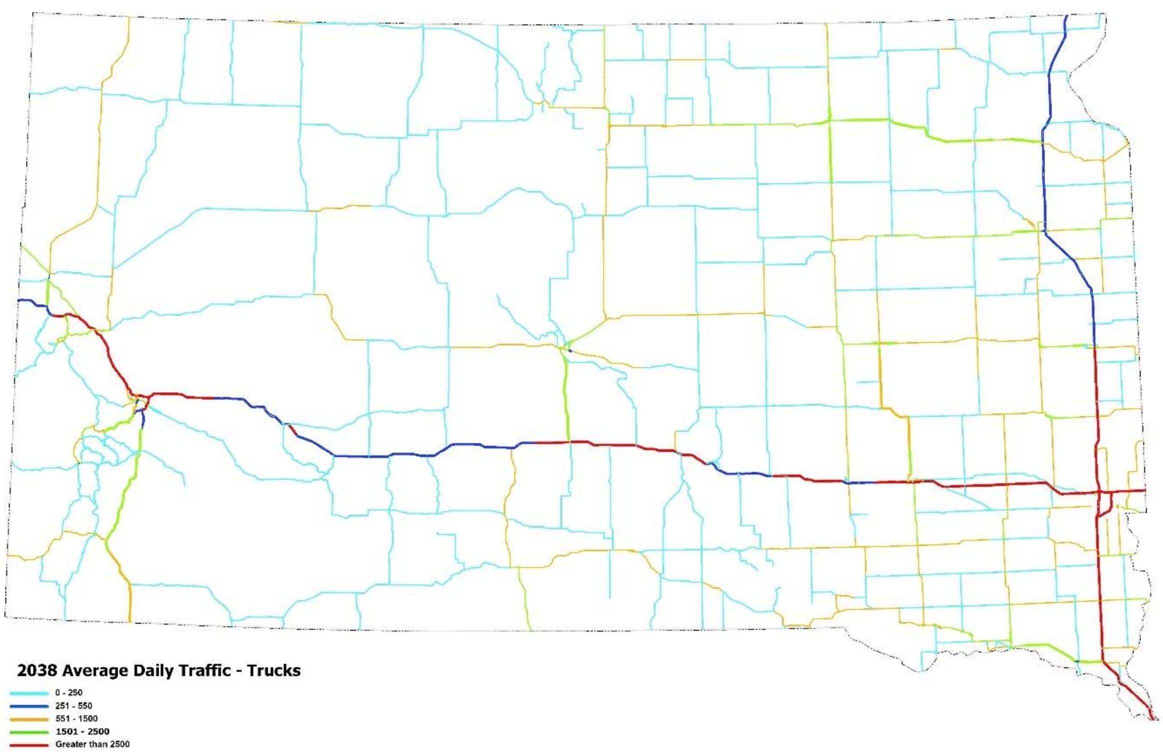


Figure 7.4: Forecast Daily Truck Traffic, 2038

Congestion and Level of Service

In areas of population growth, economic growth, and concentrated traffic, there may be short-term traffic congestion and delay. Asset decisions consider turning lanes, drop lanes, additional lanes, improved signal timing, access management, corridor studies, site-specific studies, intelligent transportation systems, or other capacity enhancements. Figure 7.5 shows population growth by county. Some of the locations where growth occurred are very rural. Because the population base was small, the percent change was larger in those locations.

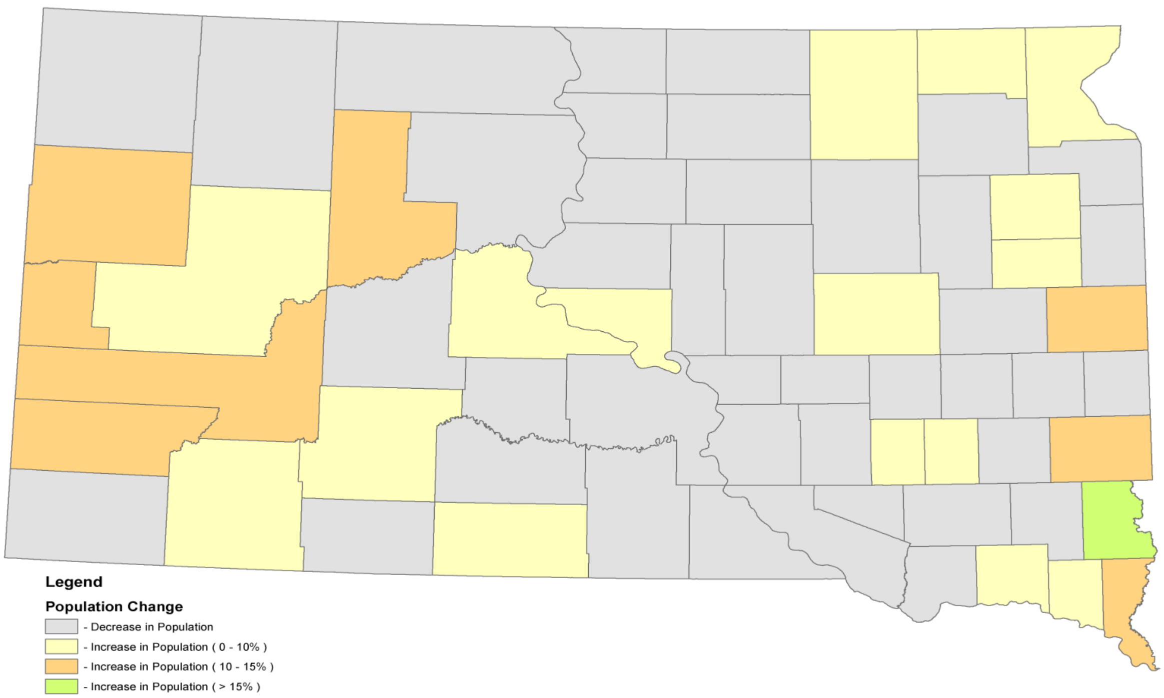


Figure 7.5: Counties with Population Growth

Special events also create short-term congestion issues. Every August, the Sturgis Motorcycle Rally creates congestion issues as hundreds of thousands of motorcycles arrive at Sturgis, South Dakota, a city of approximately 6,600 people. Other short-term events across the state concentrate traffic that may lead to congestion and capacity strain. The SDDOT deploys a significant amount of equipment and personnel to address these short-term traffic impacts.

Multiple retail and tourist attractions throughout South Dakota also induce and concentrate traffic. Examples of major urban traffic generators are commercial: Haines Avenue, La Crosse Street, Mount Rushmore Road, and 5th Street in Rapid City; 26th Street, 41st Street, Dawley Farm Village, and streets accessing Avera and Sanford Hospitals in Sioux Falls, 6th Ave in Aberdeen, and 9th Ave in Watertown. Across South Dakota, Mount Rushmore National Monument, Badlands National Park, other national parks and monuments, Custer State Park, and other state parks near Lake Oahe and Lewis and Clark Lake generate almost 6 million visits annually.

SDDOT traffic personnel monitor these areas and other locations across South Dakota. When traffic concerns arise, asset considerations are incorporated into decisions. The SDDOT categorizes highway capacity based on level of service summarized in Table 7.1. The DOT seeks level of service C or better on the urban Interstate mainline, level of service B or better on the rural Interstate, and level of service C or better on the Interstate system ramps. If the level of service falls below these indicators, the

SDDOT will evaluate the roadway to determine if there are options to economically address congestion. There may be circumstances when improvements are not economically feasible.

Table 7.1: Level of Service

Level of Service	Description
A	**Free flow--**smooth flow and high speeds.
B	**Reasonably free flow**--speeds slightly restricted by traffic conditions.
C	**Stable flow**--most drivers restricted in selecting speed.
D	**Approaching unstable flow**--little freedom to select speed.
E	**Unstable flow**--may have short stoppages.
F	**Forced or breakdown flow**--stop-and-go, forced flow.

Source: adapted from A Policy on Geometric Design of Highways and Streets, Sixth Edition, updated 2011, published by AASHTO.

The SDDOT relies on the Regional Integrated Transportation Information System (RITIS) tool developed by the Center for Advanced Transportation Technology (CATT) Laboratory at the University of Maryland to monitor network congestion and meet the mandatory performance management reporting requirements for congestion on the National Highway System. In accordance to the law, the SDDOT has set performance targets for the three required measures, Interstate Reliability, Non-Interstate NHS Reliability, and the Interstate Truck Reliability Index, as defined in 23 CFR 490 National Performance Management Measures, Subpart E and Subpart F. Table 7.2 shows these target values and the actual values over the past eight years.

Table 7.2: Travel Time Reliability on the Interstate and NHS

Year	Interstate Reliability %	Non-Interstate NHS Reliability %	Interstate Truck Reliability Index
Target	**> 90.0**	**> 85.0**	**< 1.50**
2011	100.0	100.0	1.19
2012	100.0	100.0	1.19
2013	100.0	100.0	1.22
2014	100.0	99.0	1.23
2015	99.9	98.4	1.16
2016	99.9	97.2	1.17
2017	99.8	94.5	1.14
2018	100.0	93.7	1.16

Source: RITIS

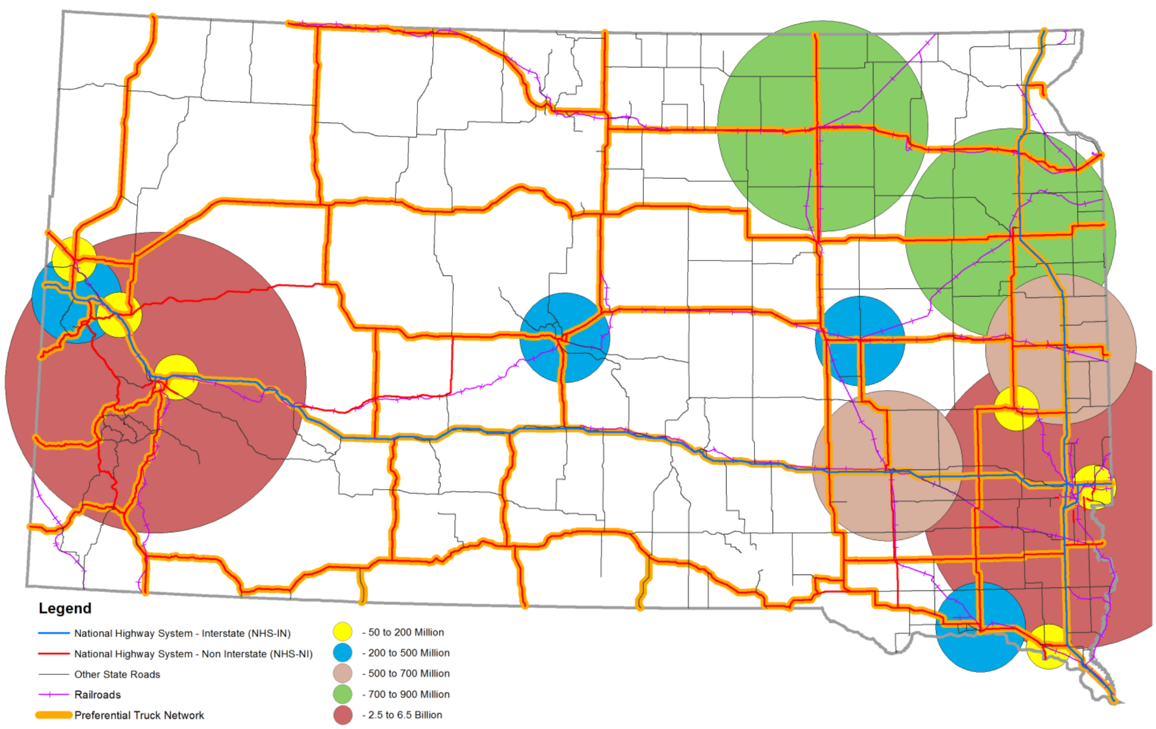
These ratings show South Dakota has minimal recurring congestion on the state's NHS highways. However, winter weather can have a large impact on travel time reliability due to the reduced speeds. This is one of the reasons why snow and ice removal is a major focus of the SDDOT's maintenance forces.

Effects of Economic Sectors on Highway Assets

The economy has significant impacts on asset condition and the need for transportation asset expansion and improvements. Conversely, asset condition has a significant impact on the economy. Business and agricultural activity can concentrate traffic in key locations. To better understand those locations, several economic measures are assessed and described in the following sections of this chapter.

Taxable Sales

The growth and demand of South Dakota's regional economic centers depend on the transportation system to meet customer needs. In a rural state, the interdependence of the regional economic centers and their service area cannot be understated. High quality highway and rail assets connecting the surrounding area to these centers strengthen both the surrounding area and the regional center. This is accomplished by improving access to each center's goods, materials, and professional, medical, and other services. The regional center needs the surrounding area to create an economy of scale large enough to economically sustain the services it provides. A center can provide more diverse and higher quality services as economies of scale expand and as the service area expands. Taxable sales are one measure of the strength of the interdependency and a measure of the size of the regional center's service area. The larger metropolitan areas in South Dakota have large taxable sales which is not attributable only to their large populations and strong economies. It is also due to travelers and businesses from across the state using the unique products and specialized services they offer. Figure 7.6 shows the comparable taxable sales for the population centers of 5,000 and greater.



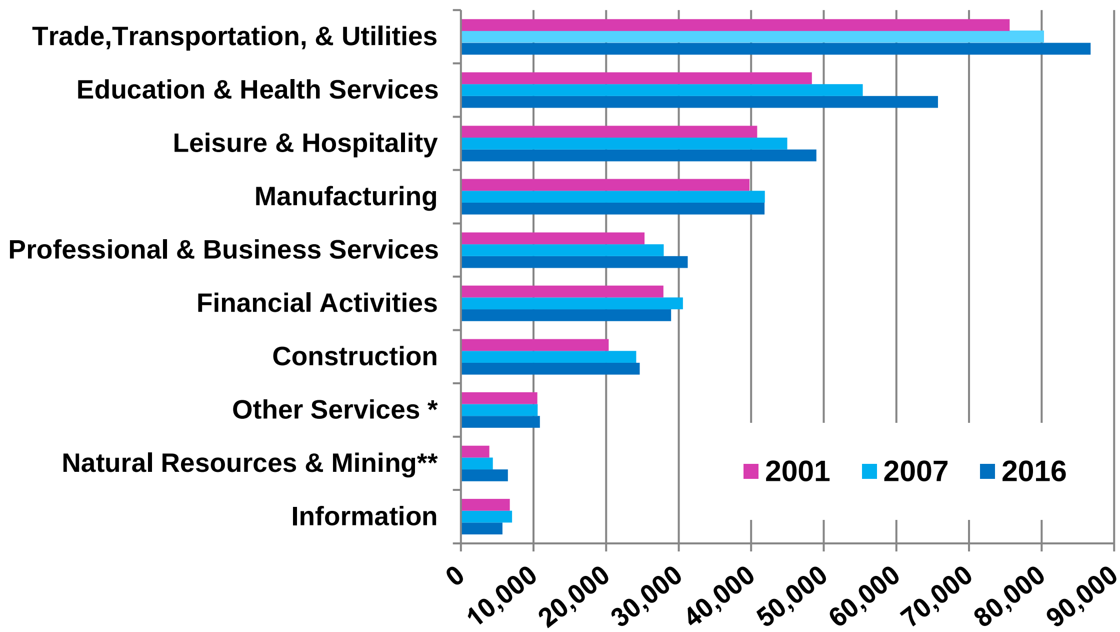
Source: South Dakota Department of Revenue

Figure 7.6: Dollars of Taxable Sales 2016

The size of the service area for the centers and the sales they generate may depend on the population density of the area served. Lower density areas tend to have large service areas to create economies of scale. Service areas can shrink if the transportation assets deteriorate, travel times increase, and access and connectivity are weakened. If that happens, trade areas can become more self-reliant, economically independent, and less specialized.

Employment

Employment growth in South Dakota has been about 17 percent since 2001 or about 1 percent per year. The primary employers in the state are trade, transportation and utilities, education and health services, leisure and hospitality, manufacturing, professional and business services, and financial activities. Collectively, they hired over 85 percent of the approximately 350,000 employees in 2016. Most of the employment growth has been in education and health services and trade, transportation, and utilities, see Figure 7.7. These sectors have different impacts on transportation assets. The department needs to carefully consider the service of these important employment generators when making asset management decisions.

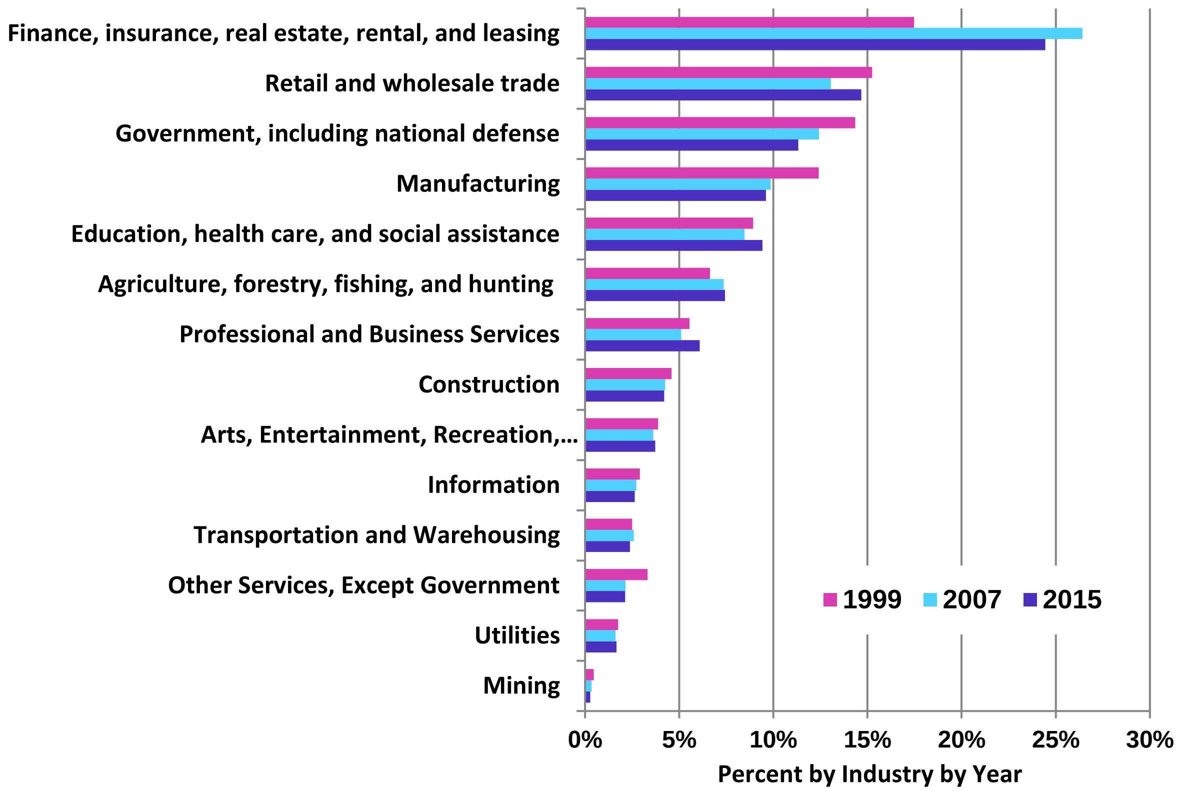


Source: Bureau of Labor Statistics, US Dept. of Commerce.
**Other services are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing dry cleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.*
***Natural Resources and Mining includes Agriculture, Forestry, Fishing and Hunting and Mining, Quarrying, and Oil and Gas Extraction*

Figure 7.7: Numbers of Jobs by Economic Sector

Gross State Product

In current inflation adjusted dollars, South Dakota's gross state product (GSP) was $47.2B in 2015, $35.2B in 2007, and $21.2B in 1999. The economy grew at about 4.5 percent per year during this period, although it has grown faster recently. The GSP for 2017 was $49.8B. Figure 7.8 illustrates how major industries' contributions to GSP have changed over time.



Source: U.S. Department of Commerce, Bureau of Economic Analysis

Figure 7.8: South Dakota Gross State Product

Freight Assets and the Economy

Figure 7.8 provides insight into the changing freight needs of certain sectors, although all sectors are growing in absolute terms. Much of the use, wear, and demand on transportation assets is linked to larger freight shipments from sectors like agriculture, retail and wholesale trade, and manufacturing. Agriculture dominates freight shipping in the agriculture, forestry, fishing, and hunting sector shown above.

Internationally, South Dakota primarily exports to Canada and Mexico and imports from Canada, Brazil, China, and Mexico. Within the United States, South Dakota exports to Minnesota, Iowa, Illinois, Nebraska, North Dakota, and surprisingly North Carolina. South Dakota imports from North Dakota, New York, California, Michigan, Illinois, Montana, Texas, and Washington. Many of the imports from distant states are of foreign origin through port cities or across international borders according to USDOT's Freight Analysis Framework.

FHWA's Freight Analysis Framework estimates that 115 million tons of freight moved by truck in South Dakota in 2016. This is equivalent to approximately 4.6 million fully loaded 18-wheel trucks. Based on Figure 7.8, the financial sector is growing significantly, and the manufacturing and government growth rates are declining slightly as an overall contributor to GSP, but finance is not as significant in generating freight as agriculture.

Grain Elevators, Ethanol Facilities, and Other Sectors

Agricultural land use and commodity movements may determine locations where transportation improvements and asset modifications are concentrated. Although the highway network has available capacity, grain elevators and agricultural processing facilities like ethanol producers may concentrate truck traffic. South Dakota’s Interstate highways ranked tenth nationally in the share of Interstate vehicle miles of travel attributable to combination trucks with multiple trailers. During harvest or when a 110-car shuttle train is being loaded some corridors may experience a spike in traffic levels.

Figure 7.9: Typical Local Elevator Truck Traffic

Loading one shuttle train may require more than 400, 18-wheel trucks. Large dairy operations will also concentrate traffic as feed, forage, and milk are transported on rural roads. From an asset management standpoint, these facilities may increase stress on transportation pavements and structures which may increase the rate of deterioration. Currently, rural congestion and capacity concerns are not an issue, but they do create truck storage, turning, and stacking issues as commodities are being loaded onto shuttle trains.

Many large agricultural commodity shipping and processing facilities are in eastern South Dakota adjacent to state highways providing access to rail. The locations of those facilities relative to South Dakota’s state highway system and rail service are shown in Figure 7.10.

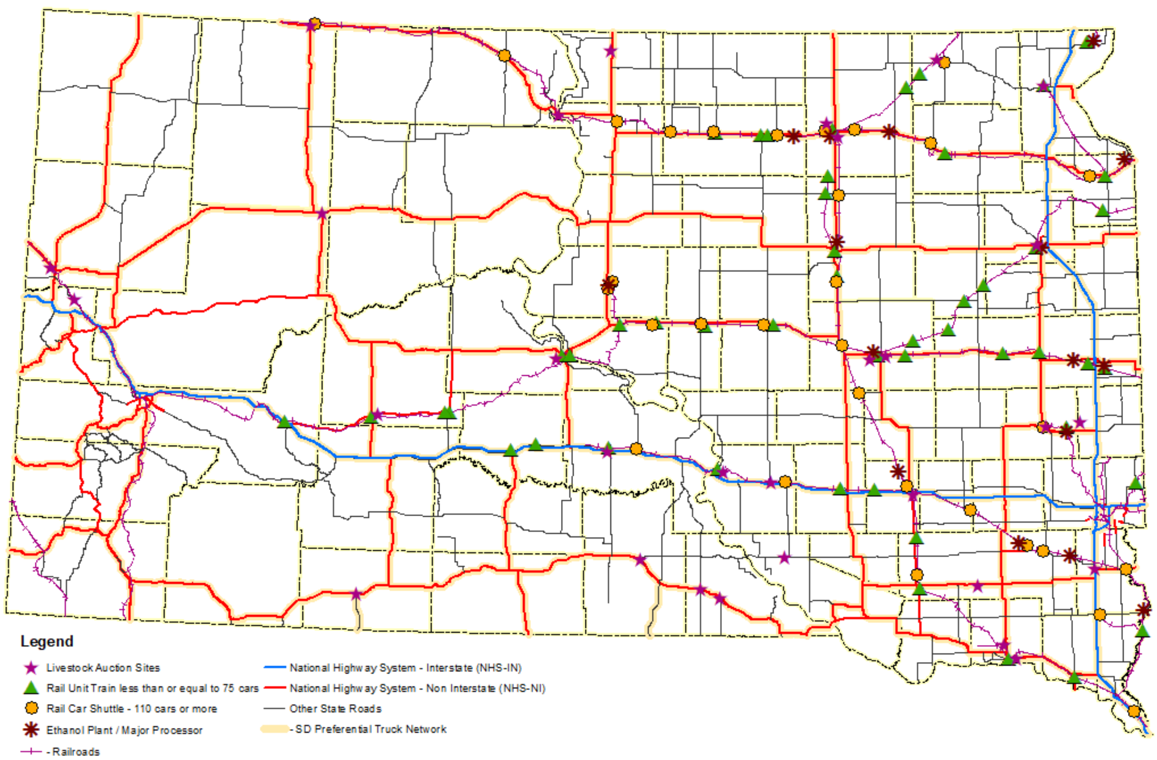


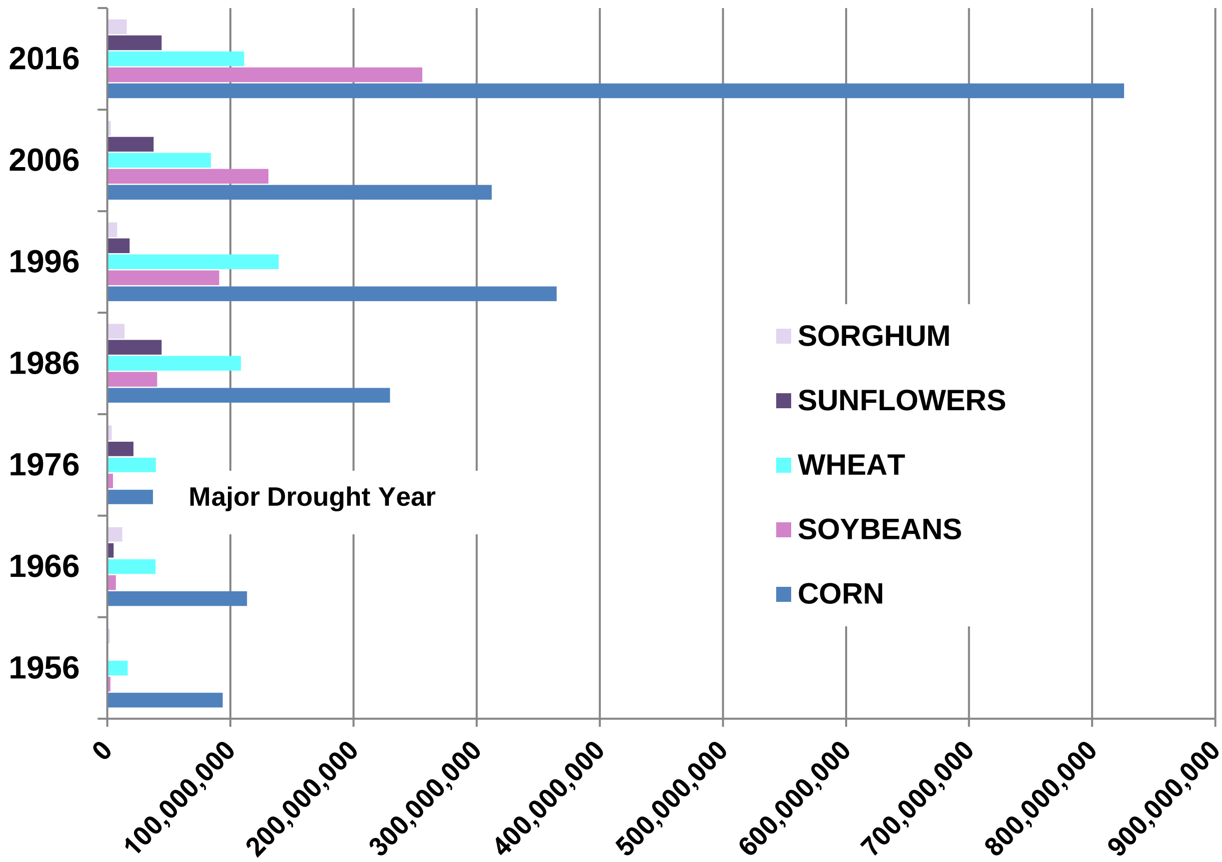
Figure 7.10: Major Agricultural Facilities

Siting such facilities along transportation systems capable of accommodating turning movements for trucks, providing adequate lane and shoulder widths, and having strong pavements, subgrades, and structures for heavy loads supports these businesses. Developers sometimes fund the additional improvements if facilities are located where these services are inadequate.

Figure 7.11: Trucks Wait at the Shuttle Train Loading Facility in Onida

Average South Dakota corn crop yields have increased by about two percent per year for a couple of decades and the acreages planted to corn production have increased. Recent growth in corn production is remarkable, growing by over 780 percent since 1956 and more than doubling since 1996. Production of other crops like wheat, soybeans, and sunflowers has also increased. Many experts expect more growth in soybean production. Production volumes and the type of crops grown change with market prices and the weather. Short-term market trends should not be used to adjust strategies for transportation assets that last 30 years or longer.

Agricultural freight movements have increased significantly and illustrate the importance of the state highway system to move crops to rail terminals and processing facilities. The increase in agricultural commodity prices, acres under cultivation, improvements in crop genetics, and changes in management practices are influencing agricultural facility siting and agricultural freight growth see Figure 7.12.



Source: National Agricultural Statistical Service, USDA.

Figure 7.12: Crop Production in Bushels by Year

Commodity movements for corn, wheat, soybeans, sunflowers, and milo generate the equivalent of over 1 million 18-wheel truck trips per year on average. Figure 7.13 shows estimated county commodity movements by trucks based on average annual production levels relative to the locations of processing and shuttle train facilities. The truck movements are estimated based on an 18-wheel configuration at 80,000 pounds using average annual crop production over multiple years. The numbers estimate the movement occurring only one time, but movements may occur several times from field, to storage bin, and finally to market. The counties with heavy crop production are very apparent from the map. Using the Federal Highway Administration's Freight Analysis Framework, there could be about 1.5 million agricultural trucks if all the internal shipments used fully loaded 18-wheel trucks. This is fifty percent over the rough estimate using only agricultural production tonnage to estimate commodity truck volumes.

Sheriff Bill Stahl.

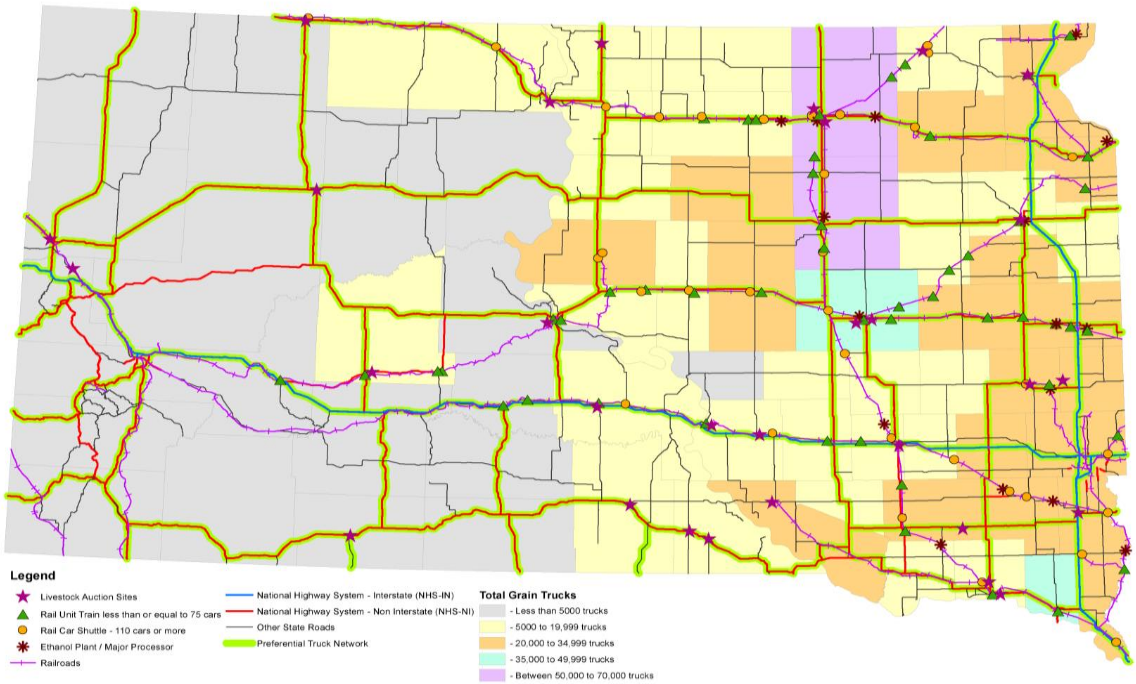


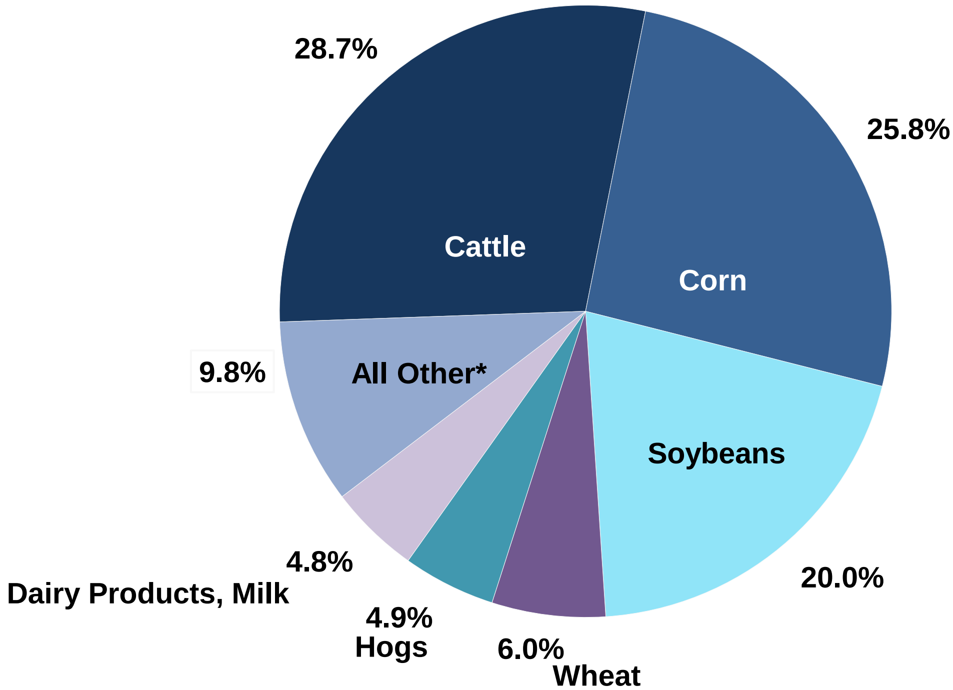
Figure 7.13: Estimate of Annual Commodity Movements by Truck

Photo Courtesv of Sheriff Bill Stahl.

Figure 7.14 Trucks Wait to Turn Left into Rail Shuttle Facility

Cattle outnumber people in South Dakota by about five to one at 3.85 million, and there are approximately 1.2 million hogs and 255,000 sheep. In 2017, total farm cash receipts were about $8.98B. Over 90 percent of farm cash receipts came from cattle and calves, corn, soybeans, wheat, hogs, and dairy and milk as shown in Figure 7.15.

Cattle do not generate as many truck movements as crop commodities, but cattle values exceed the value of most crops. Transportation asset management will need to focus on connections to livestock auctions, dairies, and feedlots. Figure 7.16 shows estimated county cattle and calf movements. The state may generate over 30,000 truck equivalent trips per year in movements from points of production.



Source: Economic Research Service, USDA.
**All Other consists of sunflowers, hay, turkeys, chicken eggs, sorghum, honey, oats, millet, dry beans, rye, barley, wool, flaxseed, mink pelts, mohair, farm chickens, and other products.*

Figure 7.15: Percent of Farm Cash Receipts by Commodity in 2015

This is a minimum estimate based on the annual average cattle production and one annual truck movement using an 18-wheel configuration. Cattle are transported using other configurations because pick-up-trailer movements are common. Cattle movements are probably much higher than shown because there are often multiple movements per year using many vehicle types. The data is based on annual averages over four periods from 1997 to 2012. There are fewer movements for hogs and sheep than cattle.

South Dakota's Rail Plan identifies rail freight loading locations adjacent to the highway system which can affect asset decision making. Considering the current trends of agricultural production and commodity shipments growing from additional land cultivation and increases in crop production per acre, SDDOT will need to continue to respond to new facility siting.

Oil production continues in western North Dakota's Bakken oil-bearing formation. The level of production correlates with oil prices. South Dakota roads serve freight traffic on corridors leading to those oil fields, mostly on the preferential truck network. SDDOT will continue to monitor truck traffic to aid decision-making to improve assets if needs grow and funding allows.

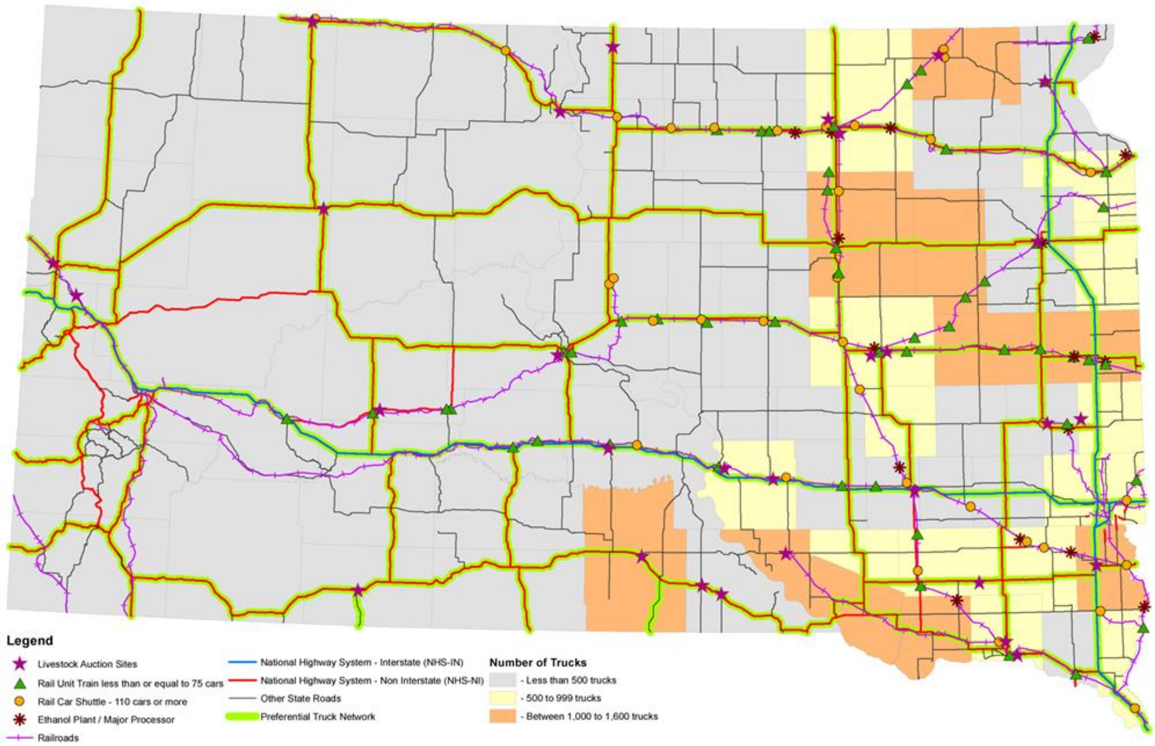


Figure 7.16: Estimate of Annual Cattle Movement by Truck

Asset Planning to Address Growth and Demand

Corridor-specific asset management strategies are initiated through various means. The need for asset studies are primarily identified by the state, MPO, city, or county long-range transportation plans, bridge studies, and the freight plan. These plans analyze highway segments and recommend corridors for detailed study. Corridor studies are initiated based on the highest ranked corridor(s). Corridor studies document needs and propose improvement strategies based on financial constraints.

Most of the transportation network has capacity available but there are issues affecting asset management at spot locations. Most spot locations are near freight intermodal facilities and in the metropolitan planning areas and larger cities. The SDDOT has developed a planning assistance program for non-MPO cities and counties to conduct transportation plans identifying future growth and demand issues. The SDDOT cooperates with the MPOs to identify growth and demand issues identified in their plans. The SDDOT uses county and city transportation plans to identify critical locations and possible strategies. In areas without plans, the SDDOT monitors freight and passenger traffic to identify asset management issues.

As an example, the SDDOT has conducted an Interstate System Corridor Study on a 10-year cycle for the past 30 years to help guide the development of a 20-year asset management and improvement strategy. These studies analyze alternatives and recommend projects for inclusion in the developmental STIP (years 5-8) to improve system conditions and operations. After a project is placed in the developmental STIP, interchange analyses or project specific studies are conducted to obtain FHWA approval for Interstate access points or to better refine the recommended project alternatives. These interchange and project development studies are supported by the environmental process to inform decisions and refine alternatives, so projects can be designed and built.

Use of ITS and TSM&O in Addressing Growth and Demand

Intelligent Transportation Systems (ITS) and Transportation Systems Management and Operations (TSM&O) are used to spread demand and mitigate congestion by providing information to the traveling public or directing travelers and traffic in ways that reduce traffic peaks and valleys using alternative routes or in other ways. Electronic permitting is a way to more safely regulate truck traffic for shipping particular loads or carrying dangerous cargo. ITS and TSM&O are being used to manage traffic during special events like the Sturgis Rally. This improves the DOT's response to short-term congestion demands and minimizes long-term infrastructure construction in response to short-term events. This efficiently addresses traffic growth and demand.

ITS and TSM&O have been used to manage growth and demand for many years through signage, motorist notification and other technology that improves traffic operations. Their use to manage growth and demand are still evolving and maturing. As time progresses, more applications to manage growth and demand will become apparent as connected and automated vehicles evolve and improve efficiency.

Serving Growth and Demand

Manufacturing, agriculture, tourism, and most of the economy depend on good transportation. Transportation asset management objectives and measures, performance plans, financial plans, and investment strategies should support beneficial economic and population change. Future growth and demand will influence asset management practices like transportation expansion, rehabilitation, and preservation. To support healthy change, it will be important to continually analyze the evolving needs of South Dakota's economy and adjust asset management strategies on the state highway system. The SDDOT staff will monitor key economic indicators like those listed in the Growth and Demand Chapter as new data becomes available to determine evolving needs. The asset managers within the SDDOT will adjust management strategies to meet the needs indicated by the data and the customers.

These strategies must balance preserving asset condition, meeting asset capacity needs, providing for adequate connectivity, supporting economic development, and aiding social equity. This balancing, supported by strong data, will define and shape the customer and user focus of the department's asset decisions.

Chapter 8 Risk Management

Risk management is defined as evaluating and forecasting risks and then developing procedures to avoid them or minimize their impact. Risk is evaluated as a possible future event that may affect the department's services and ability to attain the strategic goals. Understanding risks and adopting risk management processes are essential to delivering a safe and efficient transportation system.

The SDDOT strives to provide the level of service demanded by the public at minimum cost. Unexpected events, including economic disruptions and natural disasters, are risks that can reduce the efficiency of the agency.

Effective risk management focuses resources to manage programs through improved communication and awareness. Applying risk management to program delivery decisions makes it possible to identify, assess, and prioritize threats and opportunities. Strategies can then be developed to mitigate risks to the federal-aid highway program.

Integrating Risk into Transportation

Risk management improves communication and decision-making in project and program delivery. Acknowledging the possibility of ordinary and unusual threats in the transportation industry, SDDOT applies risk management in its daily business practices. Ignoring these threats would impede SDDOT's ability to deliver a safe and efficient transportation system. Consequences of inadequately addressing risks include:

- environmental damage
- damage to state-owned equipment and infrastructure
- injury to personnel
- injury to public health
- damage to private property
- loss of life
- traffic congestion
- loss of mobility to users of the transportation system
- legal and liability issues
- reduction of economic vitality
- inefficient use of resources
- damage to agency reputation

Adopting a formal risk management approach can reduce these consequences. Jointly applying asset management and risk management enhances SDDOT's ability to use its resources effectively. The process includes a systematic method for identifying, assessing, monitoring, and managing threats and opportunities to the agency. Proactively managing risks involves:

- gathering information about future events, threats, and opportunities
- assessing the likelihood and impact of risks
- prioritizing risks by their expected likelihood and relative importance to project, program, or system performance
- determining appropriate response strategies to risks
- executing response strategies
- monitoring the effectiveness of strategies
- re-evaluating risks

Risk Management at SDDOT

Risk management has long been an integral, if informal, element of SDDOT business management. Examples of regular risk assessment and analysis include sizing of drainage structures according to anticipated surface runoff, staffing and placing maintenance personnel to manage extreme winter weather events, and allocating funds towards individual assets (pavements, bridges, culverts, etc.) to achieve targeted asset conditions.

Risk can impact the agency at various levels. Some risks may impact the entire department, while others may impact a single asset type or a single region. In the TAMP, risks are categorized into three levels—agency, program, and project—as shown in Table 8.1. General cost inflation or funding uncertainty would be an agency risk, while asphalt price volatility would be a program risk, and the ability to deliver asphalt mix to a job site would be a project risk.

Table 8.1: Levels of Risk

AGENCY	**RESPONSIBILITY**: Executives **TYPE:** Risks that impact achievement of agency goals and objectives and involve multiple functions **STRATEGIES:** Manage risks in a way that optimizes the success of the organization rather than the success of a single business unit or project.
PROGRAM	**RESPONSIBILITY**: Program Managers **TYPE:** Risks common to clusters of projects, programs, or entire business units **STRATEGIES:** Set program contingency funds; allocate resources to projects consistently to optimize the outcomes of the program as opposed to solely projects.
PROJECT	**RESPONSIBILITY**: Project Managers **TYPE:** Risks specific to individual projects **STRATEGIES:** Use analyses techniques, contingency planning, and consistent risk mitigation strategies with the perspective that risks are managed in projects.

Source: Risk Based Asset Management: Examining Risk Based Approaches to Transportation Asset Management; Report 2: Managing Asset Risks at Multiple Levels in a Transportation Agency, FHWA, 2013

SDDOT formed a committee to formally identify potential risks to the state highway system and define levels of potential consequence and likelihood (Table 8.2 and Table 8.3). The committee comprises the Deputy Secretary, Operations Division Director, Planning and Engineering Division Director, Administration Program Manager, Research Program Manager, Federal Funding Specialist, Operations Traffic Engineer, MPO Coordinator and Long Range Planning, and Asset Management Engineer. The committee assigned an overall risk rating for 22 identified risks based on combined consequence and likelihood ratings and has identified appropriate mitigation strategies for each risk (Table 8.4 through Table 8.6). Risk rating enables the department to prioritize the identified risks, select mitigation strategies, and identify actions that will reduce risks to a manageable level, not necessarily to eliminate them altogether.

The TAMP focuses on the risks identified in the risk register and emphasizes those rated extreme or high. As risks are identified and mitigated, and each time the TAMP is updated, SDDOT will update the risk register.

Table 8.2: Risk Consequence Ratings

CONSEQUENCE RATING	DESCRIPTION	ECONOMIC IMPACT	IMPACT ON REPUTATION	SAFETY IMPACT	LEGAL COMPLIANCE
1	Insignificant or little impact on system	<$1M	Little to none	No injuries	Fully compliant
2	Low or some impact on the system	$1M – $5M	A few days of criticism in the press	Minor injuries	Agency agrees to comply
3	Moderate or noticeable impact on the system	$5M – $20M	Media criticism for most of the week, customer complaints	Serious injuries	Agency warned of compliance issue and adopts corrective action
4	High impact on the system	$20M – $50M	National media criticism and public awareness	Single fatality or multiple serious injuries	Agency sued or fined for missing mandates
5	Catastrophic impact on the system	>$50M	Loss of trust in agency or continued national coverage	Multiple fatalities	Agency liable for missing mandates

Table 8.3: Risk Likelihood Ratings

LIKELIHOOD	RATING	DESCRIPTION
Remote	**1**	Only expected to occur under exceptional circumstances or in the distant future (>10 years)
Unlikely	**2**	Occurs infrequently, such as every 6 to 10 years
Possible	**3**	Occurs occasionally, such as every 3 to 5 years
Likely	**4**	Occurs commonly and would be expected within the next 2 years
Almost Certain	**5**	Occurs regularly and is expected to occur within the next year

Table 8.4: Risk Rating Matrix

LIKELIHOOD	CONSEQUENCE				
	INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC 5
REMOTE 1	Low	Low	Moderate	High	High
UNLIKELY 2	Low	Moderate	Moderate	High	High
POSSIBLE 3	Moderate	Moderate	High	High	Extreme
LIKELY 4	Moderate	Moderate	High	Extreme	Extreme
ALMOST CERTAIN 5	Moderate	High	High	Extreme	Extreme

Table 8.5: Risk Mitigation Strategies

Risk Mitigation Strategy	
Treat	Seek to reduce the risk probability or impact by taking early action to reduce the occurrence of the risk to a feasible level. This enables the activity to continue, but with controls in place to maintain the risk at a tolerable level.
Tolerate	Take no further action due to limited ability to mitigate or mitigation cost disproportionate to the benefit gained.
Terminate	Changing the project plan to eliminate the risk or to protect the project objectives from its impact. Stop the activity, process, or program.
Transfer	Move the consequence of a risk together with ownership of the response to a third party. Pass the risk to an insurer, outsource it, or transfer to another entity. Transferring the risk does not eliminate it.
Take Advantage of	Seek an opportunity to exploit a positive impact.

Table 8.6 : Risk Register

Item	**Risk Description**	**Likelihood Score (1-5)**	**Consequence Score (1-5)**	**Risk Rating (Low, Moderate, High, Extreme)**	**Mitigation Strategy**	**Mitigation Actions**
1	*Business System Technology* Data gathering, structure, pavement, and other asset management systems - inadequate or failing systems or rapidly changing technology.	5	4	Extreme	Treat, Take Advantage	Continue to manage existing systems and evaluate new technologies and their impacts on existing practices. Continue to promote workforce development and training to help identify new technologies applicable to the transportation industry and to develop a workforce capable of implementing these new technologies.
2	*Federal Funding Uncertainty* Federal funding volatility, unpredictability, and short-term funding extensions add risk and uncertainty in programming, project delivery, planning, and performance that adversely impact asset management and attaining state targets and national goals	4	4	Extreme	Treat, Tolerate, Transfer	Continue to manage the state highway system and those routes that serve it's function, lower targets to match what can be accomplished with reduced funding; continue to promote adequate investment levels; work with Congress to strengthen the Federal Highway Trust Fund and improve the timeliness of annual appropriations
3	*State Funding Shortfall* Funding is insufficient to match Federal Highway Funds or meet transportation needs.	1	4	High	Treat	Continue to ensure adequate state revenue by informing and educating the legislature on the risks associated with insufficient state transportation funding.

Table 8.6 : Risk Register

Item	Risk Description	Likelihood Score (1-5)	Consequence Score (1-5)	Risk Rating (Low, Moderate, High, Extreme)	Mitigation Strategy	Mitigation Actions
4	*Traffic Demand Growth* Growth and developer impact on transportation capacity and safety needs.	3	3	High	Treat, Transfer	Perform planning studies in coordination with developers and local entities. Continue to pass on new infrastructure costs to developers when appropriate.
5	*Culture* Changes in political or management philosophy regarding the use of the transportation system by Governor/Legislature/ Secretary/Customers	1	4	High	Treat, Take Advantage	Continue to inform legislature on transportation needs and processes. Continue to be actively involved with state legislature and continue efforts to increase transparency.
6	*Extreme Weather and Climate Change* Impact on pavements and structures regarding damage and increased deterioration rates, ice jams, flooding, extreme temperatures, etc. Service and how to manage from a safety aspect.	4	3	High	Treat	Review and prepare action plans if damage to infrastructure compromises system functionality. Review and modify design procedures as appropriate.
7	*Consultant, Contractor, and Supplier Workforce* Retention and recruitment decline and skills do not keep pace with changes in the industry	4	3	High	Treat	Continue to provide training courses to contractors and consultants. Develop or expand existing training courses. Increase communication and teamwork to bring more national training programs to South Dakota.
8	*ROW Acquisition* The ROW acquisition process increases in complexity, cost, and time	4	3	High	Tolerate	Provide adequate time and resources to acquire property interests
9	*Freight Traffic* Freight affects the transportation network regarding safety, level of service, and asset performance and condition.	4	2	Moderate	Treat, Tolerate	Continue to monitor and perform studies to assess impacts and risks. Reassess safety, level of service, and asset performance needs as new information becomes available

Table 8.6 : Risk Register

Item	Risk Description	Likelihood Score (1-5)	Consequence Score (1-5)	Risk Rating (Low, Moderate, High, Extreme)	Mitigation Strategy	Mitigation Actions
10	*Crashes* Safety issues and not meeting safety targets	3	2	Moderate	Treat	Continue to monitor safety criteria and address concerns (guard rails, safety appurtenances, geometric design) as necessary to achieve or exceed goals. Use Traffic Incident Management to reduce secondary crashes.
11	*Geological Impacts* Landslides, rock slides, faults	3	2	Moderate	Treat	Implement slope and slide management system and re-assess needs, mitigation strategies, and efforts as more information becomes available. Review and prepare action plans to address events as they occur.
12	*Workforce* Retention and recruitment rates decline	3	2	Moderate	Treat	Continue supporting and promoting the mentoring and onboarding programs. Continue promoting the department through job fairs and involvement with local universities and technical schools. Continue to outsource as needed.
13	*Institutional Knowledge* Loss due to a high rate of retirement in the next 10-15 years	4	2	Moderate	Treat	Promote cross training and job duty/process documentation. Continue to support external training and involvement at the national level. Continue supporting and promoting the mentoring program and the DOTNET training program. Implement succession planning.
14	*Material Costs* Variability of costs of key materials like asphalt, cement, aggregate, fuel	2	2	Moderate	Treat, Tolerate	Continue to monitor costs of materials and the construction cost index. Continue to improve CCI formulas to be more responsive to the current economy. Continue to explore, test, and evaluate new materials, construction practices, and design alternatives.

Table 8.6 : Risk Register

Item	Risk Description	Likelihood Score (1-5)	Consequence Score (1-5)	Risk Rating (Low, Moderate, High, Extreme)	Mitigation Strategy	Mitigation Actions
15	*Inflation* Increasing costs of materials, labor, and services.	4	2	Moderate	Treat, Tolerate	Continue to monitor costs of materials and the construction cost index. Adjust goals and strategies as funding and costs will allow.
16	*Traffic System Technology* Smart Highways, V2V, V2I, etc. Infrastructure cost to develop, operate, and maintain	4	2	Moderate	Treat, Tolerate	Continue to thoroughly analyze the feasibility and impacts of new technologies on the performance and sustainability of the state network.
17	*Tribal Relationships and TERO Agreements* not established	3	2	Moderate	Treat	Continue open communication with tribes and promote an environment conducive to resolving issues before they delay the process.
18	*Regulations* Federal transportation changes, environmental rules (NEPA) impacts, data collection, effort and cost of compliance and delay	4	2	Moderate	Tolerate	Continue active involvement with the federal rulemaking process through NPRM review and comment, 5-state coalition, and AASHTO.
19	*Asset Damage* Damage of structures, culverts, luminaires, etc.	4	2	Moderate	Treat	Continue to develop asset management practices to improve sustainability and resilience. Continue to identify problem locations and implement new technologies to warn drivers of over height loads.
20	*Engineering* Design and technology changes and advancements	4	2	Moderate	Take Advantage	Continue to evaluate new design alternatives and technologies and their impacts on existing practices.
21	*Seismic Activity* Damage to major structures and facilities	1	2	Low	Tolerate	Minimal Seismic activity exists in South Dakota.
22	*Loss in Public Confidence* Loss of public confidence in government generally or SDDOT specifically could increase dissatisfaction with services and erode support for projects and funding	2	1	Low	Treat	Assess public sentiment through regular customer satisfaction assessments. Shape public opinion through a formal external communication plan.

Major Risks and Consequences

Eight risks were rated Extreme or High in the Risk Register (Table 8.6) and are described in more detail below. These risks will be monitored by an expert panel of SDDOT staff selected for their broad knowledge and background in risk assessment. Risks will be evaluated by this expert panel periodically. The risk register will be updated if the level of risks changes or if new risks are identified.

Risk 1 – Business System Technology

The SDDOT relies on increasingly complex information systems to acquire and analyze asset condition information, develop optimal investment strategies, manage construction contracts, pay contractors and vendors, and mange staff workload. The analysis of pavement asset condition for example, includes pavement roughness, faulting, and rutting data. These data elements are collected by a van equipped with cameras, optical and 3D elevation sensors, laser distance sensors, and accelerometers controlled by powerful onboard computers. An automated pavement management system analyzes the data to develop a revenue-constrained, statewide, multi-year investment program that optimizes return on investment on the complete highway network. AASHTOWare™ BrM software is similarly used for structures, and enterprise financial systems track revenues, expenditures, and available funding. Without ongoing support and periodic upgrades to enhance functionality or accommodate new computer technology, these systems cannot support the department's business needs.

To mitigate risks associated with technical obsolescence or system failures, the SDDOT proactively monitors existing information systems and identifies needs and opportunities for improving or replacing them. With the South Dakota Bureau of Information and Telecommunications, the SDDOT plans, prioritizes, and commissions needed work. Finally, the SDDOT invests in training and workforce development to ensure that its workforce can adopt and productively use new technology.

Risk 2 - Federal Funding Uncertainty

Because the federal-aid highway program funds more than 75 % of highway construction costs on the state highway system, a significant risk to meeting asset management goals and targets is a shortfall in federal funding. Achieving the performance targets for pavement and structure assets on the state highway system depends upon obtaining the federal funding levels noted in the financial plan. The possibility of a federal funding shortfall puts those targets and the federal goals in jeopardy. Federal funding shortfalls, funding volatility and unpredictability, and short-term funding extensions add risk and uncertainty in programming, project delivery, planning, and performance that adversely impact asset management and attaining state targets and national goals.

Federal fuel taxes and revenues have not been adjusted despite a weak revenue stream and a shortfall in the Federal Highway Trust Fund. Sustaining current federal highway funding levels may be difficult if competition increases for the non-user-based revenue that has supplemented the Federal Highway Trust Fund.

Declining or even a constant level of federal funding will seriously impact aging pavements and structures if cost inflation continues near current levels. It will hasten declining conditions, especially the lower classified highways. As stated in earlier chapters, the SDDOT allocates funding based on highway functional classifications. The National Highway System, including the Interstate system, is the top priority and will continue to receive the highest level of maintenance and funding. The next highest classifications are major arterial and minor arterial highways. State secondary routes are the lowest priority and would suffer the most if federal funds decline.

Risk 3 – State Funding Shortfall

Although state revenue is not as critical to highway construction as federal revenue, it could rank very high if federal funding does not keep pace with inflation. The federal highway program is the backbone for highway construction in South Dakota, but it typically requires 10% to 20% match, usually provided from state funds. If state revenue is insufficient to match federal dollars, total funding available for construction projects will be reduced and the condition of highways and structures will deteriorate. State funds are also used for maintenance activities such as winter operations, mowing, and equipment purchases that compete directly against capital investments in highways and structures. These activities would have to be funded even during state funding shortages, possibly forcing reductions in asset preservation and improvement investments.

Risk 4 – Traffic Demand Growth

There are always community pressures to add capacity and interchanges to existing facilities based on proposed development adjacent to state highways. These pressures will continue in the future. In the past, developers have been expected to fully or partially pay for improvements to state facilities based on anticipated traffic. If political decisions alter the requirement for private developers to invest in the needed improvements, costs would shift to the department and less funding would be available for asset preservation. Sales tax generated by economic growth does not fund transportation, but costs for constructing and maintaining new infrastructure comes from the transportation budget.

Risk 5 –Culture

Currently, the SDDOT enjoys a strong working relationship with the governor and legislature. This is largely due to many years of active public involvement with the STIP and productive engagement with legislature, especially the transportation committees. Three summer studies completed in the past ten years afforded the SDDOT the opportunity to inform the legislature of the internal workings of the department, explain the purpose and need of state highway facilities, and describe how the department uses the funding it receives. The most recent result of these summer studies was Senate Bill 1 in the 2015 legislative session, which included a gas tax increase of six cents per gallon and an increase in the vehicle excise tax from 3% to 4%. These increases are extremely valuable in helping the department meet its strategic goals.

In addition, the department prioritized asset preservation many years ago, extending asset life and greatly enhancing funds available for construction. Sophisticated pavement and structure management software enables the department to select preservation treatments that maximize the return on investment on the entire highway network with very limited political interference or controversy. Changes in the culture of the governor or the legislature to favor political project selection instead of objective preservation priorities would have a detrimental effect on highway and structure conditions and put the entire highway system at risk.

Risk 6 –Extreme Weather and Climate Change

Extreme weather has always posed a risk to the state highway system and customers. If the current trend continues and severe storms increase in frequency, the risk to the system, customers, and the SDDOT escalates. Risk to users increases in the form of safety aspects and travel time reliability. Detours around highway and structure closures from inundation and repairs can be significant. The damage to the highway system from severe storms can affect the system in two ways. Flooding can cause immediate damage and closures on the system while increases in severe winter weather can cause a sharp increase in the deterioration rates of pavements and structures. This can have a significant impact on current conditions, projected conditions, and subsequently, the financial plan. Significant weather events also impact the SDDOT by pulling staff away from their normal duties to assist with emergency operations.

SDDOT works closely with the Governor's Office, Emergency Management, and federal agencies during severe weather events. The department has developed several plans to organize emergency efforts and mitigate the impacts to infrastructure and users. Plans are routinely evaluated to identify potential improvements.

As weather patterns change, design procedures and deterioration curves are continuously updated to reflect the best information available. To improve resiliency, changes to design considerations, among other, have included: lengthening structures to reduce scour, extending or adding riprap channel armoring at more locations to reduce scour, and tying culvert sections together to reduce separation and piping. In addition, storm models used for sizing structures are frequently updated to incorporate storm intensity, duration, and frequency changes related to climate change.

Risk 7 –Consultant, Contractor, and Supplier Workforce

The ability of consultants, contractors, and suppliers to hire and retain skilled workers has declined. Many factors have contributed to the tightening of the labor market and a lack of skilled workers. The situation has affected the department through delays in project development and construction, more efforts needed to produce quality construction, and an increased burden on the department to manage plans development and construction.

To help develop labor skills, the department provides training courses to contractors and consultants. Many courses are currently available, but the department continuously works to expand accessibility of the courses and works closely with industry to ensure development needs are being met. The department also works with several entities to bring national training programs to South Dakota.

Risk 8 –Right of Way Acquisition

Right of way (ROW) acquisition continues to increase in complexity, cost, and time. Land values continue to increase and property owners, for various reasons, are becoming more reluctant to sell or divide parcels. This has caused the acquisition process to require more interactions with landowners and more frequently involve legal services. This costs the department money and resources and can cause project delays.

To reduce the frequency of project delays, the department has refined the project development process to help identify ROW needs sooner and start acquisition earlier in the process. The department also now schedules more time in the project development process for ROW acquisition.

Facilities Repeatedly Damaged by Emergency Events

When facilities are damaged by emergency events, the design of the repair includes an evaluation of the history of that facility to determine whether repairs should include design changes to mitigate future damage. 23 CFR Part 667 Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, requires formalizing the process and tracking the sites that have required repair or reconstruction on two or more occasions due to emergency events. Evaluation of the risks involved in repeatedly damaged locations is required for any emergency event after January 1, 1997.

On the state highway system, thirteen sites meet these criteria. Four are on the National Highway System. The primary types of repeat repairs are due to the unique geography of South Dakota.

A. Prairie potholes are closed hydrologic basins with no outlets. Seven repeat projects have involved grade raises through these closed basins and riprap protection to prevent damage to the roadway due to wave action and ice from rising water elevations.

B. Scour at river crossings led to four repeat projects for scour protection and debris removal.

C. The Howes Dams on SD34 near the Ziebach/Meade county line have required repeated repairs.

D. SD50 at Chamberlain has required repeated landslide repairs due to the size of the landslide involved.

The sites were each evaluated for their likelihood and consequence to determine their potential risk, according to the process shown in Figures 8.2, 8.3, and 8.4. None of the sites are categorized as a high risk. Each has been treated adequately to return it to service and mitigate the risk of future damage. Mitigation actions include continuously monitoring the SD50 landslide site by the department's Geotechnical Office. The bridge scour sites are inspected every two years during the regular structure inspection cycle to identify any major issues or changes deemed necessary to mitigate.

Table 8.7: Risk Evaluation for Facilities Repeatedly Damaged by Emergency Events Since January 1, 1997

HWY	MRM	COUNTY	TYPE	LIKELIHOOD	CONSEQUENCE	RISK RATING	REPAIR COST (Millions)
US12	350	Day	A	1	2	Low	$1.87
SD20	365	Clark	A	1	1	Low	$0.21
SD20	374	Clark	A	1	1	Low	$0.54
SD20	326	Spink	B	2	1	Low	$0.06
SD25	162	Clark	A	1	1	Low	$0.38
SD34	116	Ziebach	C	1	2	Low	$1.29
SD44	363	Hutchinson	B	2	1	Low	$0.07
SD46	355	Clay	B	2	1	Low	$0.09
SD50	220	Buffalo	D	4	1	Moderate	$0.52
US212	350	Clark	A	1	2	Low	$2.52
US212	353	Clark	A	1	1	Low	$0.53
SD253	175	Edmunds	A	1	1	Low	$0.73
SD19A	25	Turner	B	2	1	Low	$0.07

(shaded) National Highway System Route

Chapter 9 Financial Plan

To achieve the goals and objectives of the department, funding must be adequate, sustainable, and equitable for all users. The foundation of any financial plan is the available funding. Since projected needs exceed projected funding and new funding challenges will likely arise in the future, it is important to continue to explore alternative funding sources.

Two main funding sources—the state highway fund and federal-aid highway funding—sustain transportation assets on the state highway system. The SDDOT has developed a financial plan based on the best estimates of these funds.

State Highway Fund

The state highway fund is supported by the state motor fuel tax, excise tax on vehicle purchases, commercial vehicle registration and permitting fees, and miscellaneous revenues. Motor vehicle excise tax and motor fuel tax make up most of the revenue. These revenue streams were flat prior to a change in state statute in 2015. Senate Bill 1 increased the state gas tax to $0.28/gallon and the motor vehicle excise tax to 4%. These changes will help offset projected gaps in funding needs. SDDOT receives roughly $300M in state highway fund revenues annually.

Depending on the type of project and a few other factors, federal funds generally requires about 20% state matching funds. State highway funds are first used to provide this match, roughly $55M annually. Most of the remaining state funds are used for equipment, buildings, grants, employee salaries, and routine maintenance activities like snow removal and mowing. Funding levels for maintenance, equipment, and buildings are consistent with the department's needs and ability to perform the work.

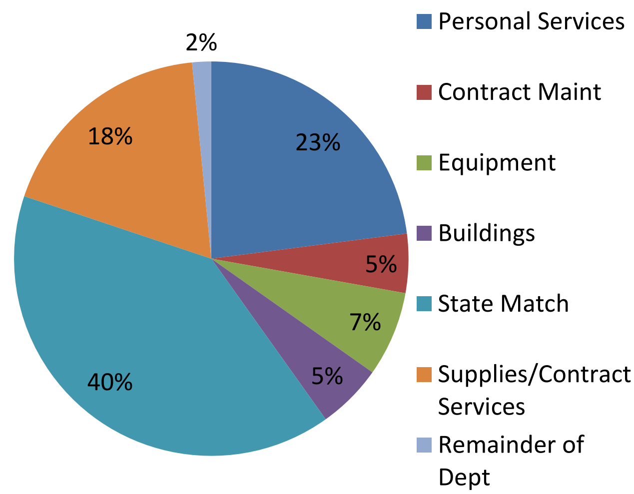


Figure 9.1: Annual Distribution of State Highway Fund Expenditures

Federal Funding

Federal funding received by the SDDOT has remained relatively flat over the last 10 years. A one-time spike in federal funding occurred with the 2009 American Recovery and Reinvestment Act. The figures in this chapter do not reflect these one-time funds. The FAST Act enacted in 2015 increases funding approximately 2% per year. Annually, SDDOT receives roughly $300M in federal aid for transportation improvements. Table 9.1 shows the current and anticipated revenues.

The SDDOT efficiently obligates the federal funds received. Because of this, the SDDOT regularly receives additional federal funding through a process that shifts funding from states that are unable to fully obligate to those that can. Over the last ten years, SDDOT has received close to $175M of federal funding from August Redistribution. These funds are not reflected in the projections shown in Table 9.1 because they are not part of the normal funding allocation.

The SDDOT receives funding from the FHWA apportioned into three main programs: the National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STBG), and the Highway Safety Improvement Program (HSIP). Several other sub-allocations are made from these three programs such as the Transportation Alternatives Program (TAP) and State Planning and Research (SPR). Each of the programs and sub-allocations has restrictions on what activities may be funded and what routes are eligible. These federal- aid requirements are identified in Section 23 of the CFR.

Federal funds for highways and structures must be used for design, preservation, rehabilitation, safety improvements, new construction, or reconstruction. Asset preservation and rehabilitation activities like chip seals, pavement resurfacing, overlaying or replacing bridge decks, and other structure repairs are eligible for federal funding if they are located on an eligible route. Federal funds may not be used for non-transportation purposes and cannot be used for certain types of maintenance operations like mowing and snow removal. The federal funding program manual “A Guide to Federal-Aid Programs and Projects” provides a description of each program. A link to this document is available in Appendix B.

Table 9.1: Ten-Year Revenue Projections (in $ millions)

Revenue Source	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
State Fuel Tax	176	179	181	184	187	190	193	195	198	201
State Vehicle Excise Tax	120	126	133	139	146	154	161	169	178	187
Non-Operating Revenue *	10	10	10	10	10	11	11	11	11	11
Miscellaneous Revenue **	17	17	18	18	18	18	19	19	19	20
Subtotal of State Revenue	324	333	342	352	362	372	383	395	407	419
NHPP	184	188	188	188	188	188	188	188	188	188
STBG	102	104	104	104	104	104	104	104	104	104
HSIP and RR Crossings	19	19	19	19	19	19	19	19	19	19
Subtotal of Federal Revenue Sources	305	312	312	312	312	312	312	312	312	312
Total Revenue	**629**	**645**	**654**	**664**	**674**	**684**	**695**	**707**	**719**	**731**

* NON-OPERATING REVENUE: Transfer from Ethanol Fuel Fund, Repeat Offender, Section 164 funds, and equipment sales
** MISCELLANEOUS REVENUES: Includes – Special Highway permits, prorate fees, investment council interest, sales and service, project reimbursement, damage recovery collections, logo sign fees, and other miscellaneous fees

Financial Risk

Due to inflation in the construction industry, what $1.00 could buy in 1999 for highway construction costs more than $2.19 in 2018. SDDOT monitors material and construction costs to annually calculate a construction cost index (CCI) used to estimate inflation impacts on the financial plan. Figure 9.2 compares total funding and funding after adjustment for CCI.

South Dakota relies heavily on federal funding to support the transportation system. Federal dollars fund approximately 70 percent of the construction budget. If the forecast of federal funding differs from the actual funding received, investment strategies and condition outcomes are affected. Substantial risk is associated with the federal funding forecast because of the uncertainty of federal highway trust fund revenues and the use of short-term continuing resolutions instead of long-term appropriations by Congress.

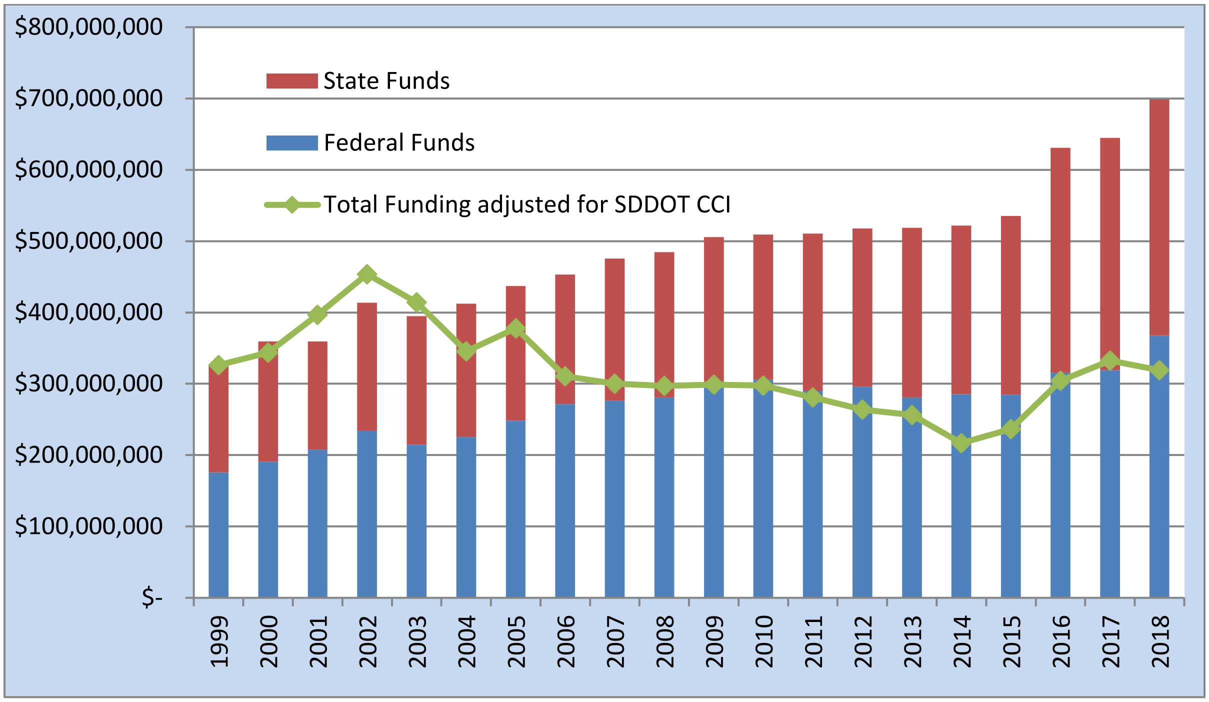


Figure 9.2: Historical Total Transportation Funding and Total Funding Adjusted for SDDOT Construction Cost Index

An increase in federal funding greater than the forecast in the financial plan would improve projected asset conditions unless construction cost inflation exceeds the increase. If the tax revenue stream to the federal highway trust fund does not change, the fund may decrease by over 40 percent after 2020. The Congressional Budget Office projection for the Highway Account of the Federal Highway Trust Fund is shown in Table 9.2. Outlays cannot exceed a predetermined end of year balance to cover prior obligations after 2020 due to the management strategy for the fund. Asset management investment strategies would have to be adjusted to accommodate the shortfall, which could have a severe impact on asset conditions and the performance of the state highway system.

PROJECTIONS OF HIGHWAY TRUST FUND ACCOUNTS – CONGRESSIONAL BUDGET OFFICE JUNE 2018 BASELINE (Billions of Dollars by Fiscal Year)														
	ACTUAL			PROJECTED										
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Start of Year Balance	9	51	41	33	24	14	2	a	a	a	a	a	a	a
Revenues and Interest	35	36	38	38	38	37	37	37	37	37	36	36	37	37
Intergovernmental Transfers	52	0	0	0	0	0	0	0	0	0	0	0	0	0
Outlays	44	44	45	46	47	48	48	49	50	51	52	53	54	55
End of Year Balance	51	42	33	24	14	2	a	a	a	a	a	a	a	a
Cumulative Shortfall	na	na	na	na	na	na	-10	-23	-38	-53	-70	-87	-105	-124

a - Under current law, the Highway Trust Fund cannot incur negative balances

Table 9.2: Projections of Highway Trust Fund Accounts by CBO

Other Potential Sources of Funding

While other state DOTs use tolling and other user fee options to generate revenue, SDDOT does not. Due to South Dakota's low traffic levels and small population, toll roads are not an economically viable option. The Transportation Infrastructure Finance and Innovation Act (TIFIA) and public-private partnerships are not used for similar reasons. Other transportation financing mechanisms, such as bonding, are not allowed due to state constitutional restrictions on the use of highway funding.

Local Government Allocation

Not all federal and state funding is expended on state-owned assets. The SDDOT sets aside approximately $54.6M per year for use by local governments, including cities, towns, townships, tribes, and counties. This includes $25.3M in the federal exchange program, $8.0M for the Bridge Improvement Grants (BIG), $4.0M of state funds for Community Access, Industrial Park and Agri-Business Grants, $0.5M for the region-wide pavement striping program, and $14.3M in federal funds for non-state-owned roads, structures, safety, highway signing, planning, and bike paths.

Counties and Class I cities have historically received a sub-allocation of Surface Transportation Program (STP) funds which are matched by the state and approved by the Transportation Commission. After the passage of Senate Bill 1 in 2015, the SDDOT created a program to exchange federal funds for state funds and issued annual checks to the cities and counties in place of their STP allocations. BIG funds, Federal Bridge Replacement funds, and Federal Planning funds are all matched by the local governments. The Transportation Alternatives (TA) program provides funds for SDDOT to construct alternative transportation projects such as bike and pedestrian paths for local and Tribal governments. Approximately $2.1M is used by SDDOT to construct projects selected from applications submitted by local and Tribal governments. The local entities pay the required match for the federal funds. The remaining $2.2M is used by SDDOT to construct bike and pedestrian paths where the SDDOT determines a need. SDDOT pays the match for these funds. The Recreational Trails Program (RTP) receives a separate allocation of $1.1M which is transferred to the Department of Game, Fish and Parks, which administers the RTP program.

Construction Budget

SDDOT’s annual construction budget is roughly $425M. Federal funds account for 70% or $300 M of this budget. The $55M state match for federal funds and $75M for state-funded projects come from the state highway fund. Most of the construction budget is used for pavement and structure construction, reconstruction, and rehabilitation. The initial level of investment for these functions is determined primarily by the analysis performed in the Trade-Off Tool as described in Chapter 4. The remainder of the construction budget is used for ADA (American Disabilities Act) projects, county and local pavement and structure projects, railroad crossings, right of way acquisition, pavement preservation, recreational trails, roadway safety improvements, the Transportation Alternatives Program, economic development grants, maintenance activities such as patching and sealing cracks, and improvements to other transportation assets such as luminaires and small culverts.

As described in Chapter 4, the Trade-Off Tool is used to determine the initial funding levels of each asset category. Through the STIP development process these individual asset funding levels are modified to accommodate the requirements of each project and several other factors. When the STIP development process is completed, the four-year construction STIP becomes the department’s short-term investment plan and the developmental STIP (years five through eight) becomes its long-term investment plan. A link to the STIP is provided in Appendix B. Chapter 10 describes how the tradeoff analysis is used during STIP development.

For several years, SDDOT has prioritized available funding on maintaining driving surfaces and structures in lieu of reconstruction, grading, and capacity improvements. This decision, along with strong asset management practices and additional federal funds provided through economic stimulus funds, has allowed the state to substantially improve pavement and structure conditions.

Chapter 10 Investment Strategies

Maintaining the performance and condition of assets requires a long-term financial plan that supports and is linked to long-term asset management strategies. Determining the amount of investment required and funds available each year for the rehabilitation, preservation, and maintenance of assets during their useful life is the basis for all investment strategies.

The pavement and structure asset management processes described in Chapter 4 develop multiple strategies that will most efficiently sustain the condition of the asset within a specified budget. The investment strategies in this chapter support progress in achieving the national goals in 23 USC 150(b) National Goals and Performance Management Measures. Those strategies are depicted in Table 10.1. All the goals are addressed by the strategies outlined below.

Table 10.1: National Performance Goals and TAMP Strategies

National Performance Goal	Strategies to Achieve Goal
(1) Safety. To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.	The Transportation Asset Management Plan (TAMP) strategies support the goals and objectives of the Highway Safety Improvement Program (HSIP) and the South Dakota Strategic Highway Safety Plan (SHSP). Implementing these plans will reduce traffic fatalities and serious injuries.
(2) Infrastructure condition. To maintain the highway infrastructure asset system in a state of good repair.	The strategies in the TAMP are integrated with the STIP and constrained by available funding to maintain highway assets as funding permits. Good repair will be promoted by implementing the TAMP through the STIP.
(3) Congestion reduction. To achieve a significant reduction in congestion on the National Highway System.	There is little congestion on the NHS to be reduced so the focus of the TAMP strategies is to keep congestion from growing on our roads and streets. Linking the TAMP with the Transportation Systems Management & Operations Program Plan (TSM&O) will also aid achieving this goal.
(4) System reliability. To improve the efficiency of the surface transportation system.	Winter weather events and traffic incidents are the main contributors to system unreliability on our transportation system. The TSM&O Plan supports the TAMP strategies which will improve system reliability.
(5) Freight movement and economic vitality. To improve the National Highway Freight Network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.	The TAMP strategies support the State Freight Plan and the Growth and Demand element of the TAMP addresses strengthening rural communities, national and international trade, and economic development. Implementing these plans will improve freight movement and economic vitality.
(6) Environmental sustainability. To enhance the performance of the transportation system while protecting and enhancing the natural environment.	TAMP strategies are designed to support existing environmental, project development, and STIP processes that protect the natural environment. Implementing the TAMP and these other processes will help sustain the environment.
(7) Reduced project delivery delays. To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.	The SDDOT is always one of the first states to obligate its federal funding and quickly deliver federally funded projects. The SDDOT has adjusted our processes to accelerate projects affected by federal requirements and other elements as much as possible. Reductions in regulatory burdens and work practices through the Administration's Infrastructure Streamlining MOU may improve timely decision making and review at the federal level, further reducing project delays.

To determine the best investment strategy, multiple funding levels within the anticipated available funding are evaluated for each funding category for pavements and statewide for structures. The Trade-Off tool is then used to compare the investment strategies and determine a starting funding level for each asset category to proceed through the remaining STIP development process. Figure 10.1 through Figure 10.12 show the projected condition levels at each funding level for each pavement funding category, federal pavement performance measure categories, statewide structures, and federal structure performance measure categories.

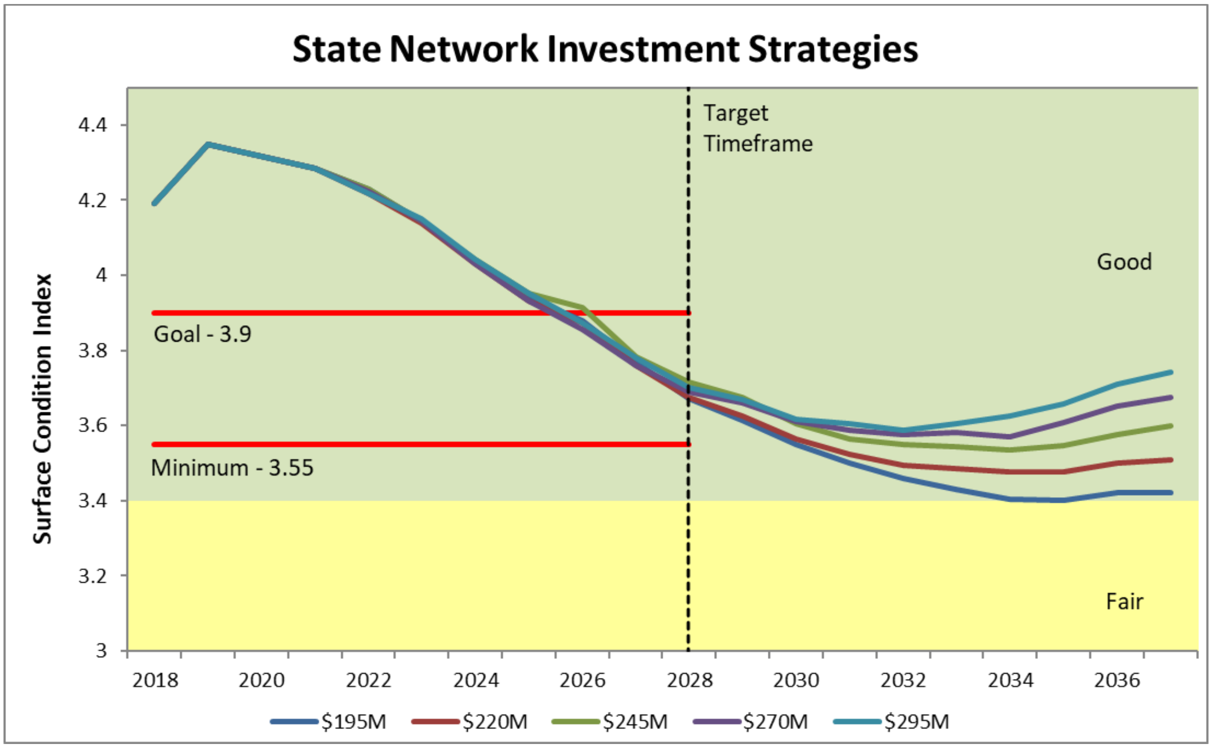


Figure 10.1: SCI Projections for All State Highways vs. Funding Level

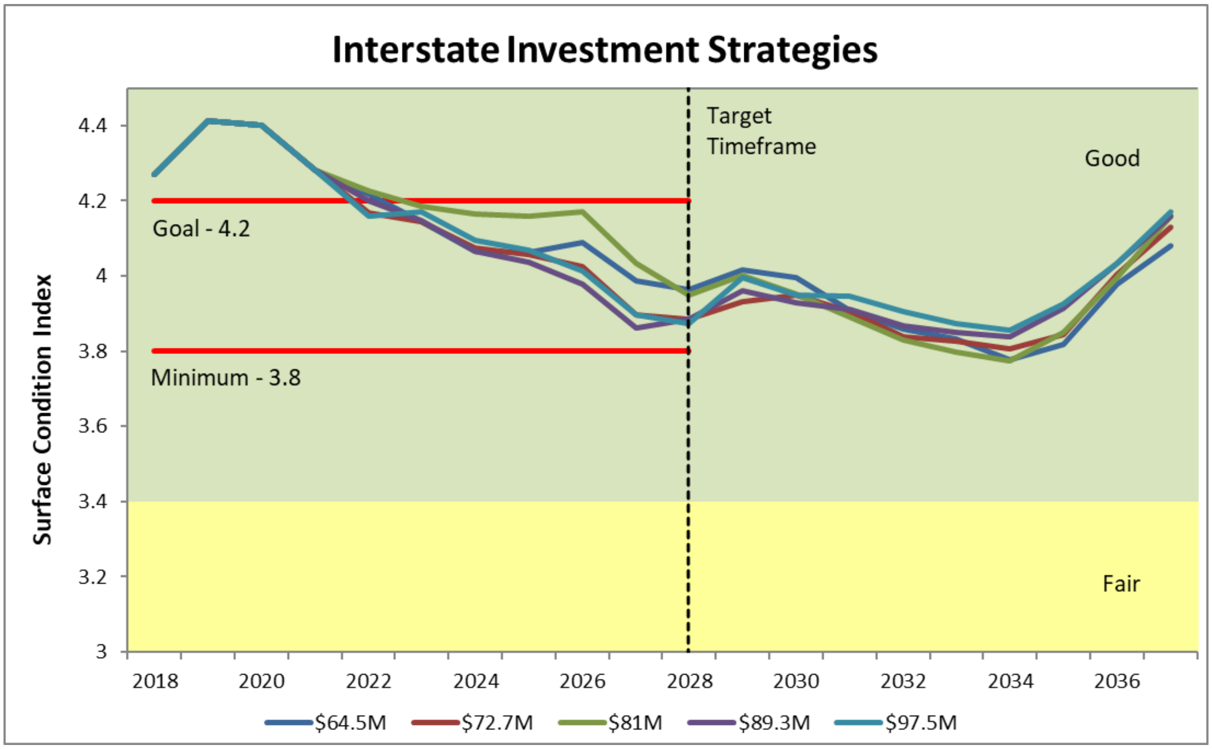


Figure 10.2: SCI Projections for Interstate Highways vs. Funding Level

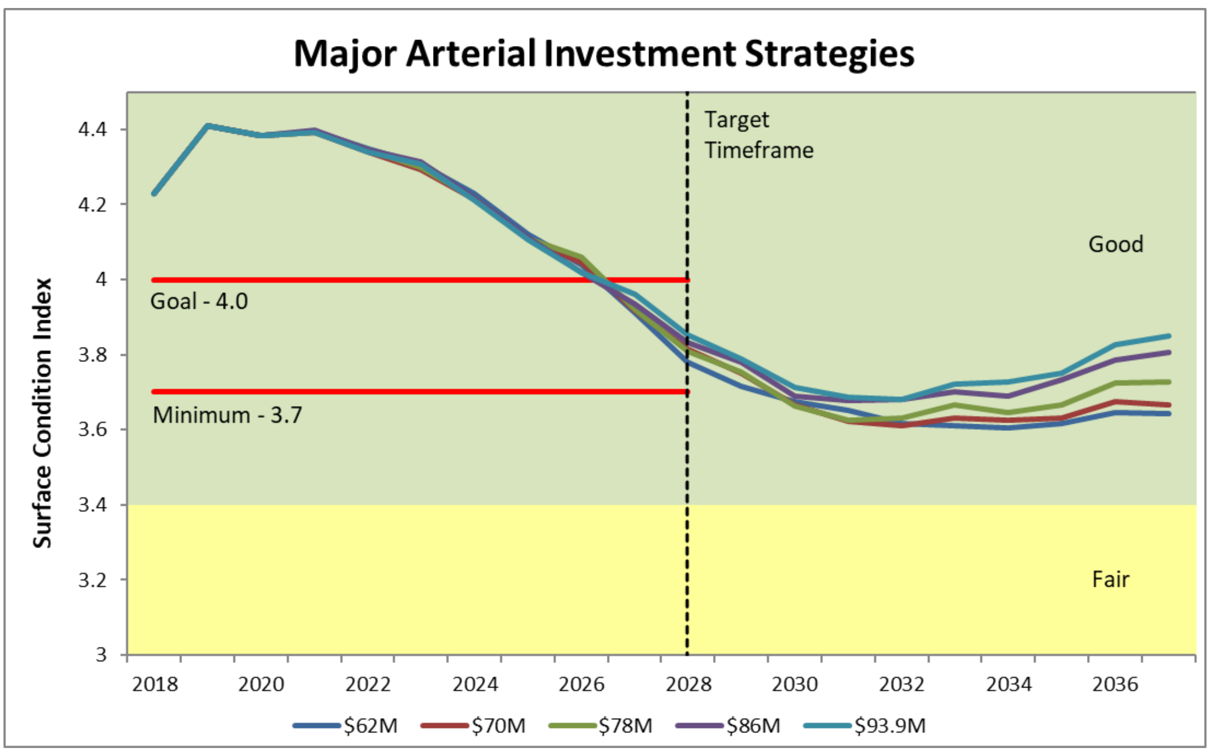


Figure 10.3: SCI Projections for Major Arterial Highways vs. Funding Level

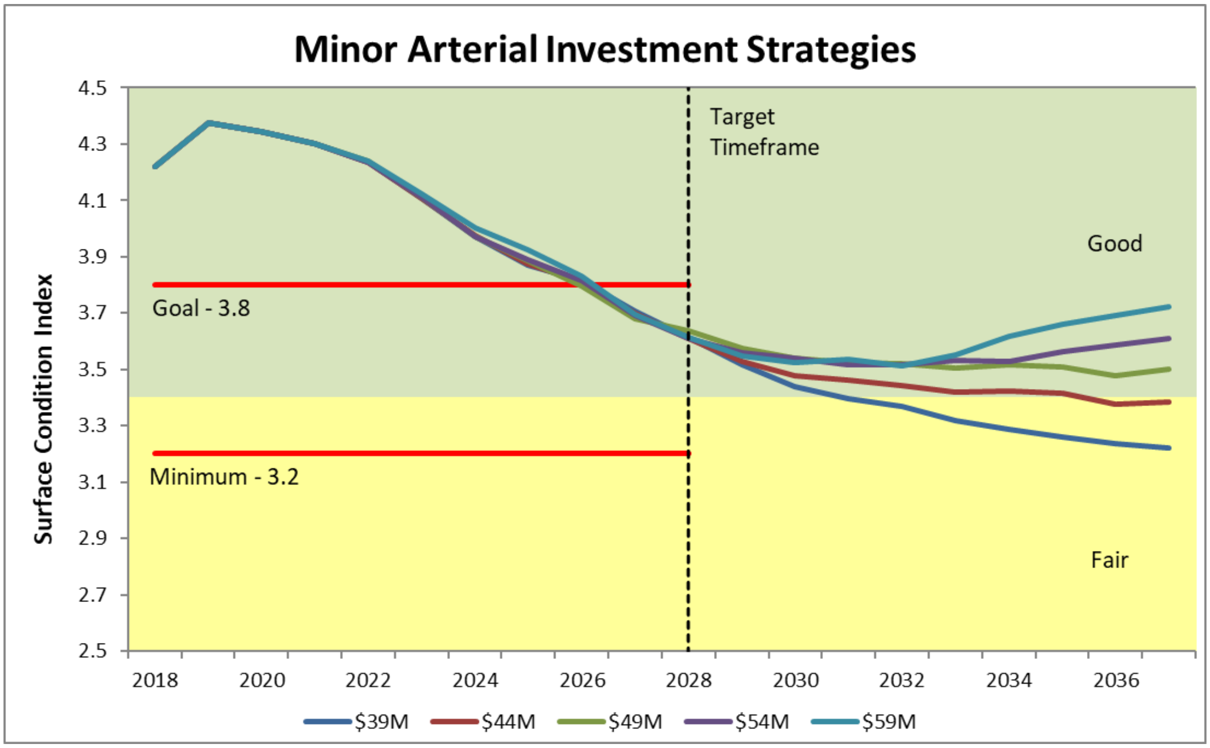


Figure 10.4: SCI Projections for Minor Arterial Highways vs. Funding Level

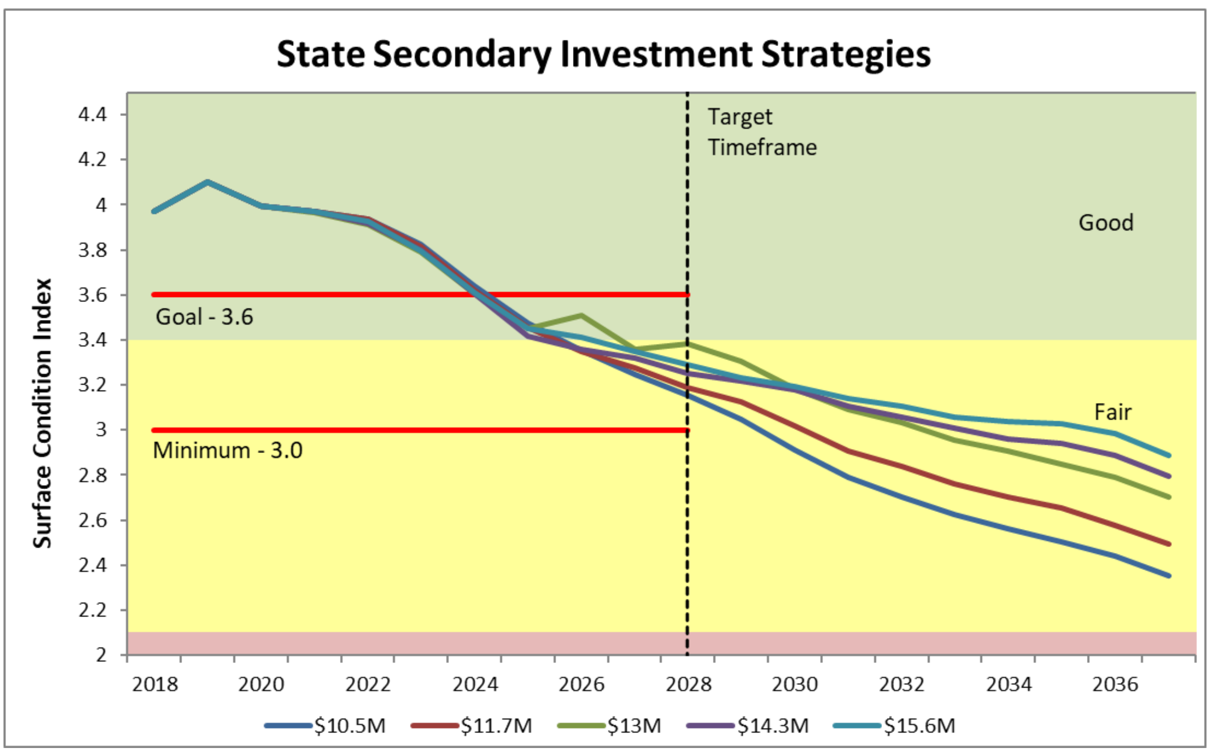


Figure 10.5: SCI Projections State Secondary Highways vs. Funding Level

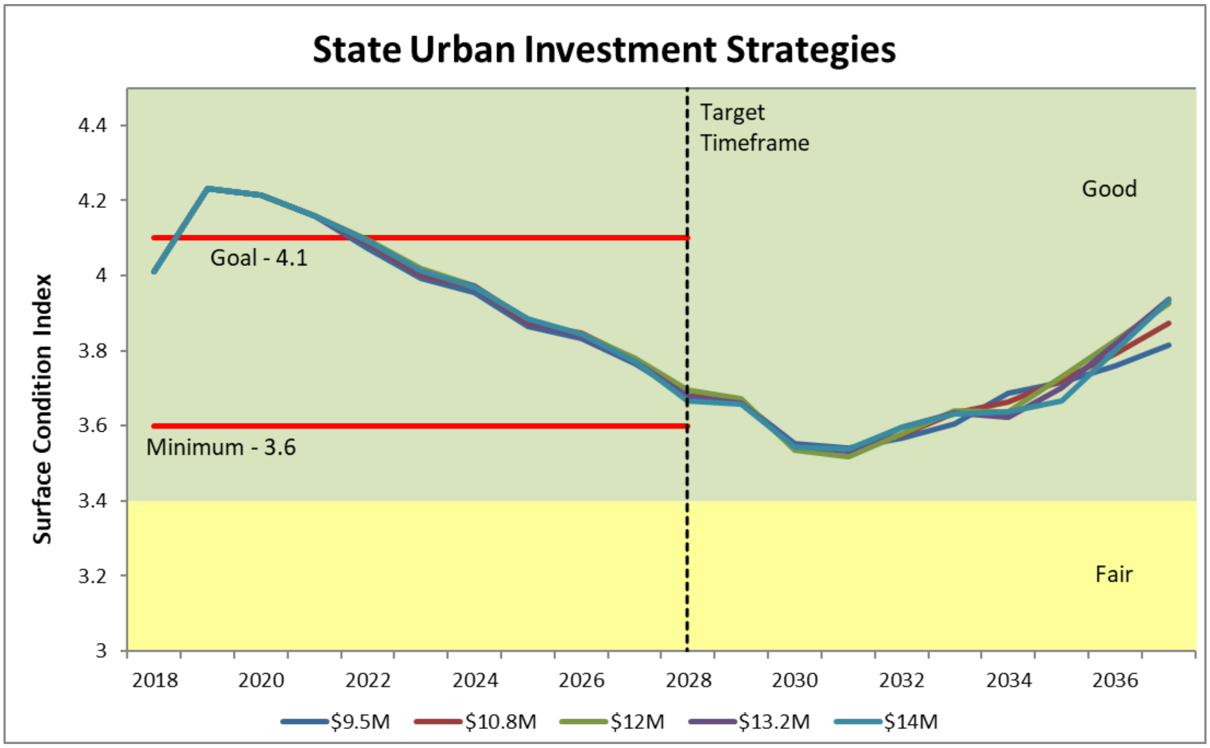


Figure 10.6: SCI Projections for Urban Highways vs. Funding Level

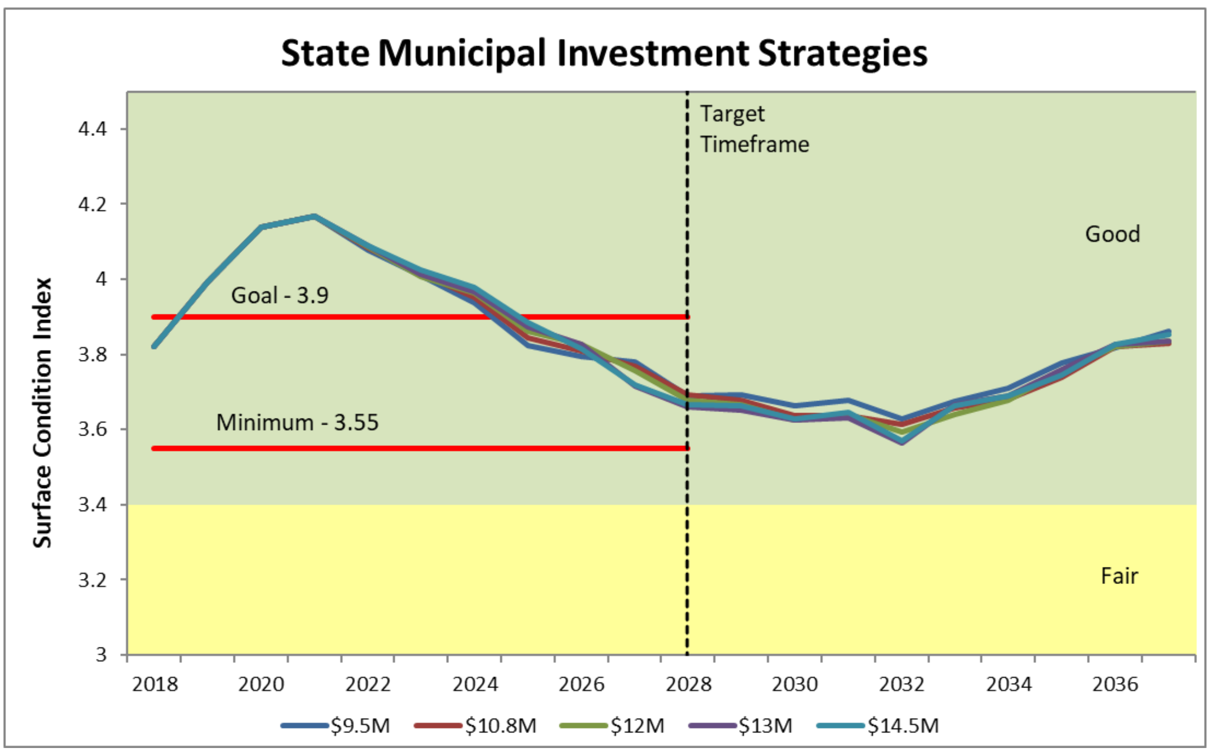


Figure 10.7: SCI Projections for Municipal Highways vs. Funding Level

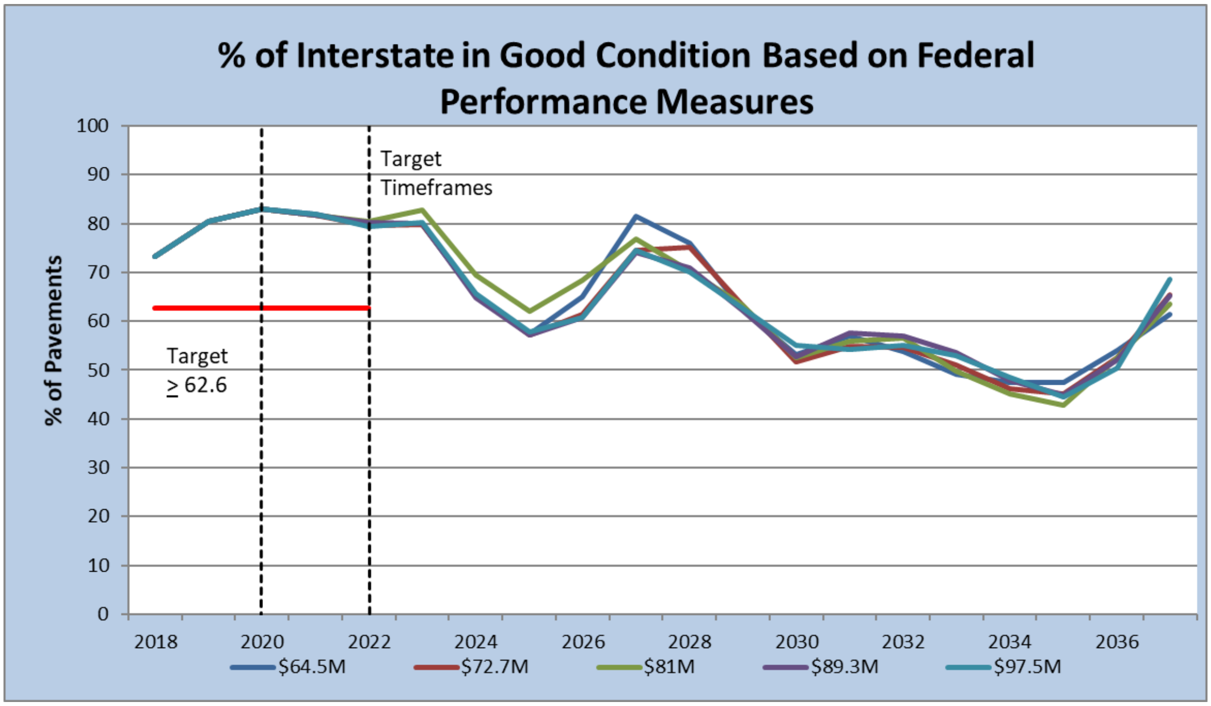


Figure 10.8: Federal Performance Measure - % Good Projections for Interstate Highways vs. Funding Level

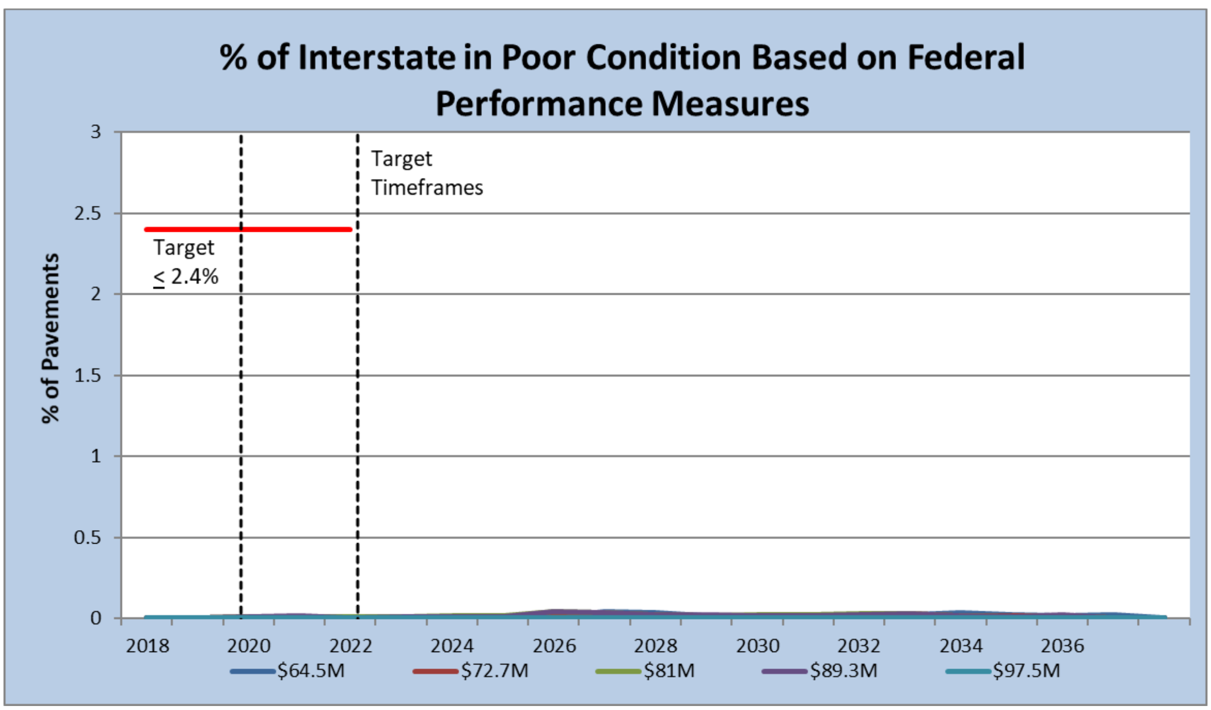


Figure 10.9: Federal Performance Measure - % Poor Projections for Interstate Highways vs. Funding Level

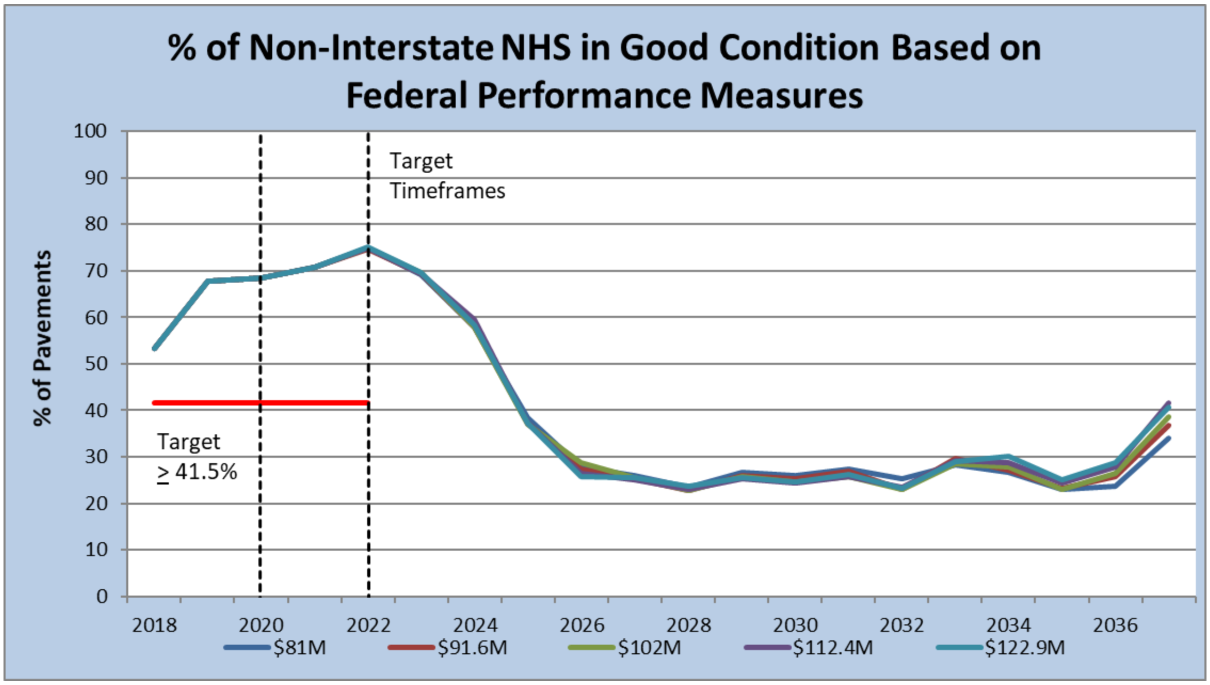


Figure 10.10: Federal Performance Measure - % Good Projections for Non-Interstate NHS vs. Funding Level

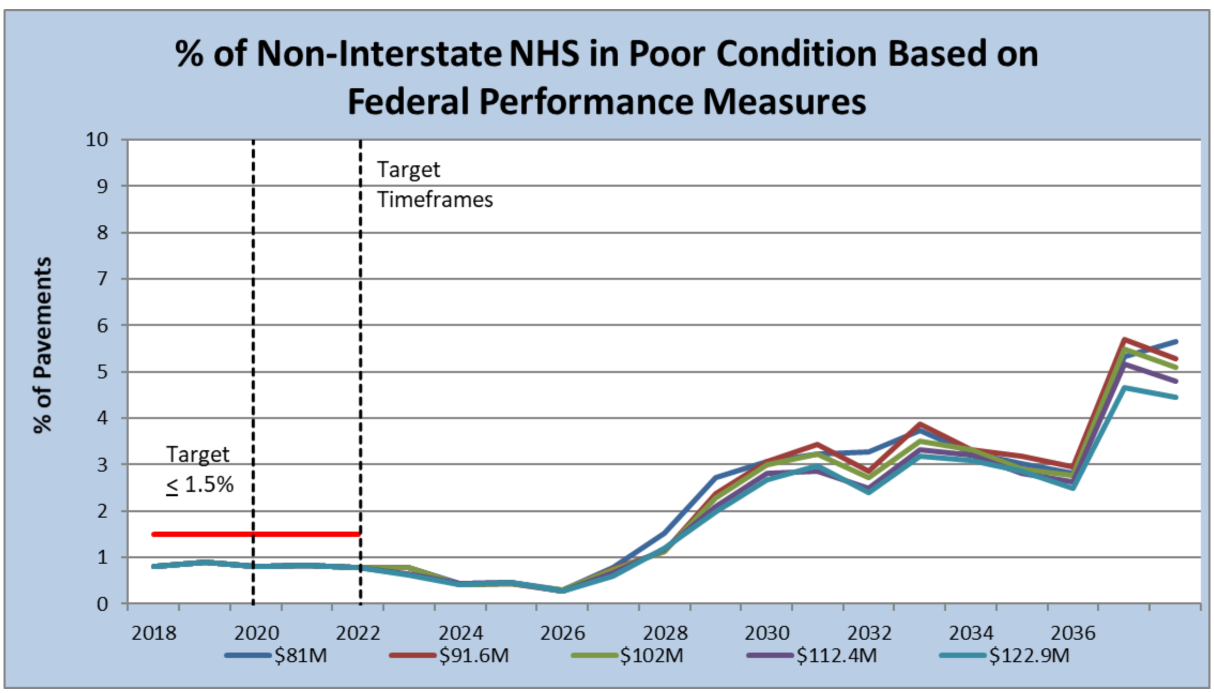


Figure 10.11: Federal Performance Measure - % Poor Projections for Non-Interstate NHS vs. Funding Level

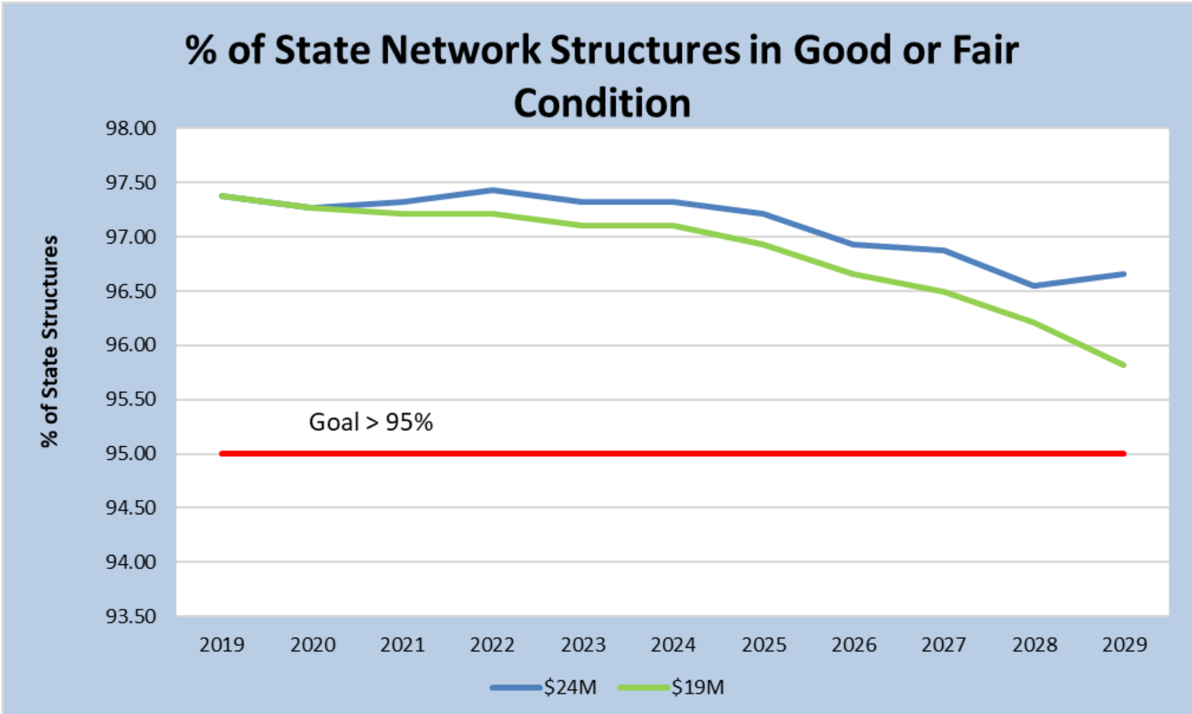


Figure 10.12: Projections for Structures in Good or Fair Condition vs. Funding Level

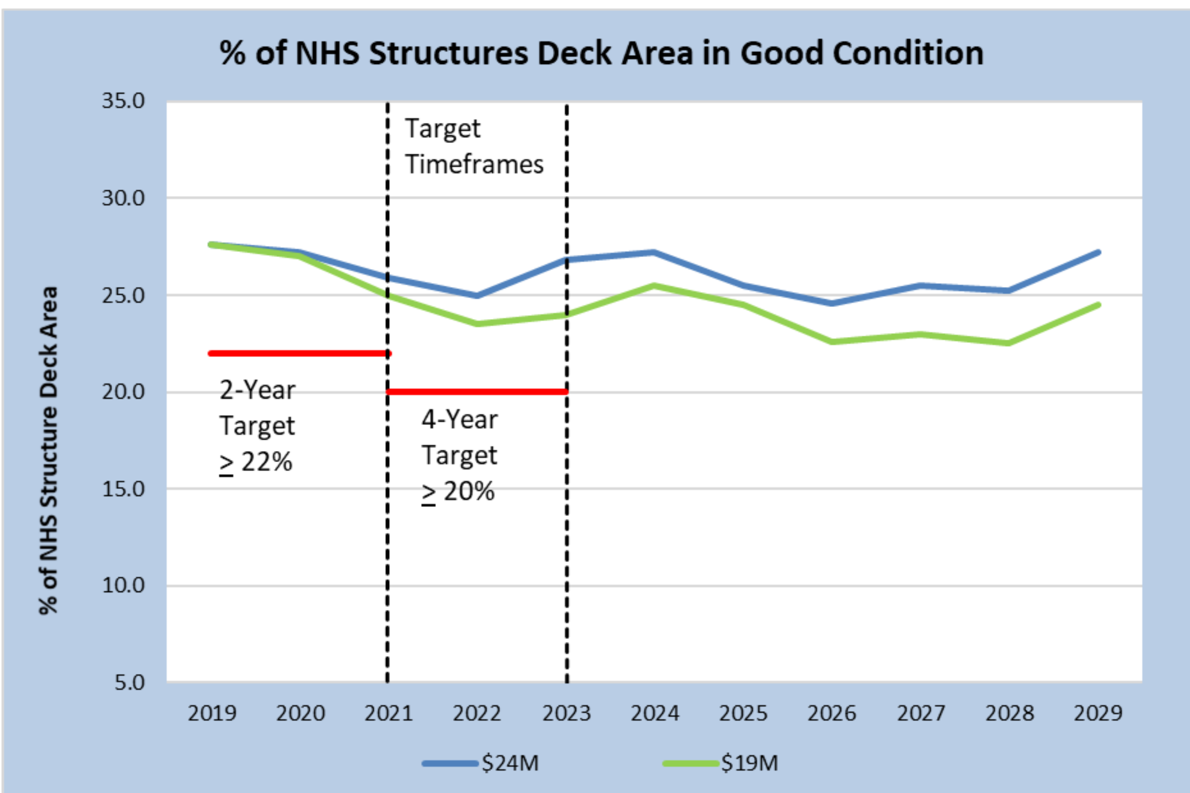


Figure 10.13: Projections for % of Structure Deck Area in Good Condition vs. Funding

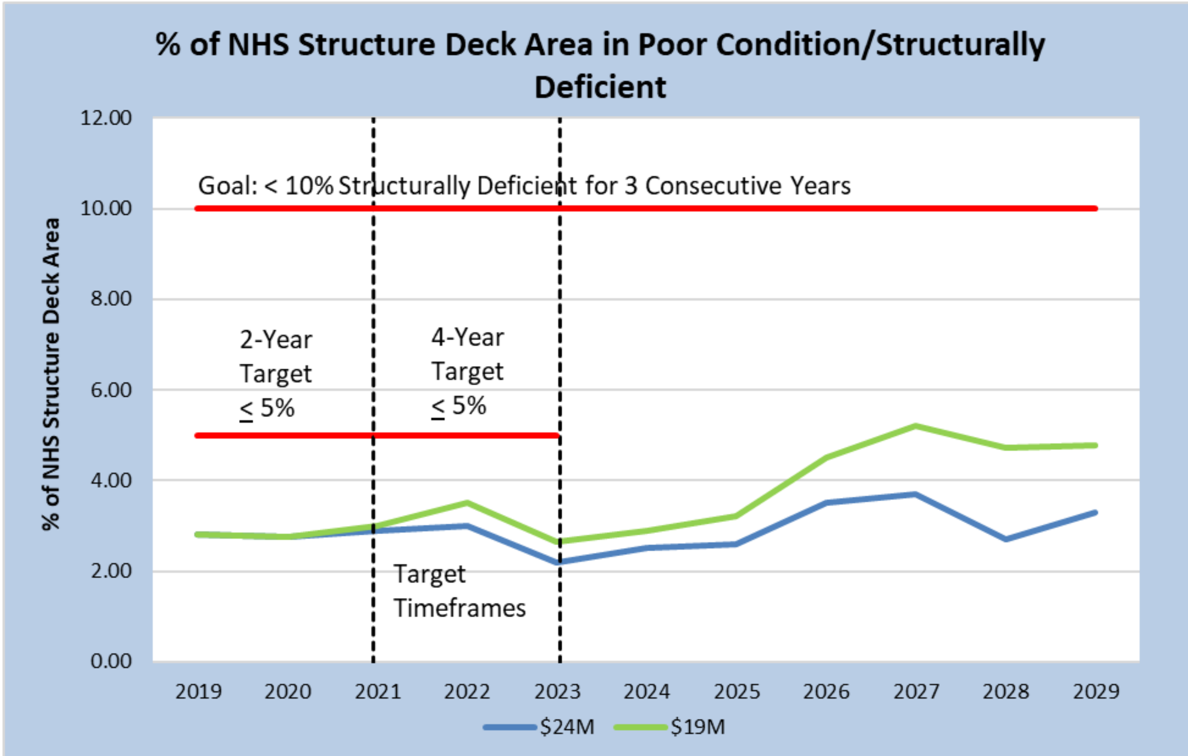


Figure 10.14: Projections for % of Structure Deck Area in Good Condition vs. Funding

Tradeoffs and STIP Development

The information shown in Figure 10.1 through Figure 10.12 is evaluated in the Trade-Off Tool to identify the starting investment levels for pavements and structures. The starting investment level relates to the cost of pavement and structure improvements, but as the scope of each project is developed, additional necessary work and the associated costs are added to the strategy. As the chosen strategy progresses through the remaining STIP development process, scheduling of each project is adjusted to accommodate project phasing with other state and local projects, manage workload across the regions, respond to public and Transportation Commission input, and address other impacts discovered through the process. The projects in the chosen strategy are also prioritized based on potential reductions in congestion, safety improvements, and economic benefits to the community. This prioritization can affect final project placement in the STIP. When the STIP development processes are completed, the STIP becomes the final investment strategy. Table 10.2 shows the starting and final investment strategy for each funding category.

Table 10.2: Starting and Final Investment Strategy

	Funding Category	Starting Investment Strategy (Millions of $ / Year)	Final Investment Strategy (Millions of $)									
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	Bridges 56.6% NHS*	18	30.8	38.4	28.2	18.0	19.4	21.6	31.7	78.9	33.4	33.4
Pavements	Interstate 100% NHS*	81	83.7	103.1	67.2	105.7	121.7	120.7	135.7	134.1	109.0	109.0
Pavements	Major Arterial 99.6% NHS*	78	132.2	75.7	120.5	60.0	104.8	80.2	103.0	69.4	93.2	93.2
Pavements	Minor Arterial 0.3% NHS*	49	51.7	68.2	72.2	97.9	75.2	70.2	106.1	94.6	79.5	79.5
Pavements	State Secondary 0.0% NHS*	12	29.4	9.7	25.9	26.4	12.9	25.6	22.1	23.9	22.0	22.0
Pavements	State Urban 77.2% NHS*	12	41.0	58.1	10.0	20.7	23.0	17.3	8.8	42.9	27.7	27.7
Pavements	State Municipal 49.4% NHS*	12	12.0	11.3	43.3	1.5	17.7	15.1	1.5	8.8	13.9	13.9
	Total	262	380.9	364.6	367.5	330.2	374.8	350.6	408.9	452.5	378.7	378.7

*Percentage of the funding category that is on the NHS

The final investment strategy is further evaluated to identify the level of investment for each work type.

Construction and Reconstruction

Highway construction is the complete rebuilding of a highway, structure, or street on an existing or new location. Highway reconstruction is widening of an existing facility or the removal and application of new surface. It can also include complete concrete surface replacement. Structure replacement is the removal and reconstruction of a structure or replacement with a culvert.

Resurfacing and Asphalt Surface Treatment

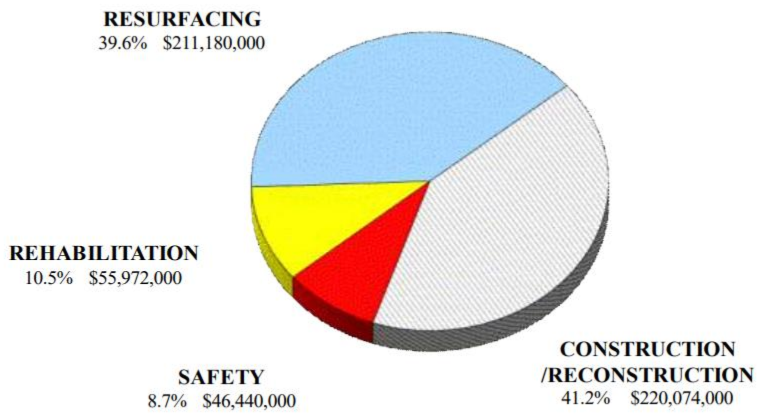
Highway resurfacing is the addition of a pavement layer or layers over the existing roadway surface to provide additional structural capacity and improved service. For this purpose, resurfacing is considered an additional pavement layer of 3/4 inch or greater and of sufficient length to be distinguished from normal maintenance (patching). Asphalt surface treatments are maintenance seals that extend the life of the pavement or seal cracks.

Rehabilitation

Rehabilitation—such as replacement of malfunctioning joints, repair of spalled joints, pavement undersealing, concrete panel replacement, reworking or strengthening of bases or subbases to improve their structural integrity, adding underdrains, erosion control, or the restoration or rehabilitation of bridge decks and rest areas—is intended to prolong the life of an asset. It can also include structure painting, fence replacement, culvert, and pipe repair.

Safety

Safety projects are designed to improve safety at hazardous locations throughout the highway system. It can also include signs, traffic signals, pavement markings, guard rail installation, turning lanes, railroad crossing improvements, and other projects such as walking paths and bike trails that enhance safe travel.



TOTAL = $533,666,000

Figure 10.15: 2019 Estimated Expenditures by Work Type

The final investment strategy must support several aspects of efficiently providing a safe and effective public transportation system. The asset management and STIP development processes ensure the best investments are chosen to maintain asset condition, reduce congestion, improve safety, and support the state's economy and the other national performance goals in 23 USC 150(b) National Goals and Performance Management Measures.

Pavement and Structure Value

The societal value of a safe and efficient transportation system far exceeds a simple replacement cost. An effective transportation system not only allows for ease of access but also provides for the economical shipment of goods and commodities. However, the system replacement value is defined as the cost to replace all the state highway and bridge infrastructure in its current condition. The cost to replace the 8,847 roadway miles of state highway system is estimated to be nearly $15.0B. Considering the current condition of the system, the present worth is $10.2B. The replacement value of the approximately 1,800 structures on the state highway system is estimated to exceed $2.0B. Considering the current condition of these structures, the present worth is approximately $1.8B.

Federal law requires an additional analysis to identify the funding level necessary to maintain the current value of pavement and structure assets on the NHS. To satisfy these requirements, an analysis like that used to develop Figure 10.1 through Figure 10.12 was performed for NHS pavements and structures. Over the next 10 years, an average annual investment of $209.7M—$38.7M more than the current $171M annual investment—is necessary to maintain the current value of the NHS pavements. $29.4M—$11.4M more than the current $18M annual investment—is necessary to maintain the current value of the NHS structures.

Appendix A Table of Acronyms

AASHTO	-	The American Association of State Highway and Transportation Officials
AC	-	Asphalt Concrete
ADA	-	Americans with Disabilities Act
ADT	-	Average Daily Traffic
B/C	-	Benefit/Cost Ratio
BCA	-	Benefit-Cost Analysis
BIG	-	Bridge Improvement Grant
BrM	-	AASHTOware™ Bridge Management Software
CATT	-	Center for Advanced Transportation Technology
CCI	-	Construction Cost Index
CFR	-	Code of Federal Regulations
CRCP	-	Continuously Reinforced Concrete Pavement
DOT	-	Department of Transportation
dTIMS	-	Deighton Total Infrastructure Management System
FAST Act	-	Fixing America's Surface Transportation Act
FHWA	-	Federal Highway Administration
FTA	-	Federal Transit Administration
GIS	-	Geographic Information System
GSP	-	Gross State Product
HSIP	-	Highway Safety Improvement Program
IBC	-	Incremental Benefit Cost Analysis
IRI	-	International Roughness Index
ITS	-	Intelligent Transportation Systems
JCP	-	Jointed Portland Cement Concrete Pavement
LCCA	-	Life Cycle Cost Analysis
LCP	-	Life Cycle Planning
MAP-21	-	Moving Ahead for Progress in the 21st Century
MOU	-	Memorandum of Understanding
MPO	-	Metropolitan Planning Organization
MRM	-	Mileage Reference Marker
NBI	-	National Bridge Inventory
NBIS	-	National Bridge Inspection Standards
NHPP	-	National Highway Performance Program
NHS	-	National Highway System
PCC	-	Portland Cement Concrete
PONTIS	-	A prior version of AASHTOware™ Bridge Management Software
QC/QA	-	Quality Control and Quality Assurance
RES	-	Roadway Environment System
RIS	-	Roadway Inventory System
RITIS	-	Regional Integrated Transportation Information System
SCI	-	Surface Condition Index

SDDOT - South Dakota Department of Transportation
SHSP - Strategic Highway Safety Plan
SLRTP - Statewide Long Range Transportation Plan
SPR - State Planning and Research
STBG - Surface Transportation Block Grant Program
STIP - Statewide Transportation Improvement Plan
STP - Surface Transportation Program
TAMP - Transportation Asset Management Plan
TAP - Transportation Alternatives Program
TIFIA - Transportation Infrastructure Finance and Innovation Act
TIP - Transportation Improvement Plan
TRIP - TRIP is a national transportation research group
TSM&O - Transportation Systems Management and Operations
USC - The Code of Laws of the United States of America

Appendix B References to Supplemental Information

1) A Guide to Federal-Aid Programs and Projects: https://www.fhwa.dot.gov/federalaid/projects.cfm

2) National Bridge Inspection Standards (NBIS): https://www.ecfr.gov/cgi-bin/text-idx?SID=885c8117ec7dab6a19b5f97e7add9e71&node=23:1.0.1.7.28.3&rgn=div6

3) SDDOT Interactive Highway Needs Book: http://arcgis.sd.gov/Server/DOT/needsbook/

4) SDDOT Pavement Management Visual Distress Survey Manual: http://www.sddot.com/resources/manuals/DistressManual.pdf

5) SDDOT's Enhanced Pavement Management System Synopsis: http://www.sddot.com/transportation/highways/planning/pavemanage/docs/Synopsis2007.pdf

6) SDDOT Reports: http://www.sddot.com/resources/reports/Default.aspx

7) SDDOT Transportation Studies: http://www.sddot.com/transportation/highways/planning/specialstudies/default.aspx

8) South Dakota Decennial Interstate Corridor Study - Phase 1: http://www.sddot.com/transportation/highways/planning/specialstudies/docs/09- 104Phase1reportFINAL.pdf

9) South Dakota Decennial Interstate Corridor Study - Phase 2: http://www.sddot.com/transportation/highways/planning/specialstudies/docs/09_104Phase2finalreport.pdf

10) South Dakota Department of Transportation Strategic Plan: http://www.sddot.com/resources/reports/2017StrategicGoalResultSummary.pdf

11) South Dakota State Rail Plan: http://www.sddot.com/transportation/railroads/railplan/default.aspx

12) South Dakota Strategic Highway Safety Plan: http://www.sddot.com/transportation/highways/traffic/safety/docs/FinalSHSP.pdf

13) State Freight Plan: http://www.sddot.com/transportation/highways/planning/freightplan/freightplan.aspx

14) Statewide Long-Range Transportation Plan (SLRTP): http://www.sddot.com/resources/Reports/FinalSDLRTP.pdf

15) Statewide Transportation Improvement Plan (STIP): http://www.sddot.com/transportation/highways/planning/stip/Default.aspx

16) 2017 Report on South Dakota Bridges: http://www.sddot.com/transportation/bridges/docs/FinalSDDOTFactBookBridgeReport.pdf

Appendix C Pavement Treatment Unit Costs

Table C.1: Summary of Rural Treatment Costs for dTIMS CT Estimates

Treatment	**Surface Cost**	**Traffic Control**	**Slope Flattening**	**ROW**	**Utilities**	**Bridge**	**Box Culvert**	**Mobilization**	**P.E.**	**C.E.**
	per 2-lane mile					*per structure*		*per project*		
Asphalt										
Reconstruction	see Reconstruction Cost Matrix Table C4	$10,000	NA	$16,000**	$33,900**	$125,000 +$170 * Area (new) +$7.00 * Area (old)	$350,000	7.0%	5.5% (2.5% for Interstate)	8.0%
Asphalt Overlay	$143,634	$4,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Mill and AC overlay on FD, THK, or AONC	$212,598	$5,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Mill and AC Overlay on TONS or TONW	$189,412	$5,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Mill and Class ‘S’ Overlay	$127,154	$5,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Mill and PCCP Overlay (FD, THK or TONS)	$1,232,092	$12,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation on FD	$628,345	$6,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation on THK	$478,587	$6,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation on TONS	$374,052	$6,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation on TONW	$374,052	$6,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Cold in Place Recycle on THK	$385,634	$5,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Cold in Place Recycle on TONS	$330,887	$5,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Rout and Seal	$4,702	$250	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Chip Seal	$23,159	$450	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Microsurfacing	$59,120	$1,500	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Shoulder Widening	$235,806***	$10,000	NA	$16,000**	$33,900**	$120,000 +$110* Area(new) +$9.00* Area (old)	125,000	7.0%	5.5%	8.0%

Table C.1: Summary of Rural Treatment Costs for dTIMS CT Estimates

Treatment	Surface Cost	Traffic Control	Slope Flattening	ROW	Utilities	Bridge	Box Culvert	Mobilization	P.E.	C.E.
	per 2-lane mile					*per structure*		*per project*		
*Blotter										
Reconstruction	see Reconstruction Cost Matrix Table C.4	$10,000	NA	$16,000**	$33,900**	$125,000 +$170* Area (new) +$7.00* Area (old)	$350,000	7.0%	5.5%	8.0%
Asphalt Overlay	$243,232	$4,750	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Blotter Reapplication	$33,166	$1,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation & New Blotter Surface	$71,334	$1,750	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Full Depth Reclamation & Gravel Surfacing	$19,890	$1,750	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Gravel										
Reconstruction	see Reconstruction Cost Matrix Table C.4	$10,000	NA	$16,000**	$33,900**	$125,000+$ 170*Area (new)+$7.00 * Area (old)	$250,000	7.0%	5.5%	8.0%
Gravel Resurfacing	$92,928	$1,275	$16,083	NA	NA	NA	NA	7.0%	2.5%	8.0%
PCCP										
Reconstruction	see Reconstruction Cost Matrix Table C4	$16,000	NA	$16,000**	$33,900**	$125,000 +$170* Area(new) +$7.00* Area (old)	$350,000	7.0%	5.5% (2.5% for Interstate)	8.0%
Remove and Replace PCCP (CRCP)	$1,392,010	$16,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Remove and Replace PCCP (Jointed)	$1,336,912	$16,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Rubblize with AC Overlay (non- Interstate)	$844,195	$16,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Rubblize with AC Overlay (Interstate)	$1,003,915	$16,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Crack and Seat with AC Overlay	$435,538	$7,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
AC Overlay (no crack & seat)	$372,951	$5,750	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Pavement Restoration 1* (Mesh) < 4% Full Depth Repair	$70,000	$3,750	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%

Table C.1: Summary of Rural Treatment Costs for dTIMS CT Estimates

Treatment	Surface Cost	Traffic Control	Slope Flattening	ROW	Utilities	Bridge	Box Culvert	Mobilization	P.E.	C.E.
	per 2-lane mile					*per structure*		*per project*		
Pavement Restoration 1* (Short Jointed) < 4% Full Depth Repair	$83,330	$3,750	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Pavement Restoration 2* (Mesh) > 4% Full Depth Repair	$200,000	$3,750	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Pavement Restoration 2* (Short Jointed) > 4% Full Depth Repair	$365,600	$3,750	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Grinding Only* (Quartzite)	$122.57	$4,250	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Grinding Only* (Granite/ Limestone)	$82,407	$4,250	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Undersealing Only*	$30,282	$4,250	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Unbonded CRC Overlay (CRCP)	$1,171,624	$16,500	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Unbonded PCC Overlay (Jointed)	$1,033,683	$15,250	$16,111	NA	NA	$30,129 (replace guardrail)	NA	7.0%	2.5%	8.0%
Saw and Seal Joints	$29,607	$900	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%

Cost Estimates from SDDOT Transportation Planning Engineer, January 15, 2017

* Treatment may have additional Ancillary Treatments, see Table C.3: Summary of Ancillary Costs for dTIMS CT Estimates

** Not included with Interstate reconstruction

*** Shoulder grade and surface, only

Table C.2: Summary of Urban Treatment Costs for dTIMS CT Estimates

Treatment	Surface Cost	Sidewalk	Traffic Control	Lighting	ADA Curb Ramps	ROW	Utilities	Bridge	Box Culvert	Mobilization	P.E.	C.E.
	sq. ft.	per mile						per structure		per project		
Asphalt												
Reconstruct to Asphalt	$10.62	$273,620	$100,000	$70,000	$100,000	$188,000	N/A	$125,000 +$170* Area(new) +$7.00* Area (old)	$350,000	7.0%	9.5%	8.0%
Asphalt Overlay	$1.34	N/A	$21,500	N/A	N/A	N/A	$220,531	$30,129 (replace guardrail)	N/A	7.0%	2.5%	8.0%
Mill & AC Overlay	$1.40	N/A	$21,500	N/A	N/A	N/A	$220,531	$30,129 (replace guardrail)	N/A	7.0%	2.5%	8.0%
Mill & PCC Overlay	$7.38	N/A	$36,500	N/A	N/A	N/A	$220,531	$30,129 (replace guardrail)	N/A	7.0%	5.5%	8.0%
Rout & Seal	$0.03	N/A	$1,500	N/A	N/A	N/A	N/A	N/A	N/A	7.0%	2.5%	8.0%
Chip Seal	$0.12	N/A	$1,250	N/A	N/A	N/A	N/A	N/A	N/A	7.0%	2.5%	8.0%
PCCP												
Reconstruct to PCCP	$13.02	$273,620	$150,000	$70,000	$100,000	$188,000	N/A	$125,000 +$170* Area(new) +$7.00* Area (old)	$350,000	7.0%	9.5%	8.0%
Remove & Replace PCCP	$7.32	N/A	$32,500	N/A	N/A	N/A	$220,531	$30,129 (replace guardrail))	N/A	7.0%	5.5%	8.0%
AC Overlay (No Crack & Seat)	$1.82	N/A	$21,500	N/A	N/A	N/A	$220,531	$30,129 (replace guardrail)	N/A	7.0%	2.5%	8.0%
Pavement Restoration 2 (Mesh)	$1.00	N/A	$16,500	N/A	N/A	N/A	N/A	N/A	N/A	7.0%	2.5%	8.0%
Pavement Restoration 2 (Other)	$1.33	N/A	$16,500	N/A	N/A	N/A	N/A	N/A	N/A	7.0%	2.5%	8.0%
Saw & Seal Joints	$0.19	N/A	$9,500	N/A	N/A	N/A	N/A	N/A	N/A	7.0%	2.5%	8.0%
Reconstruction includes Surface Removal, Grading, Drainage, and New Surfacing. Cost Estimates from SDDOT Transportation Planning Engineer, January 15, 2017												

Table C.3: Summary of Ancillary Costs for dTIMS CT Estimates

PCCP	Surface Cost	Traffic Control	Slope Flattening	Lighting	ROW	Utilities	Guard Rail	Mobilization	P.E.	C.E.
	per 2-lane mile						*per structure*	*per project*		
Grinding Quartzite	$122,571	$1,500	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Grinding Granite or Lime stone	$82,407	$1,500	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Dowel Bar Retrofit	$93,995	$2,500	NA	NA	NA	NA	NA	7.0%	2.5%	8.0%
Cost Estimates from SDDOT Transportation Planning Engineer, January 15, 2017										

Table C.4: Summary of Reconstruction Surfacing Costs for dTIMS CT

($ millions)

	Interstate	Divided (non-Interstate)		NHS & STP								
Surface Width	**38 ft.**	**36 ft.**		**40 ft.**				**36 ft.**		**32 ft.**	**28 ft.**
ADT				**≥2501**		**2500 -1501**		**1500 - 551**		**550 - 251**	**≤250**
ADTT		**≥200**	**<200**	**≥200**	**<200**	**≥200**	**<200**	**≥200**	**<200**		
ASPHALT											
5.5" AC Surfacing, 14" Base Course 3" AC Shoulders	$1.008										
5" AC Surfacing, 14" Base Course 3" AC Shoulders		$1.213		$1.239							
4" AC Surfacing, 14" Base Course 3" AC Shoulders			$1.165		$1.187						
4" AC Surfacing, 14" Base Course Gravel Shoulders							$1.108		$1.063		
5" AC Surfacing, 14" Base Course Gravel Shoulders						$1.161		$1.137			
3" AC Surfacing, 12" Base Course 1.5" AC Shoulders										$0.884	$0.884
Blotter Surfacing, 12" Base Course											$0.476
PCCP											
11" Doweled PCCP, 6" Gravel Cushion & 3" AC Shoulders	$1.224										
10" CRCP, 6" Gravel Cushion & 3" AC Shoulders	$1.300										
9" Doweled PCCP, 6" Gravel Cushion & 3" AC Shoulders		$1.512	$1.512	$1.650	$1.650						
8" Doweled PCCP, 6"Gravel Cushion & Gravel Shoulders						$1.461	$1.461	$1.431	$1.431		
GRAVEL											
4" Gravel Surface, 6" Base Course										$0.459	$0.442

Interstate costs are based on old PCCP removal and new surfacing. Divided Highway (non-Interstate) costs are based on old PCCP removal, grading and new surfacing.
NHS and STP (non-divided) costs are based on salvage old AC surfacing, grading, and new surfacing. All costs are per 2 lane mile.
Cost Estimates from SDDOT Transportation Planning Engineer, January 15, 2017

Appendix D Structure Treatment Unit Costs

Table D.1: General Structure Costs

Item	Unit Cost	Unit	Item	Unit Cost	Unit
Guardrail			**Mobilization**		
Bridge Guardrail:(PIC Information: Minn6229	$28,740.00	ST	Rehabilitation		
			Deck Replacement (Project):	$105,000.00	PR
Incidental Work (Structure Removal)			Polymer Chip Seal (Project):	$10,958.30	PR
Existing Deck Area (S.F.): overall average	$8.93	SF			
$2000 min for Local Government Structures	$10.30	SF	Overlay (Project):	$49,562.71	PR
$4000 min for State Owned Structures	$14.82	SF	Rail Retrofit (Project):	$21,365.00	PR
			New Structure "Substructure and Superstructure"		
Joint Nosing Material	$100.00	SF	Prestressed Girder Bridge	$498,777.78	ST
Bridge Deck Polymer Chip Seal Placed on Existing Chip Seal	$35.50	SY	Steel Girder Bridge	$500,000.00	ST
Membrane Sealant	$118.00	LF	Continuous Concrete Bridge	$288,166.67	ST
Two Coat Bridge Deck Polymer Chip Seal	$40.26	SY	Reinforced Concrete Box Culvert	$64,675.76	ST
Remove and Replace Transverse Stiffeners	$1,235.83	EA			
Remove and Replace Web	$8,978.36	LS	**Traffic Control (average per structure)**	$22,809.68	ST
Remove & Replace Steel Diaphragm	$1,650.38	EA	Interstate Highway	$15,330.66	ST
Reset Expansion Joint Bearing	$4,000.00	EA	State Primary Highway	$38,332.66	ST
Removal of Special Surface Finish	$2.10	SF			

CY—cubic yard; EA—each; LB—pound; LF—linear foot; LI—linear inch; LS—lump sum; SF—square foot; SI—square inch; ST—structure; SY—square yard; PR--project; TON—ton

Table D.2: State Bridge Costs

Item	Unit Cost	Unit	Item	Unit Cost	Unit
Continuous Concrete			**Specific by Bridge Type**		
Total Bridge Cost	$211.49	SF	Class A45 Concrete, Bridge	$750.33	CY
Total Substructure & Superstructure Bridge Cost	$185.01	SF	Continuous Concrete Bridges	$837.26	CY
Superstructure Cost	$86.48	SF	Prestressed Girder Bridges	$769.45	CY
Substructure Cost	$98.54	SF	Steel Girder Bridges	$861.71	CY
Prestressed Girder			Class A45 Concrete, Bridge Deck	$848.44	CY
Total Bridge Cost	$130.45	SF	Continuous Concrete Bridges	$1,019.21	CY
Total Substructure & Superstructure Bridge Cost	$112.08	SF	Prestressed Girder Bridges	$828.89	CY
Superstructure Cost	$70.71	SF	Steel Girder Bridges	$703.42	CY
Substructure Cost	$49.36	SF	**Structure Excavation**	$117.35	CY
Steel Girder (Cont. Comp.)			Continuous Concrete Bridges	$74.69	CY
Total Bridge Cost	$173.89	SF	Prestressed Girder Bridges	$91.03	CY
Total Substructure & Superstructure Bridge Cost	$158.17	SF	Steel Girder Bridges	$179.09	CY
Superstructure Cost	$108.82	SF	**Steel Piling**		
Substructure Cost	$39.02	SF	HP 10 x 42 Bearing Pile	$10.00	LF
Piling			HP 10 x 42 Test Pile	$10.00	LF
Sheet Pile, furnish and drive	$16.14	LF	HP 10 x 57 Bearing Pile	$54.08	LF
Prebore Piling	$37.30	LF	HP 10 x 57 Test Pile	$67.60	LF
Micropile	$6,292.59	EA	HP 12 x 53 Bearing Pile	$35.15	LF
Micropile Proof Load Test	$14,753.84	EA	HP 12 x 53 Test Pile	$47.90	LF
Micropile Verification Load Test	$42,211.74	EA	HP 12 x 74 Bearing Pile	$67.81	LF
Drilled Shafts			HP 12 x 74 Test Pile	$114.81	LF
Drilled Shaft Excavation (C.Y.):	$661.84	CY	HP 12 x 84 Bearing Pile	$43.00	LF
Class A45 Concrete, Drilled Shaft (C.Y.):	$436.20	CY	HP 12 x 84 Test Pile	$55.00	LF
Permanent Casing 32"	$160.00	LF	HP 14 x 73 Bearing Pile	$42.39	LF
Permanent Casing 38"	$306.00	LF	HP 14 x 73 Test Pile	$72.79	LF
Permanent Casing 44"	$253.41	LF	HP 14 x 89 Bearing Pile	$94.25	LF
Permanent Casing 74"	$500.00	LF	HP 14 x 89 Test Pile	$136.64	LF
Permanent Casing 86"	$1,300.00	LF	**Reinforcing Steel**		
Bridge Painting			Reinforcing Steel	$1.13	LB
Lump Sum	$43,335.00	LS	Epoxy Coated Reinforcing Steel	$1.14	LB
Square Foot	$3.66	SF	Structural Steel, Misc.	$3.57	LB
Prestressed Concrete Beams			Structural Steel	$1.33	LB
Type 36M	$197.00	LF	Structural Steel (Cost/S.F. of Bridge):	$58.61	SF
Type 45M	$233.37	LF	**End Bridge**		
Type 54	$212.29	LF	Granular Bridge End Backfill	$68.36	CY
Type 72	$295.00	LF	Conc. Bridge Approach Slab For Bridge	$218.50	SY
Type 81	$242.00	LF	Conc. Bridge Approach Sleeper Slab	$253.30	SY
Rebar			Approach Slab Underdrain Excavation	$153.77	CY
No. 4	$29.23	EA	4" Underdrain Pipe	$12.57	LF
No. 7	$35.44	EA	Bridge Elevation Survey	$1,222.50	LS
No. 5	$30.86	EA	Compression Seal Joint	$236.00	EA
No. 11	$92.07	EA	Bridge End Embankment	$18.45	CY
No. 14	$117.57	EA	Strip Seal Expansion Joint	$160.00	LF
Deck Drains			Membrane Sealant Expansion Joint	$88.70	EA
Girder Bridge	$398.00	EA	Precast Concrete Headwall for Drain	$317.66	EA
Concrete Slab Bridge	$550.00	EA	Porous Backfill	$94.63	TON
Retaining Walls			**Erosion Control**		
MSE (Large Panel) Retaining Wall	$20.90	SF	Bridge Berm Slope Protection, Crushed Aggregate	$39.49	SY
MSE Segmental Retaining Wall (07-08)	$41.18	SF	Fabric, Type A Drainage (S.Y.)	$3.38	SY
Special Type C Concrete Retaining Wall	$66.87	SF	Fabric, Type B Drainage (S.Y.)	$2.53	SY
Metal Bin Retaining Wall (08)	$12.88	SF	Controlled Density Fill	$466.20	CY
Long Span Str. Plate High Profile Arch (08)	$4,001.60	LF	**Riprap (Ton):**		
MSE Wire Face Wall	$34.70	SF	Class A:	$31.00	TON
Gravity Large Concrete Block Wall	$42.70	SF	Class B:	$36.57	TON
Railing			Class C:	$41.93	TON
Chain Link Fence for Bridge Sidewalk	$25.31	LF	Class D:	$50.00	TON
Steel Pedestrian Railing on Concrete Barrier	$104.25	LF	**Miscellaneous**		
Steel Pedestrian Railing, Sidewalk	$167.32	LF	Special Surface Finish	$3.20	SF

CY—cubic yard; EA—each; LB--pound; LF—linear foot; LI—linear inch; LS—lump sum; SF—square foot; SI—square inch; ST—structure; SY—square yard; PR--project; TON—ton

Table D.3: Bridge Rehabilitation Costs

Item	Unit Cost	Unit	Item	Unit Cost	Unit
General			32" Permanent Casing (2006)	$75.76	LF
Breakout Structural Concrete	$3,104.99	CY	4" Underdrain Pipe	$16.42	LF
< 10 CY	$3,474.32	CY	Abrasive Blast Bridge Deck	$3.89	SY
> 10 CY	$2,525.22	CY	Abutment Joint Drain	$17,026.00	EA
Class A45 Concrete, Bridge Repair	$2,226.19	CY	Approach Slab Underdrain Excavation	$26.31	CY
< 40 CY	$2,226.19	CY	Asphalt Bridge Joint	$157.96	LF
> 40 CY (2016 amount)	$1,783.56	CY	Asphalt Concrete Deck Overlay	$27.87	SY
Epoxy Coated Reinforcing Steel	$2.33	LB	Bearing Stiffener, Install (2007)	$275.00	EA
< 10,000 Lb	$2.33	LB	Bearing, Furnish	$9,842.00	EA
> 10,000 Lb (2016 amount)	$3.12	LB	Bearing, Install	$2,500.00	EA
Rebar Splices (EA):		EA	Bolted Girder Splice	$3,561.56	EA
No. 4	$17.37	EA	Breakout and Replace Grout Pad	$2,500.00	EA
No. 5	$25.13	EA	Bridge Berm Protection, Crushed Aggregate	$45.00	SY
No. 6	$44.08	EA	Bridge Deck Epoxy Chip Seal on existing	$28.55	SY
No. 7	$28.77	EA	Bridge Deck Grinding	$9.07	SY
No. 9	$52.44	EA	Bridge Elevation Survey	$1,353.56	LS
No. 10	$255.00	EA	Bridge End Backfill	$44.05	CY
Reinforcing Steel	$2.44	LB	Bridge End Backfill Excavation	$22.00	CY
Structural Steel, Misc.	$7.67	LB	Bridge End Backfill Underdrain Pipe	$13.76	LF
Structural Steel (2-year average)	$2.83	LB	Bridge End Embankment	$30.22	CY
			Bridge End Support	$2,500.00	LS
Railing Replacement	$192.82	LF	Bridge Joint Sealant	$981.42	EA
Remove Bridge Railing	$13.21	LF	Concrete Removal - Class A	$144.44	SY
Class B Bridge Guardrail, 2T Design	$63.88	LF	Class A45 Concrete Fill	$497.17	CY
Class B Bridge Guardrail, 2T Design Modified	$32.67	LF	Class A45 Concrete, Drilled Shaft	$474.41	CY
			Concrete Removal - Class B	$177.77	SY
			Class M6 Concrete	$2,932.98	CY
			Compression Seal	$63.00	LF
			Compression Seal Joint	$231.02	LF
			Conc. Approach Slab for Bridge	$229.44	SY
			Conc. Approach Sleeper Slab	$296.80	SY
Bridge Rail Modification	$230.48	LF	Concrete Patching Material, Bridge Deck	$55.07	CF
Bridge Rail Replacement	$210.77	LF	Contractor Furnished Borrow	$18.84	CY
			Deck Drains - new (girder)	$330.00	EA
Guardrail	$27,800.66	ST	Deck Drains - new (slab)	$76.64	EA
Approach Pavement Work	$26,062.00	ST	Type B Drainage Fabric	$3.34	SY
			Drilled in Shear Bar	$71.24	EA
Extend Deck Drains	$2,050.00	EA	Drilled Shaft Excavation (2006)	$386.59	CY
Fatigue Retrofit Steel Girder Type C	$108.33	EA	Concrete Patching Material, Misc.	$286.40	CF
Fatigue Retrofit Steel Girder, Peening	$2,500.00	EA	Concrete Patching Material	$100.00	CF
Finishing & Curing	$56.25	SY			
Granular Bridge End Backfill	$171.07	CY			
Install Dow el in Concrete	$25.16	EA	Total Asphalt Overlay w/ AC Overlay	$127.04	SY
Jack Superstructure - Steel Bridge	$7,243.41	LS	Total Asphalt Overlay w/o AC Overlay	$94.53	SY
Jack Superstructure & Shift Bearing Shoes	$18,974.88	LS			
Laminated Elastomeric Bearing Pad	$748.31	EA	Two Coat Epoxy Chip Seal		
Low Slump Dense Concrete Bridge Deck Overlay	$358.14	CY	Epoxy Chip Seal (Bare Deck)	$55.41	SY
Magnetic Particle Weld Inspection	$8.80	LI	Epoxy Chip Seal (RACS)	$61.30	SY
Modify Bridge Rail	$24.46	LF			
Modify Expansion Device	$12,542.72	EA	Total Low Slump Overlay	$179.18	SY
Modify Fixed Joint (03/06)	$25,000.00	EA	Bridge Deck Epoxy Chip Seal (Bare)	$43.70	SY
Modify Girder Ends:	$1,093.00	EA	Epoxy Chip Seal (RACS)	$49.59	SY
Porous Backfill (Ton)	$60.80	TON	Epoxy Chip Seal on Existing Epoxy Chip Seal	$24.60	SY
Precast Concrete Headwall for Drain	$368.38	EA			
Prefabricated Membrane Strip	$27.79	SY	**RipRap**		
Remove and Replace Deteriorated Conc.	$371.89	SY	Class A	$50.00	CY
Remove and Replace Steel Diaphragms	$1,650.38	EA	Class B	$55.07	CY
Remove Concrete Anchor Block 2005	$350.00	EA	Class C	$45.51	TON
CY—cubic yard EA—each	LB--pound LF—linear foot	LI—linear inch LS—lump sum	SF—square foot SI—square inch	ST—structure SY—square yard	PR--project TON—ton
Remove Concrete Bridge Approach Slab	$38.68	SY	**Pile - Furnish and Drive**		

Table D.3: Bridge Rehabilitation Costs

Item	Unit Cost	Unit	Item	Unit Cost	Unit
Remove Concrete Bridge Deck (2004)	$74.85	SY	HP 10 x 42 Steel Bearing Pile	$52.83	LF
Remove Rubberized Asphalt Chip Seal	$5.89	SY	HP 10 x 42 Steel Test Pile	$60.00	LF
Replace Expansion Device	$36,759.59	EA	HP 10 x 57 Steel Bearing Pile	$50.00	LF
Reset Bearing	$4,000.00	EA	HP 10 x 57 Steel Test Pile	$55.00	LF
Special Surface Finish	$12.30	SF	HP 12 x 74 Steel Bearing Pile	$65.09	LF
Strip Seal Expansion Joint	$141.86	LF	HP 12 x 74 Steel Test Pile	$61.50	LF
Strip Seal Gland	$75.00	EA	Timber Bearing Pile (05/06)	$34.29	LF
Structure Excavation, Bridge	$18.04	CY	Timber Pile Shoe (05/06)	$153.81	EA
Stud Shear Connector	$128.00	EA	Timber Pile Splice (05/06)	$153.81	EA
Concrete Removal - Type 1A	$31.83	SY			
Concrete Removal - Type 1B	$144.95	SY	Abutment Modification	$98,015.06	LS
Concrete Removal - Type 1C	$196.07	SY	Abutment Replacement	$25,819.94	LS
Concrete Removal - Type 1D	$184.84	SY	**Approach Slab - Remove and Replace**		
Concrete Removal - Type 2A	$11.83	SY	With Bridge End Backfill	$226.56	SY
Concrete Removal - Type B	$18.64	LF	Without Bridge End Backfill	$205.90	SY
Repainting					
Bridge Repainting, Class I	$12,199.92	LS	Sliding Elastomeric Bearing	$1,680.00	EA
Bridge Repainting, Class I	$20.25	SF	Bearing Replacement	$42,905.23	LS
Bridge Repainting, Class II	$47,226.06	LS	Bent Repair	$1,710.15	LS
Bridge Repainting, Class II	$4.83	SF	Berm Repair	$14,376.92	LS
Paint Residue Containment	$32,282.37	LS	Channel Stabilization	$18,308.97	EA
Paint Residue Containment	$3.67	SF	Deck Replacement	$923.86	SY
Class I	$13.96	SF	End Block Modification	$33,394.68	EA
Class II	$3.65	SF	Fatigue Retrofit	$64,427.79	EA
Remove AC Bridge Deck Overlay	$17.55	SY	Girder Modification	$70,023.12	EA
Asphalt Concrete Composite	$420.00	TON	Joint Modification (same as Modify Expansion Device)	$12,542.72	EA
Grind Weld	$19.15	LI	Joint Replacement	$32,864.91	EA
Heat Straighten Steel Members	$68,222.61	LS	Fixed Expansion Bearing	$1,409.78	EA
Magnetic Particle Weld Inspection, Impact Damage Repair	$3.73	SI	10" Fabric Formed Conc. Mattress	$36.45	SF
Surface Grinding of Structural steel	$13.39	SI	Epoxy Urethane Bridge Deck Overlay	$48.00	SY
Bridge Cleaning	$30,000.00	SF	Chain Link Fence for Bridge Sidewalk	$21.61	LF
Controlled Density Fill	$779.30	CY	Class A45 Concrete, Bridge Deck	$1,595.00	CY
Class A45 Concrete, Misc. (2008)	$2,800.00	CY	Column Fiber Wrap	$3,269.39	EA
Galvanic Anode	$470.62	EA	Drilled Hole in Existing Steel	$370.89	EA
Field Painting	$2,500.00	LS	Field Weld	$6.61	LI
Hot Applied Elastomeric Membrane	$20.28	EA	Membrane Sealant Expansion Joint	$107.53	LF
Nonmetallic Fiber Reinf. Conc. Overlay	$683.35	CY	Finger Type Expansion Joint Assembly	$56,035.40	EA

CY—cubic yard LB--pound LI—linear inch SF—square foot ST—structure PR--project
EA—each LF—linear foot LS—lump sum SI—square inch SY—square yard TON—ton

Table D.4: State Box Culvert Costs

Item	Unit Cost	Unit	Item	Unit Cost	Unit
Single			**General**		
Average Cost	$1,361.25	LF	Class A45 Concrete, Box Culvert	$640.12	CY
Average Barrel Length	115.60	LF	Reinforcing Steel	$1.04	LB
Average Opening Area	70.40	SF	Structure Excavation, Box Culvert	$38.11	CY
Single Extensions			Undercutting Box Culvert	$62.15	CY
Average Cost	$1,393.58	LF	**Extensions**		
Average Barrel Length	33.55	LF	Breakout Structural Concrete	$360.94	CY
Average Opening Area	54.50	SF	Install Dowel in Concrete	$30.84	EA
Twin			**Railing**		
Average Cost	$2,526.49	LF	Steel Railing, Sidewalk	$60.32	LF
Average Barrel Length	$82.00	LF	Bridge Sidewalk Chain Link Fence	$54.50	LF
Average Opening Area	$185.67	SF	**Erosion Control**		
Twin Extensions			Fabric, Type B Drainage	$3.43	SY
Average Cost	$3,572.12	LF	Riprap		
Average Barrel Length	$30.00	LF	Class A	$46.00	TON
Average Opening Area	$98.00	SF	Class B	$47.09	TON
Triple			Class C	$85.00	TON
Average Cost	$4,824.44	LF	Class D	$55.00	TON
Average Barrel Length	$110.00	LF			
Average Opening Area	$333.00	SF	Bank & Channel Protection Baskets	$300.00	CY
Triple Extensions			Controlled Density Fill	$230.40	CY
Average Cost	$4,629.28	LF	Natural Streambed Material	$54.13	CY
Average Barrel Length	$8.00	LF	Composite Fabric Wrap, Concrete repair	$60.35	SF
Average Opening Area	$144.00	SF	Concrete Metalizing	$36.30	SF
4 – Barrels			Two Coat Bridge Deck Polymer High Friction	$45.56	SY
Average Cost	$5,028.99	LF	Remove Concrete Curb and Gutter	$15.00	LF
Average Barrel Length	$98.00	LF	Remove Concrete Sidewalk	$180.00	SY
Average Opening Area	$513.33	SF	Reset Rocker Bearing	$8,487.50	EA
4 - Barrel Extension			Roadway Canopy	$13,000.00	LS
Average Cost	$6,064.39	LF	Rust Penetrating Sealer	$5,278.42	LS
Average Barrel Length	$72.00	LF	Special Steel Railing	$595.00	LI
Average Opening Area	$336.00	SF	Ultrasonic Weld Inspection	$23.00	LI
5-Barrels			Bridge Deck Polymer Chip Seal	$20.30	SY
Average Cost	$8,298.21	LF	Spot Repair Existing Bridge Deck Epoxy C Seal	$42.70	SY
Average Barrel Length	$84.00	LF	Steel Pedestrian Railing	$231.55	LF
Average Opening Area	$840.00	SF	Steel Pedestrian Railing on Conc. Barrier	$92.39	LF
5 - Barrel Extension			Steel Pedestrian Railing on Sidewalk	$320.00	LF
Average Cost	$3,872.42	LF	Type C6 Concrete Gutter	$19.06	LF
Average Barrel Length	$236.33	LF	Waterproofing Membrane for Structure	$16.30	SF
Average Opening Area	$200.00	SF			

CY—cubic yard LB--pound LI—linear inch SF—square foot ST—structure PR—project
EA—each LF—linear foot LS—lump sum SI—square inch SY—square yard TON—ton

Table D.5: State Culvert Cost Summary by Type

Item	Unit Cost	Unit	Item	Unit Cost	Unit
Cast In Place			**Precast**		
Single Barrel			**Single Barrel**		
Average Cost	$1,396.02	LF	Average Cost	$1,270.43	LF
Average Barrel Length	139.33	LF	Average Barrel Length	80.00	LF
Average Opening Area	73.33	SF	Average Opening Area	66.00	SF
Double Barrel			**Double Barrel**		
Average Cost	$2,977.01	LF	Average Cost	$2,143.72	LF
Average Barrel Length	75.33	LF	Average Barrel Length	88.67	LF
Average Opening Area	182.00	SF	Average Opening Area	189.33	SF
Triple Barrel			**Triple Barrel**		
Average Cost	$2,583.63	LF	Average Cost	$4,593.55	LF
Average Barrel Length	99.63	LF	Average Barrel Length	86.67	LF
Average Opening Area	224.25	SF	Average Opening Area	272.00	SF
4 - Barrel					
Average Cost	$5,028.99	LF			
Average Barrel Length	98.00	LF			
Average Opening Area	513.33	SF			
5 - Barrel			**5 - Barrel**		
Average Cost	$1,275.13	LF	Average Cost	$8,295.21	LF
Average Barrel Length	160.00	LF	Average Barrel Length	84	LF
Average Opening Area	77.25	SF	Average Opening Area	840	SF

CY—cubic yard LB--pound LI—linear inch SF—square foot ST—structure PR—project
EA—each LF—linear foot LS—lump sum SI—square inch SY—square yard TON—ton