Nebraska Department of Transportation

Transportation Asset Management Plan

Disclaimer

The Nebraska Department of Transportation (NDOT) in cooperation with the Federal Highway Administration (FHWA), hereby submits this initial Transportation Asset Management Plan (TAMP) for certification review for the TAMP process by the FHWA as per 23 U.S.C. 119(e)(6).

APPROVED BY THE NEBRASKA DEPARTMENT OF TRANSPORTATION

This 27 day of December 2022

John Selmer
Director

CERTIFIED BY THE FHWA NEBRASKA DIVISION OFFICE

This 28 day of March 2023

James R. Simerl
Acting Division Administrator

Contents

List of Figures

List of Tables

Acronyms List

AASHTO - The American Association of State Highway and Transportation Officials

AC - Asphalt Concrete

ADT - Average Daily Traffic

B/C - Benefit/Cost Ratio

BrM - AASHTOware™ Bridge Management Software

CFR - Code of Federal Regulations

CRCP - Continuously Reinforced Concrete Pavement

FAST Act - Fixing America's Surface Transportation Act

FHWA - Federal Highway Administration

FTA - Federal Transit Administration

FY - Fiscal Year

HSIP - Highway Safety Improvement Program

IRI - International Roughness Index

ITS - Intelligent Transportation Systems

JCP - Jointed Portland Cement Concrete Pavement

LCCA - Life Cycle Cost Analysis

LCP - Life Cycle Planning

LOS - Level of Service

MAP-21 - Moving Ahead for Progress in the 21st Century

MPO - Metropolitan Planning Organization

NBI - National Bridge Inventory

NBIS - National Bridge Inspection Standards

NCHRP - National Cooperative Highway Research Program

NHI - National Highway Institute

NHS - National Highway System

PCC - Portland Cement Concrete

STIP - Statewide Transportation Improvement Plan

STP - Surface Transportation Program

TAM - Transportation Asset Management

TAMP - Transportation Asset Management Plan

TIP - Transportation Improvement Plan

USC - The Code of Laws of the United States of AmericaVE Rockfall Vehicle Exposure Score

VMT - Vehicle Miles Traveled

Executive Summary

At the Nebraska Department of Transportation (NDOT) our mission is to "enhance the quality of life through a convenient, safe, and innovative transportation system." This mission statement NDOT has implemented guided the development of the following Strategic Goals.

STRATEGIC FOCUS AREAS

- Challenge our business practices.
- Develop our workforce.
- Serve our customers.
- Engage our partners.

KEY OUTCOMES

- Enhanced project delivery that is predictable and reliable.
- Modernize operational and financial systems.
- Become the most desirable place to work.
- Become the delight of the people we serve.
- Strengthen and enhance relationships with our partners.

The NDOT TAMP describes current asset management practices to increase transparency. This TAMP highlights one of the agency's eight strategic goals: "Asset Management – To operate, maintain, upgrade and expand physical assets effectively throughout their life cycle" and describes many of the detailed processes that support and guide decisions for project development and delivery.

Overview of National Strategic Goals

National Performance Goal	Strategies to Achieve Goal
(1) **Safety.** To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.	NDOT TAMP strategies support the goals and objectives of the Highway Safety Improvement Program (HSIP), our Nebraska's Performance-Based Strategic Traffic Safety Plan, and the Nebraska Strategic Highway Safety Plan (N-SHSP). Implementing these strategies will reduce traffic fatalities and serious injury.
(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 Statewide Transportation Improvement Plan (STIP), the Transportation Improvement Plans (TIPs), and the Surface Transportation Plan to maintain highways assets. A state of good repair will be promoted through implementation of these plans.
(3) **Congestion reduction**. To achieve a significant reduction in congestion on the National Highway System.	Properly selected and timed preservation strategies extend the service life of pavement and minimize traffic congestion associated with lengthy reconstruction projects. Strategies for selecting repair work candidates described in the TAMP maintain the existing capacity with least long-term impact to level of service.
(4) **System reliability.** To improve the efficiency of the surface transportation system.	The implementation of the TAMP ensures roadways are maintained in a State of Good Repair, leading to a reliable transportation network.
(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.	Freight movements on Nebraska roadways include a wide range of commodities, including agricultural products produced in rural areas. Maintaining roadways in an efficient and timely manner allows products from rural areas to reach wider national and international markets and promotes the economic vitality of our state and nation.
(6) **Environmental sustainability.** To enhance the performance of the transportation system while protecting and enhancing the natural environment.	NEPA CE Assignment occurred in the fall of 2018. This allows NDOT to deliver safety and highway improvement projects to the public faster while preserving environmental quality. The program allows for more flexibility in project decision-making, while maintaining existing requirements for environmental consultation, review, and compliance. NDOT is building stronger relationships with stakeholders and public agencies through direct engagement and ownership of NEPA decision-making.
(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.	NDOT reduced delays in project development and delivery processes by strengthening our project and program management and improving connections between project delivery and construction efforts. NDOT created new teams responsible for stewardship of project cost, scope and schedule and developed new change control procedures to improve agency work practices.

NDOT's asset management process follows these steps which are described in detail throughout this document.

INSPECTIONS

Inspections are performed to assess and monitor the condition and performance of roads and bridges. Performance gaps, the difference between existing and desired performance, are identified and options to minimize those gaps for at the lowest practicable cost are considered.

FUNDING

Existing funding levels and their over-all impact on asset management practices are evaluated to develop meaningful performance targets and to ensure Nebraska Roads and Bridges are maintained in a State of Good Repair (SOGR)[1]

PERFORMANCE

Condition and desired performance targets are used in a life-cycle cost analysis to determine District allocations and identify projects for inclusion on a 10-year project candidate list.

EXECUTIVE REVIEW

NDOT Division and District personnel review currently scheduled work and prioritize new projects from the 10-year project candidate list for inclusion in the Surface Transportation Program Book.

STIP

The Surface Transportation Program Book[2] and Surface Transportation Improvement Program (STIP)[3] are published.

NEW BASELINE

After construction work is complete, pavement condition is documented during annual inspection.

COMPARISON

System-wide condition and performance are compared with established targets.

[1] For a definition of "State of Good Repair", see Appendix B.
[2] The Nebraska Surface Transportation Book can be found at: https://dot.nebraska.gov/projects/publications
[3] The State's Transportation Improvement Program can be found at: http://dot.nebraska.gov/projects/publications/stip/

Implementation of the TAMP is a continuation of Nebraska's asset management process which has resulted in a SOGR for the highway system. Asset management practices involve technical details and processes that are defined in this TAMP. This Transportation Asset Management Plan can be found at the following link. https://dot.nebraska.gov/news-media/publications/

NDOT's decision-making process considers:

- Life-cycle costs
- Preservation-strategy effectiveness
- Deterioration rates, and
- Potential risks to the highway system.

Other considerations that can affect asset management processes include:

FUNDING

Determining if there are enough funds to construct a project, given the statewide needs of the entire state transportation network.

ENVIRONMENTAL

Identifying any environmental concerns like extreme weather events that can control the timing of strategies for projects..

DELIVERABILITY

Verifying that NDOT can survey, design and acquire right-of-way necessary to construct the project when needed.

CONSTRUCTABILITY

Analyzing whether or not the project conflicts with other construction projects in the vicinity. Analyzing whether or not the project can be done safely and with minimal impact on mobility for transportation users.

STAFFING

Confirming there is enough field personnel in the area to handle the workload.

STAKEHOLDER INPUT

Taking into consideration comments and inquiries from the public, business interests and local governments regarding concerns about timing, plans and costs related to a project.

CHAPTER 1 Introduction

1.1 Overview

The Nebraska Department of Transportation (NDOT) manages 10,000 miles of public roads that includes about 96 percent of the National Highway System (NHS). NDOT also reports on an infrastructure network that includes approximately 98,000 miles of public roads.

NDOT has eight districts that oversee maintenance, operations, and construction. A central office in District 1 provides NDOT administration, project development, research, and other support. A graphic representing the districts and central office responsibilities is shown in Figure 1.

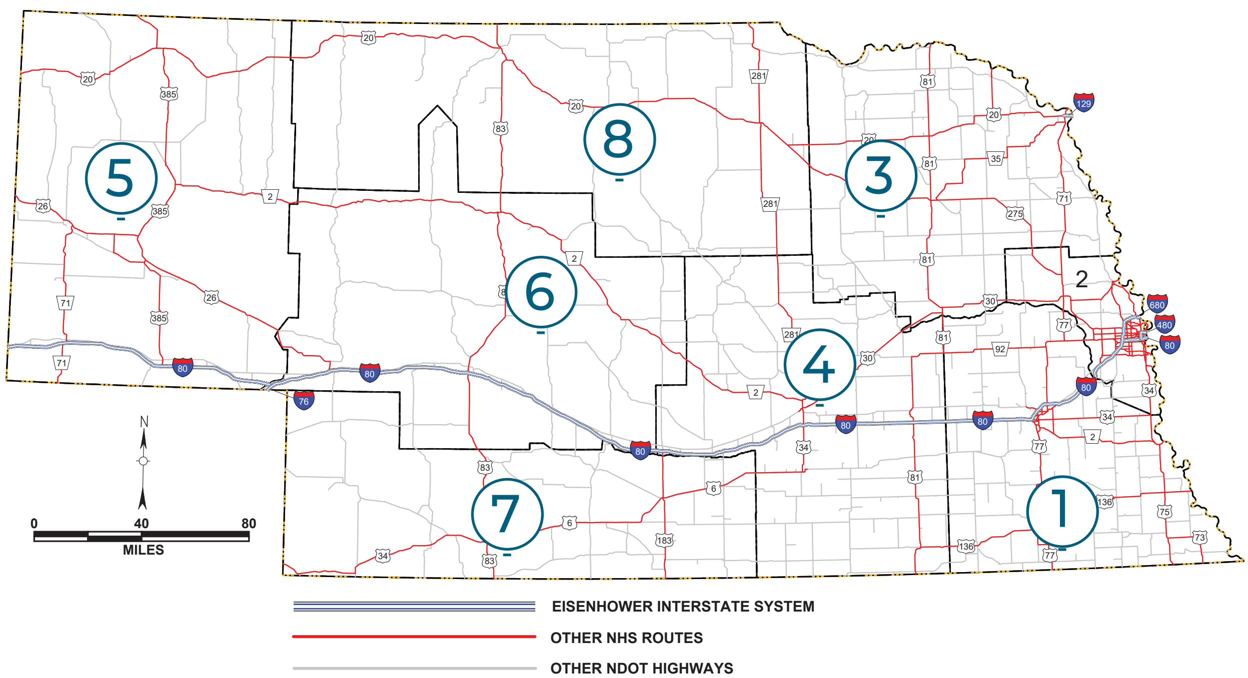


Figure 1 - National Highway System in Nebraska *(April 2022)*

With the passage of the Moving Ahead for Progress in the 21st Century Act (MAP-21), each state transportation agency is required to develop a risk-based Transportation Asset Management Plan (TAMP) for the National Highway System (NHS).

MAP-21

Moving Ahead for Progress in the 21st Century

a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at a minimum practicable cost

Prior to the passage and implementation of MAP21, NDOT had an established process of asset management objectives and priorities. This TAMP reflects NDOT's e nhanced m ethod a nd describes NDOT's strategic approach to meet the needs of the system and its users not only on the NHS, but all highways and bridges owned by the State. The Material & Research Division's Roadway Asset Management (R.A.M) section houses and coordinates the development of the TAMP document. Any TAMP related decisions are decided through a steering committee comprised of division heads from Materials & Research, Bridge, Program Management, Local Projects, Strategic Planning, Roadway, and Controller.

This plan covers a 10-year financial period and will be reviewed and recertified by the Federal Highway Administration (FHWA) every four years.

1.2 Resilience, Risk and Life Cycle Cost

TAMP requirements were amended to require State DOTs to consider extreme weather and resilience within their lifecycle cost and risk management analysis (Public Law 117-58 § 11105) of the Bipartisan Infrastructure Law, changes were made to Title 23, United States Code (U.S.C) Section 119(e)(4).

The FHWA memo 'State Asset Management Plan Under BIL' from May 5, 2022, conveyed the following expectations.

1. Clearly explain the processes used to develop the extreme weather and resilience portions of the risk management and life-cycle planning sections of the TAMP,
2. Include discussions of extreme weather and resilience in the risk management and life-cycle planning sections of the TAMP, and
3. Discuss how their investment strategies are influenced by the results of their risk management and life-cycle planning analyses, as provided in 23 CFR 515.7(e).

NDOT addresses expectations and related requirements referenced in (23 CFR 515.7e) in the sections below:

(1) Performance gap analysis within Section 4.3; and
(2) Life-cycle planning for asset classes within Sections 5.2 through 5.4; and
(3) Risk management analysis within Chapter 7; and
(4) Anticipated available funding and estimated cost of expected future work types associated with various candidate strategies based on the financial plan within Section 8.5 and 8.7.

1.3 TAMP Contents

The content of the Nebraska Transportation Asset Management Plan (TAMP) is organized into eight chapters. A brief description of each chapter is provided below:

CHAPTER 2
Asset Inventory and Condition
Provides a brief overview of the State and National Highway System (NHS), a summary of pavement and bridge inventory, how the condition of the inventory is collected and measured and the general condition of the assets.

CHAPTER 3
Asset Management, Objectives, Practices, and Measures
Outlines the Nebraska Department of Transportation's (NDOT) objectives and strategies for successful asset management, identifies asset condition goals, and describes the process of assessing the performance of the State's assets.

CHAPTER 4
Performance Gap Identification
This chapter provides summaries of NDOT's short-term (10-year), long-term (20-year), and planning horizons for asset management, and performance gap analyses.

CHAPTER 5
Life Cycle Planning
Describes pavement and bridge life cycle management practices and costs associated with design, construction, inspection, maintenance, rehabilitation, and disposal.

CHAPTER 6
Future Growth and Demand
Provides an overview of Nebraska's future population, freight growth, and system demand.

CHAPTER 7
Risk Management Analysis
Summarizes NDOT's approach to risk-based asset management, describes system risks identified by NDOT, provides a risk register for system and programmatic risks, including the likelihood of a risk occurring, potential consequences of occurrence, and mitigation strategies. System and program resiliency is described.

CHAPTER 8
Financial Plan and Investment Strategies
Summarizes the funding sources for Nebraska's transportation system, financial reporting requirements, financial management practices, funding levels and allocation processes that support asset management planning.

Supplemental information that contributes to the TAMP is located in the Appendices.

CHAPTER 2

Asset Inventory and Condition

2.1 Overview

The Nebraska Transportation Asset Management Plan (TAMP) focuses on two major assets: pavement and bridges on the National Highway System (NHS). The Nebraska Department of Transportation (NDOT) manages and reports on all state-owned pavements and bridges; the NHS is not managed separately from the State system. Local owners in coordination with the State, manage the subgroup of locally owned NHS pavements and bridges. Additionally asset classes may be included in future editions of the TAMP.

NDOT is directly responsible for operating and maintaining approximately 10,000 miles of roads more than 3,500 bridges[4] [5]. Additionally, NDOT is responsible for reporting on an infrastructure network of approximately 98,000 miles of public roads and more than 15,000 bridges in the state. NDOT uses the information collected to provide numerous reports to the public, other State and local agencies. Yearly reports are provided to the Federal Highway Performance Monitoring System (HPMS) and the FHWA National Bridge Inventory (NBI)[6] [7].

The NHS in Nebraska, which is a focus of this document, is more than 3,600 miles in length, with about 13 percent being interstate highways, 87 percent State highways, and 4 percent locally owned roadways. The NHS includes about 1,500 bridges, with approximately 96 percent located on State highways and the rest on the local system. A map of Nebraska's NHS is shown in Figure 1[8].

NDOT collects all pavement inventory and condition data for the interstate, state-owned highways, and locally owned NHS routes. Bridge inventory and condition is collected by NDOT for state-owned bridges. Bridge inventory and condition for locally owned bridges is collected by the local agencies and supplied to NDOT using BrM, a web-based software that is licensed from the American Association of State Highway and Transportation Officials and has been customized for NDOT use.

Summaries of pavement and bridge inventory on the NHS, the State Highway System and the local roadway networks, is found on the NDOT Materials & Research website[9] and the NDOT Bridge Division website[10]. A summary of the NDOT's historical asset performance for the State Highway System is found in the NDOT Annual Report[11].

[4] Nebraska bridge inventory details are available at: https://dot.nebraska.gov/business-center/bridge/
[5] Nebraska pavement inventory is available at: http://dot.nebraska.gov/business-center/materials/
[6] All states bridge inventory is available from the FHWA at: https://www.fhwa.dot.gov/bridge/britab.cfm
[7] All states pavement inventory data is available from the FHWA at: https://www.fhwa.dot.gov/policyinformation/
[8] Nebraska's NHS system map is available at: https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/ or http://dot.nebraska.gov/travel/map-library/
[9] Nebraska pavement inventory is available at: http://dot.nebraska.gov/business-center/materials/
[10] Nebraska bridge inventory is available at: http://dot.nebraska.gov/business-center/bridge/
[11] Nebraska's Annual Report can be found at: http://dot.nebraska.gov/news-media/annual-report/

2.2 Asset Values

Current value for state-owned NHS pavements
$6.6B

Annual investment required to maintain interstate in current condition
$94M

Investment needed to maintain non-interstate state-owned NHS in current condition
$136M

Current value of NHS bridges
$3.8B

Bridge value based on replacement cost at $230 per square foot.

Annual investment to maintain current conditon
$29M

Bridge maintenance cost based on average annual expenditures 2017-2021.

2.3 Pavement Inventory

The expanse of Nebraska pavement on the NHS currently measures approximately 3,700 miles measured along the centerline of each highway. The number of lane miles that make up the NHS is approximately 10,200 and can be seen in Table 1. In this document, pavement is defined as the surfaced travel way width of the highway, which does not include roadway appurtenances such as shoulders, guardrails, sign structures, lighting, or signs. NDOT's main source for pavement inventory and condition data is found in a mainframe relational database with the route number and reference posts as the keys. A summary of the tables in the database is replicated in sequel for use in NDOT's Pavement Optimization Program (POP).

The POP application offers a variety of data and functions for nearly every step of the asset management process, including current pavement condition ratings. For more information on POP, see Section 3.3.1, the pavement management systems manual[12], or the pavement optimization program-user guide[13].

[12] The Pavement Management Systems Manual can be found at: https://dot.nebraska.gov/business-center/materials/
[13] The Pavement Optimization Program – User Guide can be found at: http://dot.nebraska.gov/business-center/materials/

In Nebraska, the NHS network is comprised of three types of pavement:

1. Jointed Portland Cement Concrete (PCC) *(i.e., rigid)*
2. Asphalt Cement Concrete (ACC) *(i.e., flexible, bituminous, or black top)*
3. Composite Pavement (ACC over PCC)
   these types are considered ACC in all analysis

SURFACE TYPE / LANE MILES
PCC / 3563.670
ACC / 3279.150
ACC over PCC / 3672.480

Table 1 - NHS Lane Miles

System	Number of Lane Miles
Interstate	2,068
Non-Interstate State Highways	7,577
Local	525
Intermodal Connector	7

2.4 Pavement Condition

NDOT uses two main pavement condition measures in the determination of performance. The Nebraska Serviceability Index (NSI) and the International Roughness Index (IRI). With the passage of MAP-21, Nebraska's pavement condition will also be rated as Good, Fair, or Poor according to Federal rules.

2.4.1 Nebraska Serviceability Index (NSI)

The Nebraska Serviceability Index (NSI) is a rating used to gauge the overall health of the highway network or a specific segment of highway. This rating is used to manage all pavements on the State Highway System including the NHS. NSI ratings are computed annually and are performed on both PCC and ACC pavements. Before an NSI value is calculated, visible surface distress is recorded during visual inspections and is intended primarily to characterize severity and extent of pavement distress as described in the Surface Distress Survey Manual[14]. This characterization identifies distresses, but does not attempt to determine the cause of distress nor does it identify appropriate corrective treatments.

Additional condition metrics of a roadway are measured by NDOT's inertial profiling system, specialized vans furnished with equipment to take multiple measurements (Figure 2). This system, provides information on roadway smoothness, rut depth, texture, and faulting, as well as photos of the pavement sections. All pavement condition data is collected in accordance with NDOT's Data Quality Management Program[15]. Below is a excerpt of the NDOT's Data Quality Management Program which outlines NDOT's process in detail.

1.2 How Data is Collected

The Nebraska Department of Transportation (NDOT) owns two pavement data collection vehicles (DCV) to conduct semi-automated pavement condition surveys. Supplemental pavement condition distress surveying is done manually using video images or by in the field visual survey. NDOT is in the process of transitioning to automated distress detection, which will replace manual in the field visual surveys with the exception of verification. Automating this process will provide repeatability, eliminate subjectivity, increase safety, reduce costs, and provide more time for verification and quality control.

[14] The Surface Distress Survey Manual can found at: http://dot.nebraska.gov/business-center/materials/
[15] The Data Quality Management Program can be found at: http://dot.nebraska.gov/business-center/materials/

1.3 When Data is Collected

NDOT begins its annual DCV collection around the first of April to insure a good sun angle for images. This of course depends on the weather, as surveying is not performed on pavements when they are wet or there is snow on the shoulders or right-of-way. The goal for the completion of the non-interstate state highways is August 15th. NDOT uses the month of September to collect the Interstates and locally owned National Highway System (NHS). Visual surveys are accomplished throughout the entire year, weather permitting.

1.4 Where Data is Collected

NDOT collects pavement condition data on approximately 10,000 centerline miles of state highways and approximately 135 centerline miles of locally owned roadways on the NHS. Other pavement condition collections may be performed as necessary for ramps, recreation roads, and detour routes. For two-lane highways, the same chosen direction is collected each year. For multi-lane highways and interstates, both directions are collected each year in the driving lane. NDOT collects condition metrics from the DCV at one-tenth mile increments and performs visual distress surveys at each one-mile reference point. Additional visual surveys are taken at the following control points:

- *Beginning of route*
- *Surface type change*
- *Beginning of change from 2-lane to multi-lane facilities*
- *Corporate boundaries*
- *District boundaries*

1.5 What Data is Collected

The DCV collects digital images on and along highways and 3D-sensor data for measuring roughness, rutting, and faulting. Additional information available from the DCV includes a 3D surface model, cross-slopes, coordinates, and horizontal/vertical alignments. See "Condition Data Items Collected" table on next page.

Data collected from visual surveys include the severity (absent, low, medium, high, extreme) and extent (absent, trace, occasional, frequent, extensive, complete) of the distress types shown (see table on next page) of the Data Quality Management Program. More information on visual surveys can be found in NDOT's Surface Distress Survey Manual.

Condition Data Items Collected

General Data	Bituminous, Asphalt and Composite Pavements	Jointed Concrete Pavements and Concrete Overlays
Data Collection Vehicle • Location (highway, RP, offset, length, latitude & longitude determined by GPS coordinates) • Perspective, ROW, rear, and rear downward surface images • Optional Geometric Data (horizontal and vertical curaves, cross-slope, super-elevation	*Data Collection Vehicle* • IRI • Rutting *Visual Surveys* • Longitudinal Cracking • Transverse Cracking • Grid/Block Cracking • Alligator Cracking • Raveling/Weathering • Bituminous Patching • Failures • Excess Asphalt	*Data Collection Vehicle* • IRI • Faulting *Visual Surveys* • Corner Breaks • Longitudinal Cracking • Transverse Cracking • Longitudinal Joint Spalling • Bituminous Patching • Joint Repairs • Panel Repairs • Joint Seals • Crack Seals

Inertial profiling van

Profiling van interior computer monitor

Profiling equipment and data storage

Figure 2 - Inertial Profiling Equipment

Once data from the visual inspections and the profiler is uploaded into the database, a function is used to combine the distress and condition measurements into pavement condition factors, which are used to calculate the final NSI value. Condition information is used to monitor pavement performance over time and to help determine appropriate strategies for maintenance, rehabilitation, or reconstruction. A complete description of this process may be found in the Pavement Management System Manual[16] or see Section 3.3.1 for more details.

[16] The Pavement Management System Manual can be found at: http://dot.nebraska.gov/business-center/materials/

NSI is the primary value used to manage pavement assets and is one of the main performance measures tracked by NDOT. The full range of NSI condition ratings and corresponding physical descriptions are categorized according to the NSI scale listed in Table 2. A summary of the condition of various systems as they relate to NSI is shown in Figure 3, which is reported in NDOT's Annual Report[17].

Table 2 - Nebraska Serviceability Index (NSI)

Rating	Condition	Description
Very Good	90 - 100	Pavement like new
Good	70 - 89.99	Several years of service life remaining
Fair	50 - 69.99	Few years of service life remaining
Poor	30 - 49.99	Candidate for rehabilitation
Very Poor	0 - 29.99	Possible replacement

NDOT has historically reported the percent of the highway system rated as good and very good, based on NSI, for in the Annual Report and will continue to do so. For more information on Federal and State performance measures, see Section 3.5.

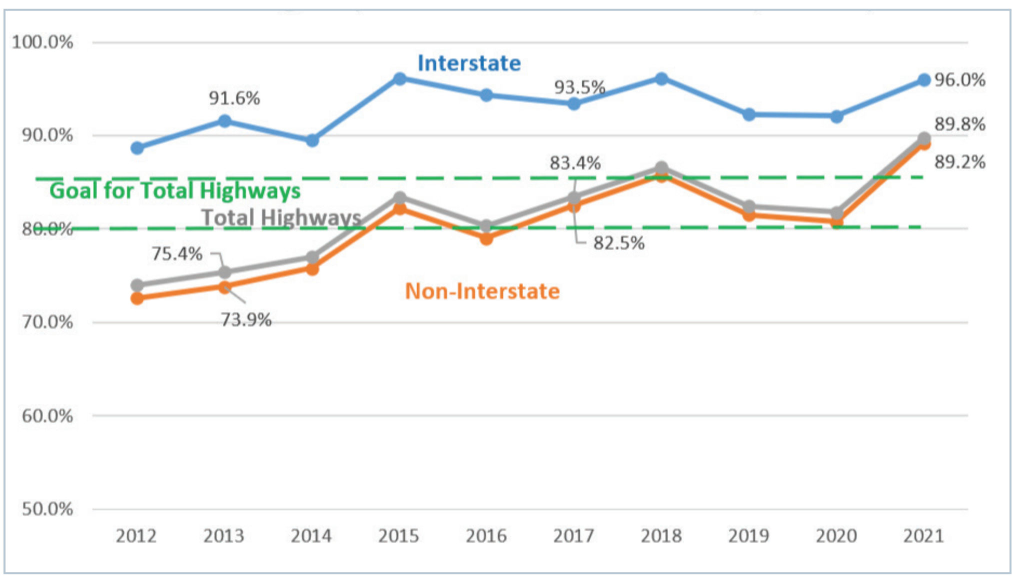


Figure 3 - Percent of Miles on NHS Rated Good or Very Good Based on NSI >70

[17] The Annual Report can be found at: http://dot.nebraska.gov/news-media/annual-report/

2.4.2 International Roughness Index (IRI)

The second measure of pavement performance is smoothness. Measurements of pavement smoothness, or the ride quality, are collected annually using the inertial profiling van. Collected data is evaluated according to the International Roughness Index (IRI), which is a scale for roughness based on the simulated response of a generic motor vehicle to the roughness in a single wheel path of the road surface. Nebraska collects the IRI for both wheel paths and calculates an average IRI that is reported for all segments.

Table 3 - International Roughness Index (IRI)

Rating	Scale (in/mi)
Good	<95
Fair	95-170
Poor	>170

Its value is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a reference vehicle would respond to the roughness inputs, and accumulating the suspension travel. IRI is reported in terms of inches/mile. The lower the IRI rating, the smoother, safer, and more satisfying the ride is to users. Table 3 contains the IRI rating and scale.

The NDOT has adopted FHWA's pavement condition performance measures, as follows:

Good Condition	Suggests no major investment is needed.
Fair Condition	Suggests minor investment and preventative maintenance is needed.
Poor Condition	Suggests major reconstruction investment is needed.

The pavement conditions are calculated based on data that the NDOT collects through the HPMS.

The smoothness of roads, as measured by IRI, is critical to the safety and mobility of the traveling public. The IRI value is one of the main performance measures tracked by NDOT, which is reported in the annual report. A summary of the condition of the NHS as it relates to IRI rating is shown in Figure 4.

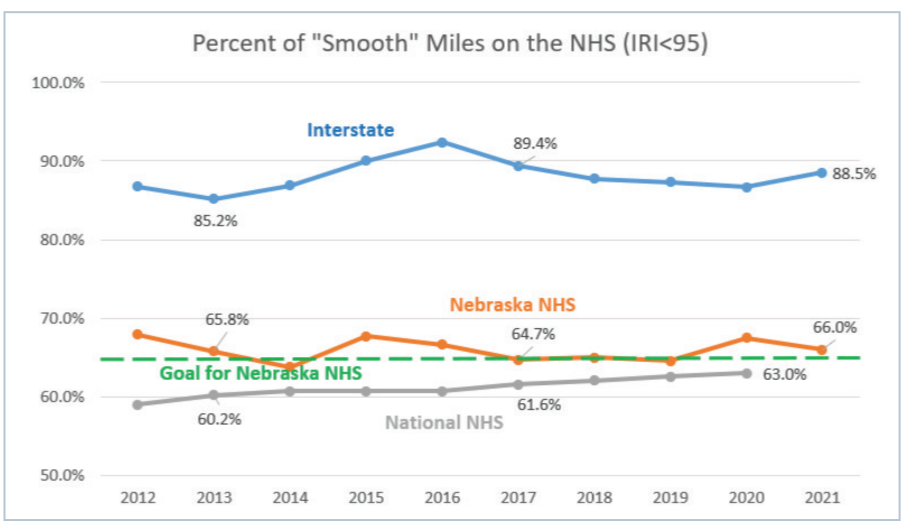
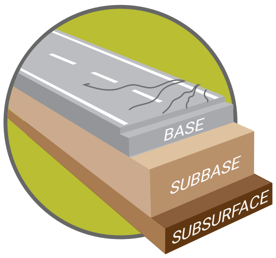


Figure 4 - Percent of Miles on the NHS with an IRI Rating of Good Based on IRI< 95 in/mi

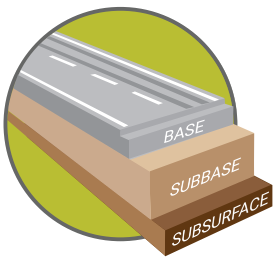
2.4.3 Rutting, Cracking, Faulting, and the Present Serviceability Index (PSI)

In addition to the NSI and IRI ratings on the Nebraska State Highway System, current condition ratings related to cracking, rutting, faulting, and PSI are available upon request from the Materials & Research Division. Factors for the deterioration of these ratings are used in the Life Cycle Cost Analysis.

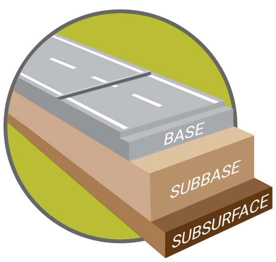
The pavement conditions are determined by using quantitative data on the following metrics.



Cracking is measured by the percentage of cracks in the pavement surface. Cracks are often caused (or accelerated) by excessive loading, poor drainage, poor subbase, and construction flaws.



Rutting is typically caused by heavy vehicles. It is measured in asphalt by the depth of the rut along the wheel path.



Faulting is a difference in elevation across a concrete joint or crack (usually along concrete slab edges). Faulting is typically caused by pumping of fine subgrade material under heavy vehicle traffic.

2.4.4 Federal Pavement Condition Ratings

Federal pavement condition ratings of good, fair, or poor for a pavement section will be based on the combined values of good, fair or poor condition for IRI, cracking, rutting, and faulting. See Table 4 and Section 3.5 for more details.

Table 4 - Federal Rating Scale for Pavement Condition Metrics

Rating	Good	Fair	Poor
IRI (inches/mile)	<95	95-170	>170
Present Serviceability Rating (PSR)* (0.0-5.0 value)	≥4.0	2.0-4.0	≤2.0
Cracking Percent (%)	<5	CRCP: 5-10 Jointed: 5-15 Asphalt 5-20	>10 >15 >20
Rutting (inches)	<0.20	0.20-0.40	>0.40
Faulting (inches)	<0.10	0.10-0.15	>0.15

PSR may be substituted for IRI on routes with speed limits <40 mph

Deterioration models have recently been studied in a report called "Linking Infrastructure Challenges with Data"[18]. In this study the deterioration rates used in calculating the resulting NSI values were assumed to have a blanket assumption of 1.5% per year for concrete and 2.5% per year for asphalt. These rates are significant determinants in NDOT's NSI calculation and funding formulas for maintenance and construction allocation. This study was conducted to identify deterioration rates that are more descriptive than the assumed rates. This study could not distinguish a deterioration rate due to exogenous variables(maintenance activities). However, the findings found that higher traffic volume roads do not, on average, see higher deterioration rates than other roads, suggesting that NDOT's roadway design and maintenance strategies effectively mitigate pavement distresses.

The Pavement Management System Manual[19] describes the methodology for the prediction of federal measures through equations and modeling. The equations that were developed provide the method for calculating the present serviceability index (PSI) for bituminous and rigid pavements. The NSI and PSI provides a numerical value which can be used for evaluation of current pavement quality (see Table 5). As a guide to interpreting the NSI and PSI, the following subjective descriptions apply:

Table 5 - Evaluating Pavement

NSI	PSI	Verbal Descriptions
90 thru 100	4.0 thru 5.0	Excellent *(pavement like new)*
70 to 90	3.0 to 4.0	Good *(several years of service life remaining)*
50 to 70	2.0 to 3.0	Fair *(few years of service life remaining)*
30 to 50	1.0 to 2.0	Poor *(candidate for rehabilitation)*
0 to 30	0.0 to 1.0	Very Poor (*possible replacement)*

[18] Linking Infrastrure Challenges with Data report can be found at : https://dot.nebraska.gov/media/117073/pavement-deterioration-rates.pdf
[19] The Pavement Management System Manual can be found at: http://dot.nebraska.gov/business-center/materials/

2.5 Bridge Inventory

The Nebraska Bridge Inspection Program Manual defines a bridge as "a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between the undercoping of abutments or spring lines of arches, or extreme ends of openings for multiple boxes"[20]. There are currently more than 3,500 bridges on the State Highway System. The NHS includes about 1,430 bridges on the State system and about 70 bridges on local roadway networks[21]. Ninety-five percent of NHS bridge deck area is on the State Highway System. All bridge inspection information for both state and local bridges is stored and maintained by NDOT. The graphs in Figures 5, 6 & 7 provide an overview of the age, types of bridges, and bridge size on the State and NHS networks.

For a complete listing of State and NHS bridges, see the FHWA National Bridge Inventory[22].

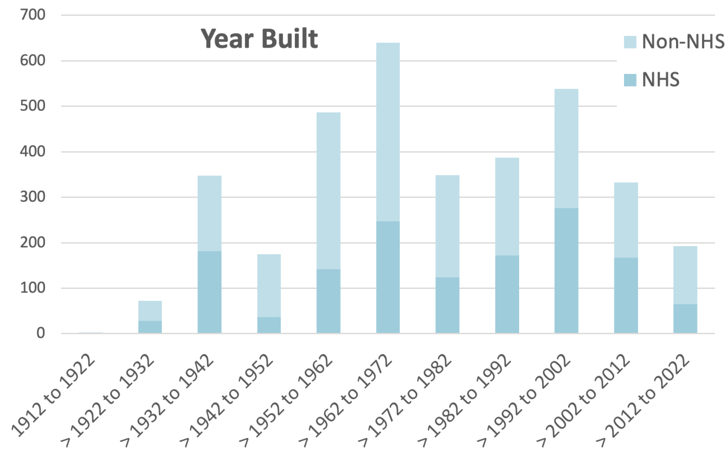


Figure 5 - Number of State-Owned Bridges Constructed per Decade*

**It should be noted that year of construction is not known exactly for some older bridges. For these bridges, it has been an agency practice to code the year of construction as 1935.*

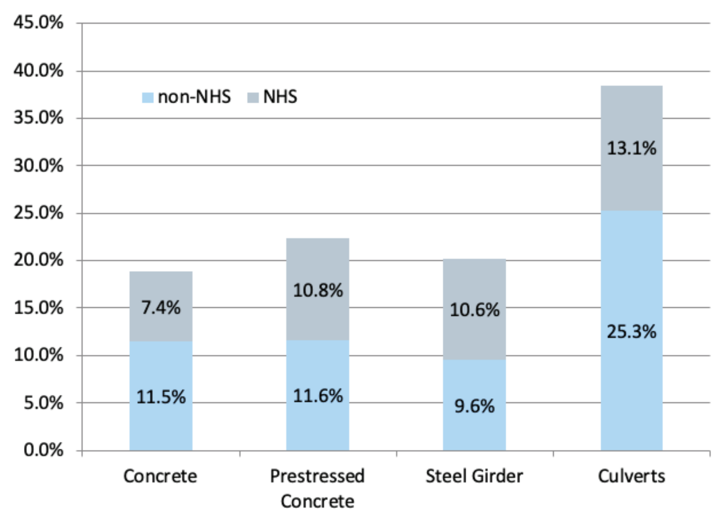


Figure 6 - Prevalence of Structure Types (percent of total number)

[20] 3-NBI.3 FHWA Coding Manual Definitions from the Bridge Inspection Program Manual https://dot.nebraska.gov/business-center/bridge/inspection/
[21] Nebraska bridge inventory and condition reports are available at: http://dot.nebraska.gov/business-center/bridge/
[22] FHWA National Bridge Inventory https://www.fhwa.dot.gov/bridge/nbi.cfm

Bridge length is determined by the requirements to span a waterway, roadway, or railroad under the bridge. The width of bridges is determined by traffic requirements defined in the Nebraska Minimum Design Standards.

Due to low life cycle cost and maintenance needs, concrete box culverts are the preferred bridge type on the State and NHS systems. When longer or higher structures are needed, other bridge types are built.

The average (non-culvert) bridge on the non-NHS State system is about 39.6 ft. wide and 215.1 ft. long. On the NHS, State and Local system combined, the average dimensions are about 102.9 ft. wide and 601.9 ft. long.

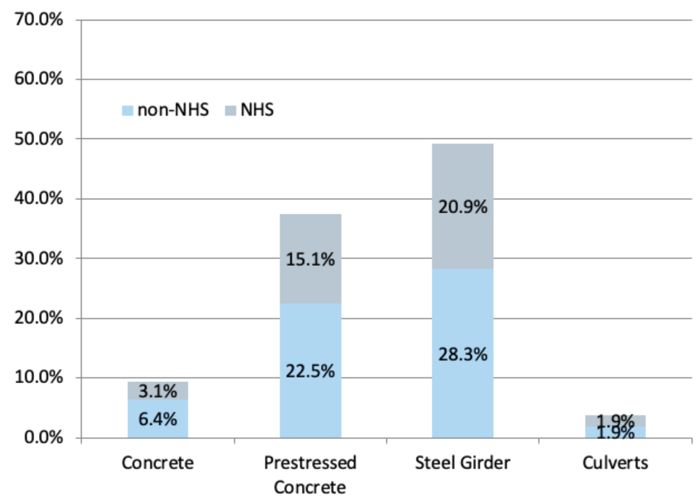


Figure 7 - Prevalence of Structure Types (percent of total deck area)

2.6 Bridge Condition

NDOT reports bridges in Good, Fair and Poor condition based on National Bridge Inspection program data. Bridges are considered to be in good condition if all major National Bridge Inspection components (bridge deck, bridge superstructure and bridge substructure or culvert) are in good condition or better (9, 8, 7). Bridges are considered to be in poor condition if one or more of the major components is in poor condition or worse (4 or less). Bridges that do not meet the criteria for good or poor condition are considered to be in fair condition (5 or 6)[23]. The term "Structural Deficiency" previously included bridges with poor condition and some bridges with better condition that had geometric or weight capacity deficiencies. This term is no longer in use and instead, structures with any major component rated 4 or less are classified as in "Poor" condition[24]. Figure 8 shows the relationship between bridge age and condition. The current status of bridges in good, fair or poor condition can be found in the Bridge Condition Report on the NDOT Bridge Division website: http://dot.nebraska.gov/business-center/bridge/. Over time, bridges deteriorate due to exposure to adverse conditions.

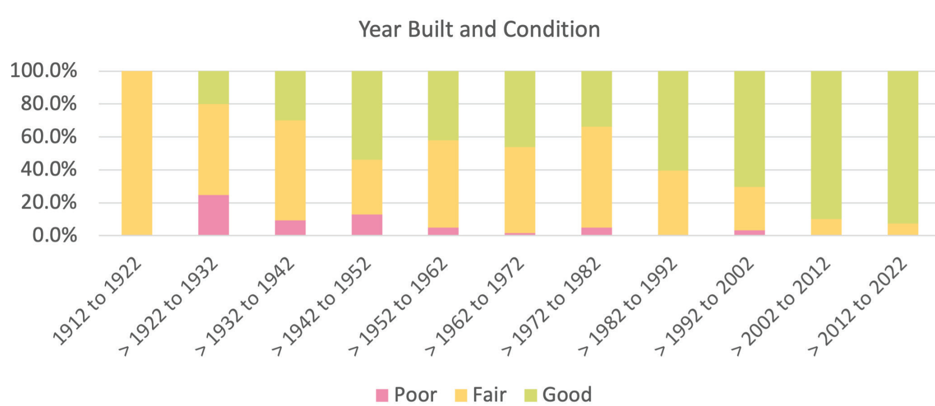


Figure 8 - Condition of State Bridge Inventory by Year Constructed

[23] These measures for Bridge Condition were adopted by NDOT after review of 23 CFR § 490.409
[24] 23 CFR § 490.405

CHAPTER 3

Asset Management Objectives, Practices, and Measures

3.1 Overview

NDOT uses a performance-based approach for asset management that focuses on evaluating system performance, identifying asset needs, and establishing investment priorities. Performance measures have been developed to monitor the condition of Nebraska's pavement and bridges. Performance measures are reported separately for the State system and the National Highway System (NHS), but the State system is the asset pool for competing project development. Various strategies are used to meet the objectives to preserve, rehabilitate, and replace the major assets managed by NDOT. The following subsection describes the various program and policy documents that inform processes used to manage NDOT assets.

3.1.1 Asset Management Resources and References

Programming and planning documents can be found at the following links:

1. *Nebraska's Long-Range Transportation Plan (LRTP)*
   http://dot.nebraska.gov/projects/publications/lrtp/
   a. Nebraska's LRTP defines methods for measuring performance and monitoring progress toward plan goals and objectives, providing a vision for transportation development 20 years into the future. This plan is updated every 5 to 7 years.

2. *State Highways Needs Assessment*
   https://dot.nebraska.gov/business-center/financial-reports/
   a. The State Highways Needs Assessment is a report presented to the State Legislature on a yearly basis that provides 20-year revenue projections and quantifies the cost to remove geometric deficiencies, address capacity needs, and preserve the highway system at a preferred condition level. It is a tool to communicate the funding level gaps over a 20-year period.

3. *NDOT's Annual Report*
   https://dot.nebraska.gov/news-media/annual-report/
   a. NDOT's Annual Report gives a yearly update on key performance measures for the NDOT including; Safety, Fiscal Responsibility, Environmental Stewardship, Project Delivery, Asset Management, Mobility, The four C's, Communication, Coordination, Collaboration, & Cooperation, and finally Workforce Development.

4. Nebraska's Surface Transportation Program
   https://dot.nebraska.gov/projects/publications
   a. Nebraska's Surface Transportation Program is an annual plan that consists of detailed maps, inventory lists, and preliminary estimates of current and planned construction projects for each of the eight districts in the state.

5. *NDOT STIP Guidelines*
   https://dot.nebraska.gov/projects/publications/stip/
   a. These guidelines describe the practices and procedures used by the NDOT, FHWA and the MPOs to develop and maintain the STIP and TIPs.

6. *Nebraska's State Transportation Improvement Program (STIP) and the Metropolitan Planning Organizations (MPOs) Transportation Improvement Program (TIP)*
   https://dot.nebraska.gov/projects/publications/stip/
   a. The Statewide Transportation Improvement Program (STIP) is NDOT's 4 year Highway Improvement Program developed under Title 23 United States Code (USC), Section 135 Statewide Planning, (f) Statewide Transportation Improvement Program. It includes by reference the Transportation Improvement Programs (TIP's) from the Grand Island, Omaha, Lincoln, and South Sioux City MPOs. It is updated annually.

7. *TMPOs Transportation Improvement Programs (TIP's) affecting the Nebraska's STIP*
   a. Grand Island Area Metropolitan Planning Organization
      https://www.grand-island.com/government/city-clerk/boards-and-commissions/mpo
   b. Lancaster County Planning Commission
      https://www.lancaster.ne.gov/702/Lincoln-Lancaster-County-Planning-Commis
   c. Omaha-Council Bluffs Metropolitan Area Planning Agency
      http://mapacog.org/services/transportation/planning/
   d. Siouxland Interstate Metropolitan Planning Council
      https://simpco.org/divisions/transportation-planning/

8. *MPOs Long Range Transportation Plans that inform MPO TIPs*
   a. Grand Island Area Metropolitan Planning Organization
      https://www.grand-island.com/departments/public-works/metropolitan-planning-organization/
   b. Lancaster County Planning Commission
      https://lincoln.ne.gov/city/plan/lrtpupdate/final/lrtp.pdf
   c. Omaha-Council Bluffs Metropolitan Area Planning Agency
      http://mapacog.org/projects/lrtp/
   d. Siouxland Interstate Metropolitan Planning Council
      https://simpco.org/divisions/transportation-planning/long-range-transportation-plans-lrtp/

9. *NDOT Operating Manual for MPO Transportation Planning (MPO Manual*)
   https://dot.nebraska.gov/business-center/mpo/

The Manual provides guidance to the Nebraska MPOs and the NDOT Strategic Planning Division, Program Management Division, and Local Assistance Division staff for carrying out metropolitan transportation planning responsibilities that use federal transportation planning funds. Local owners are responsible for the operation and maintenance of NHS routes under their jurisdiction.

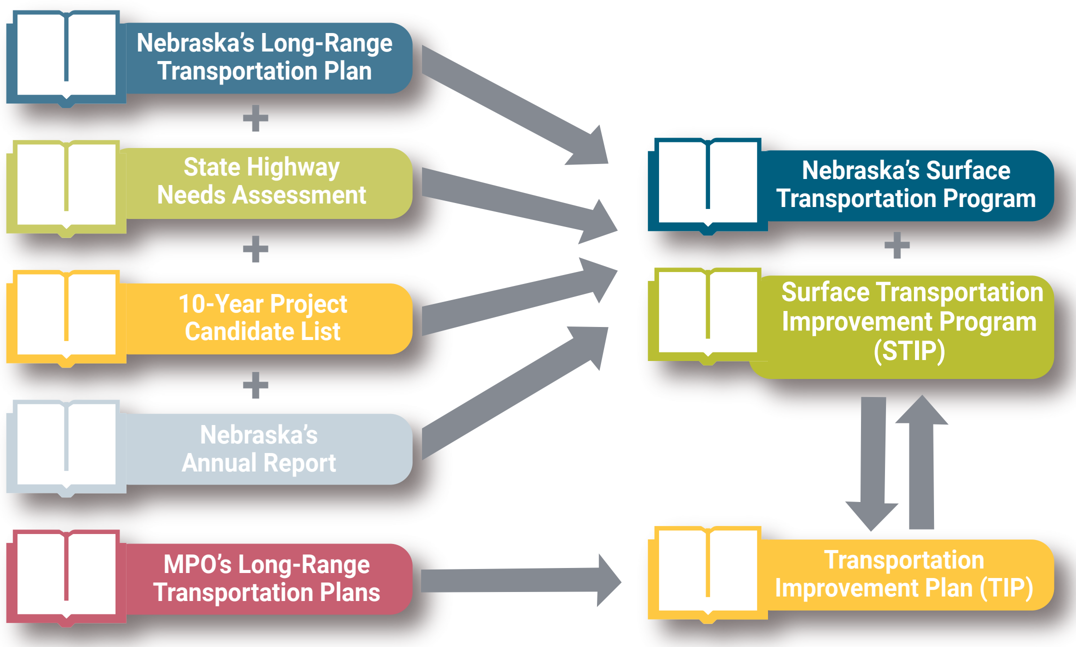


Figure 9 - NDOT's Process Overview

The programming and policy reference documents described in Section 3.1.1 are shown in Figure 9 to demonstrate how they inform the selection of projects for the State's program and STIP, along with the selection of projects for MPOs TIPs. The diagram is intended to show the general nature of how each of these documents inform the decision making process.

Understandably, the process by which decision makers arrive at a program of projects is the result of careful review of available information. This includes the review of data, stakeholder values and input, schedules and a host of other considerations. NDOT communicates these considerations to MPOs and stakeholders in a variety of ways including, Technical Advisory Committee meetings, ad hoc meetings, emails, news releases, etc. Some of these communication protocols are described in the NDOT MPO Planning Manual[25].

[25] The NDOT MPO Planning manual can be found at: https://dot.nebraska.gov/media/6846/mpo-operating-manual.pdf

3.2 Pavement and Bridge Management Objectives

NDOT's major objectives:

1. Maintain pavement and bridges in a state of good repair (SOGR).

   It is necessary to maintain the quality of pavement and bridges in order to improve the safety and mobility of transportation system users. Safety considerations focus on reducing frequencies and rates of fatalities, injuries, and property damage, which in turn reduces the economic impact of these occurrences. To increase mobility, attention is given to the management of existing infrastructure by conducting routine inspections and analyzing condition data in order to prioritize maintenance and rehabilitation candidates and employ the most cost-effective treatments.

2. Optimize budget expenditures

   NDOT's goal is to optimize the use of funds available to Nebraska for the greatest benefit of the State Transportation System. Progress toward this goal is accomplished by minimizing overhead costs to maximize funding for transportation services. NDOT is committed to objective and transparent processes that consider needs, available and projected funding, risks, operational constraints, minimized life cycle costs, and matching the level of service to public expectations. The construction program is developed to balance trade-offs between competing objectives and maximize performance at the lowest possible life cycle cost.

3. Meet or increase the expected life-span of the major assets

   Good asset management practices help provide the best use of resources at each phase of a major asset's life cycle. NDOT uses life cycle costs when evaluating construction and preservation strategies. Future maintenance and operating costs can exceed the initial cost of an asset over a long period of time. Higher initial costs can provide substantial long-term cost savings. Assets that are well managed tend to have longer life spans and are more cost effective. The uncertainty associated with long-term decisions is addressed with probabilistic analysis to determine the most likely outcomes among competing alternatives.

Strategies to meet the major objectives

1. Strategically preserve, rehabilitate, and replace the major assets

   NDOT performs regular inspections and condition evaluations in order to implement the appropriate strategy at the appropriate time for pavement and bridges. Strategies are evaluated at project and systemic levels. Deliverable projects that meet agency goals are prioritized in the program. High priority projects with deliverability obstacles are evaluated to determine and address obstacles, then reconsidered for optimal program strategies and timing. NDOT programs use-in-place repair and thin asphalt overlay strategies, where cost effective, on existing highways. These strategies extend pavement life while offering a noticeable improvement in smoothness and a faster construction schedule than traditional rehabilitation or reconstruction strategies.

2. Support the development of asset management systems to include all major assets

   In the past, fleet and buildings have been identified as major assets. Other assets have also been considered as potential major assets, but more data and analysis are needed before they can be included in the TAMP.

3. Identify elements that will be used in the measurement of the major assets

   There are multiple elements necessary to measure assets: trained and qualified employees, standard procedures and reporting systems, and analysis. NDOT reviews these measures to ensure their quality and accuracy and updates these when necessary.

4. Continue and expand methods to assist in the assessment of assets

   Standardized methods have been created and implemented for pavement and bridge inspections and can be found in the Surface Distress Survey Manual[26] and the Bridge Inspection Manual[27]. Methods for other major asset candidates are still under consideration but will not be included with this report. Procurring new technologies to better the collection procedures such as profilergraphs and survery equipment.

5. Train NDOT staff on the use of inspection and data collection methods

   NDOT has implemented training programs for both pavement and bridge inspectors. Pavement raters and profiler drivers attend training on a yearly basis. Profiler drivers work with the vendor before collection season to calibrate the profiler vans sensors and learn any new software updates. Pavement raters spend time in the field as a group to reinforce survey methods and build consistency. Bridge inspection training is provided by the National Highway Institute (NHI). The Nebraska Local Technical Assistance Program (LTAP) facilitates NHI bridge inspector training. Bridge inspection is evaluated through a contracted Quality Assurance program. The NDOT Bridge management employees have on-going training through in-house seminars and collaborative research with the University of Nebraska.

6. Provide annual status updates of assets in the NDOT Annual Report[28]

   NDOT produces an Annual Report, which contains historical trends and current major asset condition performance ratings. The current ratings are evaluated against asset management targets.

NDOT's information systems are a key component of the strategies used to meet asset objectives. NDOT's Business Technology Support Division monitors and evaluates technological advances to determine if new software or data management practices could increase efficiency and effectiveness of data collection and reporting.

A general workflow of NDOT's approach to managing pavement and bridges is depicted in Figure 10. The workflow is a continuous process consisting of (a) inspection and rating, (b) analyzing the data, (c) making decisions on how to address any issues, (d) ongoing maintenance and/or resurfacing and reconstruction, as appropriate.

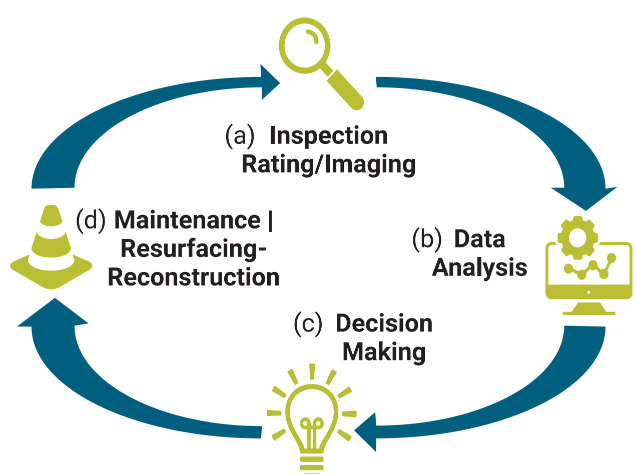


Figure 10 - Workflow of NDOT's Asset Management Plan

[26] The surface distress survey manual can be found at: http://dot.nebraska.gov/business-center/materials/
[27] The Bridge Inspection Manual can be found at: http://dot.nebraska.gov/business-center/bridge/inspection/
[28] The Annual Report can be found at: http://dot.nebraska.gov/news-media/annual-report/

3.3 Pavement Information Systems and Practices

3.3.1 Pavement Information Systems

Using the Nebraska Pavement Management System manual (NPMS)[29] as a guide, Pavement Asset Management personnel have been collecting and storing surface data and efficiently managing the condition of Nebraska's roadways since the system's development in 1984. The initial system was developed based on the American Association of State and Highway Transportation Officials "Guidelines on Pavement Management." In 1994, the scope of this system expanded to include all locally-owned roads on the National Highway System (NHS).

To further improve Nebraska's pavement management system, the Pavement Optimization Program (POP) was developed in house and put on-line in 2004. POP is a comprehensive program that utilizes all pertinent data, including inventory, pavement condition, performance targets, programmed projects, traffic volumes, deterioration rates, and current pavement strategy costs to manage pavement assets. POP also allows managers the ability to run a Life Cycle Cost Analysis based on benefit/cost by selecting pavement condition target levels, time periods, and funding levels *(see Chapter 5 for more details)*. In 2012, Nebraska introduced a prioritization assessment component, which ranks potential pavement section projects using several system factors *(see Section 4.3.1 for more details)*.

The POP application has two main components, the Pavement Management Data tab and the Life Cycle Cost Analysis tab as shown in Figure 11. For either tab, the user can select the area of interest (statewide, district, or highway) and the system (all systems, interstate, expressways, NHS) to be viewed or analyzed.

The Pavement Management Data component allows users to view all pertinent data for the area/ system selected as shown in Figure 12. Each highway is broken down into historical project length pavement sections for inventory and analysis purposes. Some of the key elements for each pavement section are:

- Highway Number, Reference post range, Location, Length
- Age, Surface type, Number of lanes
- Condition ratings, Geometric deficiencies
- Maintenance cost per lane mile
- Current and Future Average Daily Traffic Counts for both cars and trucks
- Optimum and Critical years for rehabilitation
- Number of Crashes and the 5-year average

In addition to these elements, users can view cross-sections, roadway images, and historical condition graphs. The Life Cycle Cost Analysis component allows users to run analysis on the areas of interest and system in two different ways.

1. Users can compute the cost to maintain a selected NSI value or condition level over a selected number of years.
2. Users can compute the resulting NSI value or condition level, over a selected number of years, given a specific budget.

[29] The Pavement Management System Manual can be found at: http://dot.nebraska.gov/business-center/materials/

Both of these options use the following factors in the analysis:

- Current condition ratings for age, NSI, PSI, cracking, rutting, and faulting
- Deterioration rates for NSI, PSI, cracking, rutting, and faulting
- Length, strategy types and cost per mile as shown in Tables 15 & 16

Both types of analysis use the above factors and decision trees as shown in Figures 13 & 14 to assign a proper strategy to pavement sections at the proper time to either compute the cost to achieve the desired condition or the resulting condition from a set budget.

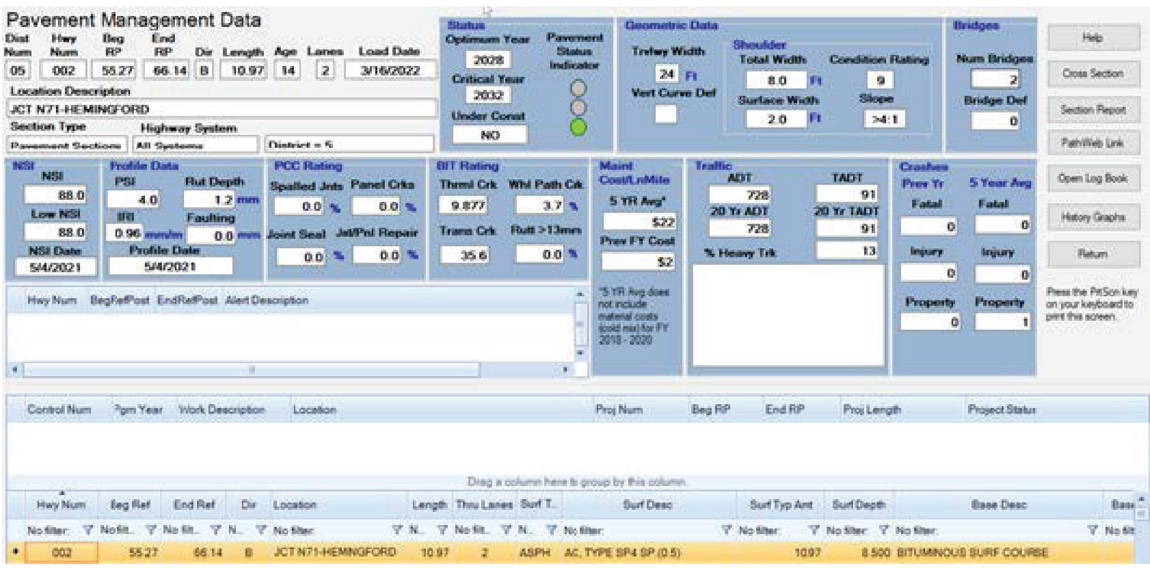


Figure 11 - POP Main Screen

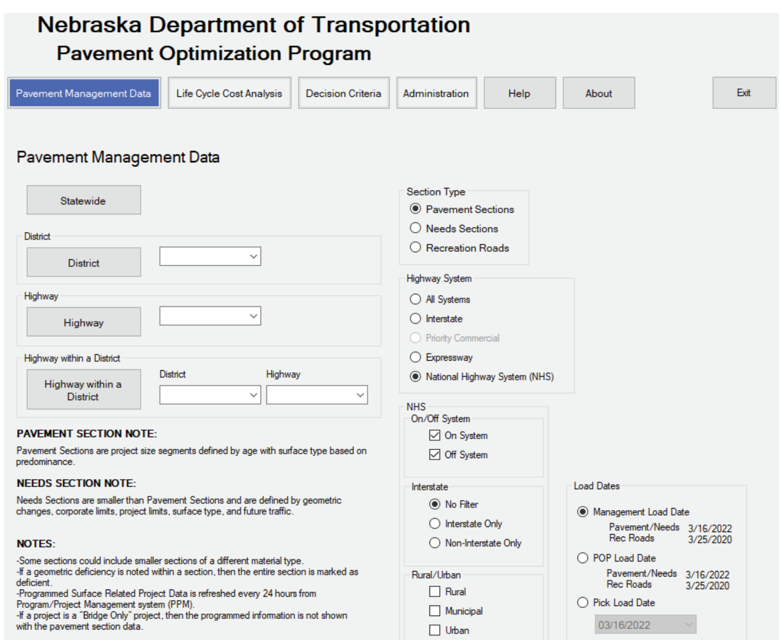


Figure 12 - POP Pavement Management Data Screen

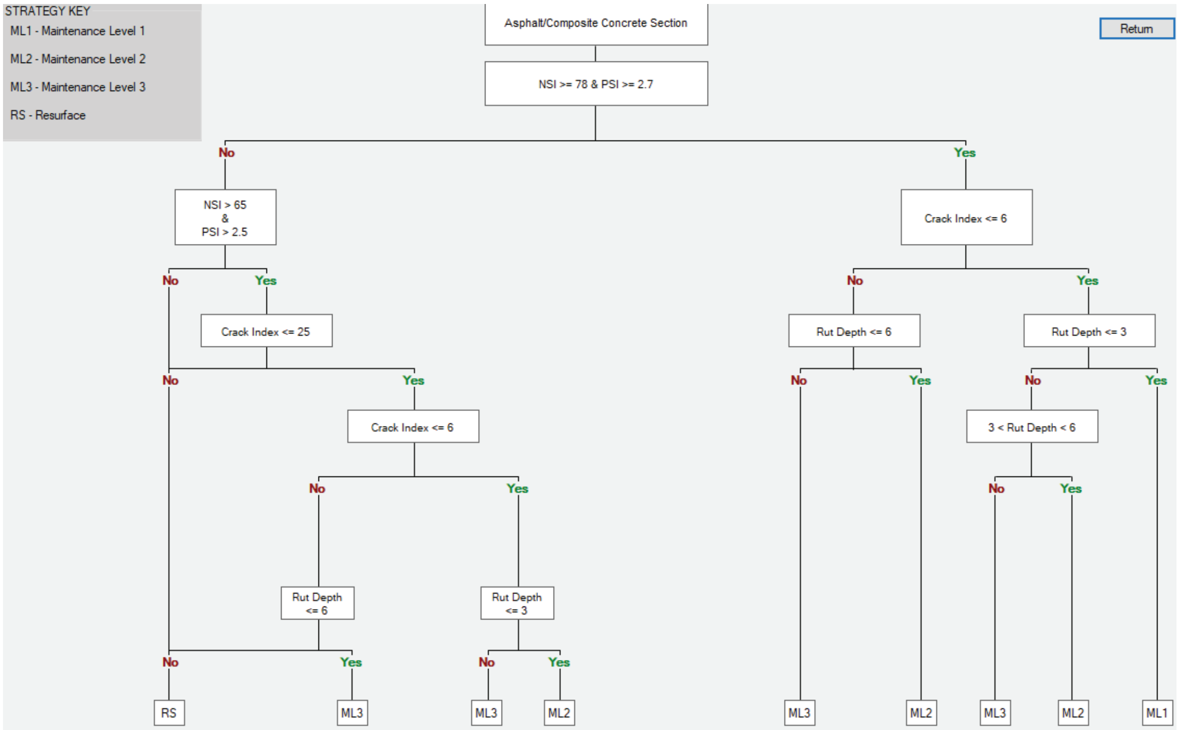


Figure 13 - POP Asphalt Decision Tree

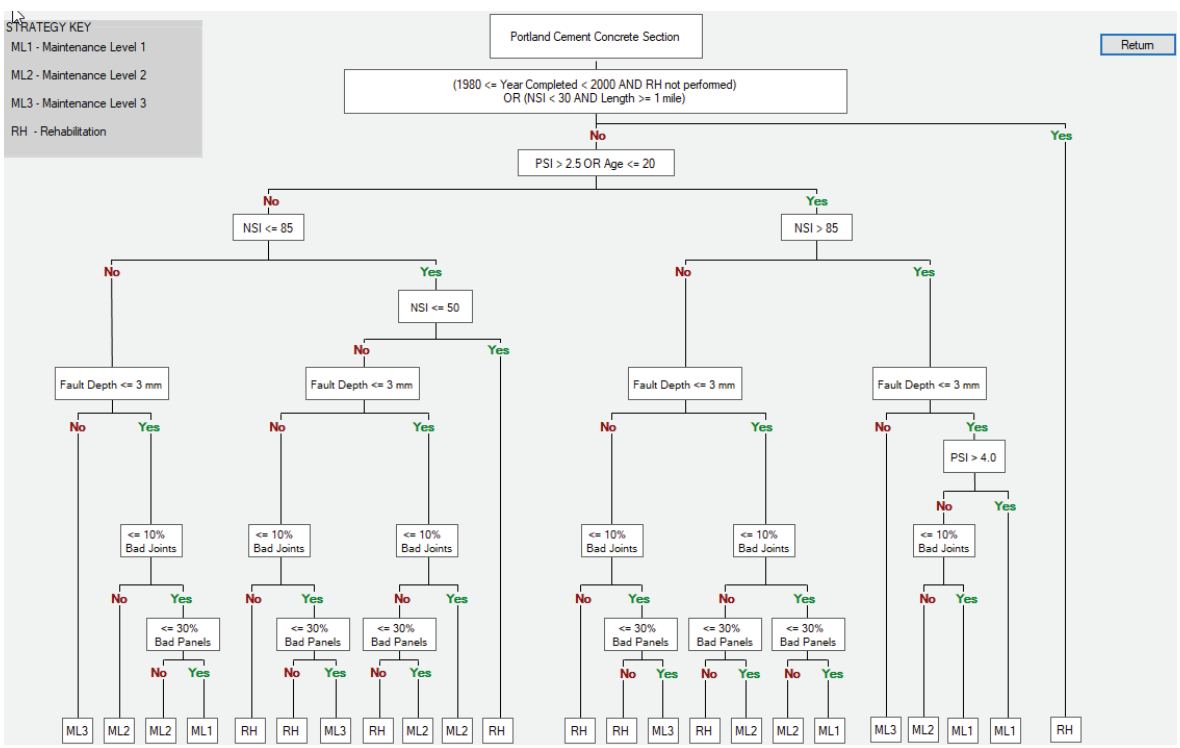


Figure 14 - POP Concrete Decision Tree

3.3.2 Pavement Data and Pavement Program Allocation Development

NDOT uses the Life Cycle Cost Analysis in POP to perform a variety of condition, maintenance, and cost-related analyses.

One of the key practices is the development of the "Needs Assessment" report, required by the Nebraska State Legislature since 1988[30]. The 20-year assessment communicates the cost to eliminate geometric deficiencies, address capacity, and obtain Nebraska's condition target for NSI, which identifies potential gaps in funding levels.

Another key practice to pavement asset management is the development of the 10-year project candidate lists for each district (see Figure 23). A 10-year Life Cycle Cost Analysis is run in POP to bring the entire system to a selected performance target. This analysis prioritizes projects, through identifying the right improvement strategy, the cost, and the right construction time for each highway pavement section. These project candidate lists are provided to the NDOT Program Management Division and each of the eight NDOT District Engineers to assist in the development of their annual transportation programs. Similar project candidate lists are provided to MPOs as a tool to help in the development of their individual TIP's (Figure 16).

In addition to the practices above, due to the importance of the interstate, NDOT has an Interstate Task Force that reviews programmed projects for the interstate by driving the system annually to verify the timing and strategy for planned work. The task force uses the latest condition and project data as a resource for this review. After the field review, the task force meets to finalize the interstate projects for the next five years.

3.4 Bridge Information Systems and Practices

3.4.1 Bridge Inventory and Appraisal Data Collection and Storage

The NDOT Bridge Division manages the inspection program for the State Highway System and the inspection data repository for all bridges in Nebraska (both State and Local systems). Bridge inventory and inspection data and documents are collected and maintained in accordance with the guidelines and requirements in the Nebraska Bridge Inspection Program Manual (Nebraska BIP Manual)[31].

Since April 2014, NDOT has inspected bridges on the NHS and State systems using Element Level Inspection. NDOT has collected NBI method general condition data since 1998.

Inspection reports and data are recorded by bridge inspectors using BrM, a web-based software that is licensed from AASHTO and has been customized for NDOT use. Data from the bridge inspection reports is maintained in a SQL server database and stored on a State system server along with bridge inspection photographs, plans and other documents. BrM allows State and local bridge owners and managers to directly access the inspection records and contains many features that support bridge management.

3.4.2 Bridge Data Quality Assurance and Maintenance

Quality control for bridge inspection reports is described in Section 1.9 of the Nebraska Bridge Inspection Program Manual. NDOT contracts with an independent bridge inspection consultant to conduct a bridge inspection review process to maintain high standards for bridge inspection reporting.

[30] Needs assessment statutes are available at: https://nebraskalegislature.gov/laws/statutes.php?statute=39-1365
[31] The NBIP Manual can be found at: http://dot.nebraska.gov/business-center/bridge/inspection/

All inspection data is reviewed prior to the annual submittal to the FHWA using an automated online National Bridge Inventory File Check feature. This process checks for common errors and inconsistencies with inspection appraisal and inventory data. Additional data quality review is conducted with scheduled tasks to identify and remedy inconsistent data or missing data and documents.

After submittal to the FHWA, bridge inspection records are reviewed for compliance with the National Bridge Inspection Program (NBIP) compliance metrics[32]. These 23 metrics are intended to assure compliance with the National Bridge Inspection Standards (NBIS) at 23 CFR Part 650, Subpart C.

Decisions for bridge inspection and bridge management require current, accurate and sufficiently detailed data. Access to bridge data for decision makers can be provided through BrM. This application has features for generating bridge inspection reports, exporting tables of bridge data, and exporting KML files that can be opened in programs such as Google Earth. Inventory, inspection and construction program data can also be accessed directly. These direct links to bridge information ensure that the most current information is used to guide decisions.

3.4.3 Bridge Data and Bridge Program Allocation Development

Current and historic bridge inspection data, inventory data and documentation are used to guide bridge programming decisions. Strategies for bridge work are developed for three groups of bridges. The consequences and likelihood of condition and serviceability changes are evaluated for these groups of bridges.

- poor condition bridges that need major work such as replacement
- bridges that are on roadway projects, which can provide an opportunity to perform bridge work without additional traffic disruption
- good condition bridges that are high-asset value candidates for preservation

Bridge inspection data is screened by an automated risk-based decision tree process for major work (Re-decking, Rehabilitation and Replacement)[33]. The suggested strategies are previously evaluated for Life Cycle Cost effectiveness for bridges that meet the threshold values for condition, age, material properties and design type[34]. The NDOT Bridge Management Section then performs an engineering review of the automated results and other inspection data to identify and confirm candidates for bridge work programming. Low-condition bridges that are candidates for major replacement or rehabilitation work are prioritized. Top priority candidates are assigned a suggested year for inclusion in the construction program. Lower priority candidates are included for a 10-year planning horizon. These lower priority candidates are reviewed annually for inclusion in the construction program.

Similarly, good condition bridges with high-asset value are identified as preservation candidates in an automated process[35]. Next, an engineering review evaluates and specifies preservation strategies where in 2020 NDOT conducted a bridge preservation study called, "Bridge Asphalt Overlay with Waterproffing Membrane Effectiveness." There is a window of opportunity for application of preservation treatments. Prioritization for preservation work increases with time, before bridges deteriorate from good to fair condition. Top-priority bridges are suggested for programming.

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[32] The 23 Metrics for the Oversight of the National Bridge Inspection Program https://www.fhwa.dot.gov/bridge/nbis.cfm
[33] See Appendix C for an illustration of the major bridge work decision tree.
[34] See "Life-Cycle Assessment of Nebraska Bridges" by George Morcous 2013" https://dot.nebraska.gov/media/5690/final-report-m312.pdf
[35] For a detailed case study see "Bridge Asphalt Overlay with Waterproofing Membrane Effectiveness Study" https://dot.nebraska.gov/media/116390/vcs-report-us-75-77-cn-32309-final.pdf. The Appendix C of this study also provides background on the effectiveness of concrete overlays.

Roadway projects provide a significant opportunity for bridge work without causing added traffic disruption. Most bridge preservation strategies are delivered in coordination with roadway projects. On average, roadway projects occur about every 15-20 years in the vicinity of State and NHS bridges. As roadway projects are developed, any bridges that are in the roadway project limits are reviewed by the Bridge Management Section. Typical work that is performed on bridges in conjunction with roadway work are concrete repairs and application of bridge deck preservation treatments such as epoxy polymer overlays, or asphalt overlay with a waterproofing membrane system and joint replacement.

Bridge management decisions are augmented by a combination of in-house and customized commercial software including AASHTOWare BrM and the FHWA Life Cycle Cost Analysis tool RealCost. Categories of repair strategies are evaluated with Life Cycle Cost Analysis to assure long-term cost effectiveness[36].

3.5 Performance Measures

NDOT uses a performance-based approach to manage its pavement and bridge transportation assets. Each year, NDOT reviews the asset management measures and practices in order to define clear standards, provide the best service, and report on the progress made toward reaching performance goals. This information is compiled and disseminated in NDOT's Annual Report[37].

Moving forward, NDOT will continue to use state performance measures for management of assets and reporting to the NDOT Annual Report. In addition, NDOT will report the following pavement indices to the FHWA to be used in determining national performance measures:

- Average IRI
- Cracking Percentage
- Average Depth of Rutting
- Average Height of Faulting

Additional historical indices used by NDOT to measure the performance of the State highway system:

- Number of Fatalities
- Serious Injury Crashes
- Motor Vehicle Crashes
- Overhead as a Percentage of Annual Expenditures
- Accuracy of Project Estimates in the One-Year Program
- Construction Competitiveness
- Corrective Action for Environmental Commitments
- Percent of Projects Delivered in the One-Year Program
- Percent of Projects Delivered in the Five-Year Program
- Percent of Projects Completed Within the Number of Days Allowed
- Number of Years to Prepare an Asset Preservation Project for Construction
- Average Time to Complete the NEPA CE for Federally Funded Construction Projects
- Percent of Miles of Pavement Rated Good or Better based on NSI
- Percent of Miles on the NHS with IRI <95 in/mi
- Percent of State-Owned Bridges in Good Condition
- Percent of Total Deck Area Structurally Deficient
- Omaha Urban Freeway Incident Clearance Time
- Rural Interstate 80 Reliability

[36] Unit costs can be found at: https://dot.nebraska.gov/business-center/business-opp/hwy-bridge-lp/item-history/
[37] NDOT Annual Report https://dot.nebraska.gov/news-media/annual-report/

3.5.1 State Pavement Performance Measures

NDOT's performance measures evaluate the condition and smoothness of pavement according to the Nebraska Serviceability Index (NSI) and the International Roughness Index (IRI). These performance measures are tracked in NDOT's Annual Report. For the purpose of this report, NDOT is setting state performance measure targets for NSI only.

Nebraska manages and sets targets for all non-interstate state highways the same regardless of whether they are on the NHS or not. The interstate system, being NDOT's highest priority has its own performance measure target.

Table 6 shows the pavement performance measures as well as NDOT's targets for each measure.

Table 6 - State Pavement Performance Measures

Asset Type	Performance Measure	Target
Pavement	Weighted average NSI for the interstate system	≥86
	Weighted average NSI for the non-interstate NHS system	≥80

To achieve these goals, NDOT will invest in pavement preservation and preventative maintenance. NHS interstates and highways receive appropriate pavement designs and maintenance strategies to accommodate higher number of users and their economic and strategic importance.

As required by MAP-21, states must set national performance measures targets for pavements. These targets will be used to determine if Nebraska is making significant progress toward meeting the national performance measures targets.

Table 7 shows the national pavement performance measures for the NHS as well as NDOT's targets for each measure. These targets were originally set conservatively due to limited cracking data. The target for percent of pavements on the interstate system in good condition was increased from ≥50 to ≥65 in 2022.

Table 7 - National Pavement Performance Measures

Asset Type	Performance Measure	2- & 4-Year Targets
Pavement	Percent of pavements on the interstate system in good condition	≥65
	Percent of pavements on the interstate system in poor condition	≤5
	Percent of pavements on the non-interstate National Highway System in good condition	≥40
	Percent of pavements on the non-interstate National Highway System in poor condition	≥10

3.5.2 Bridge Performance Measures

In recent years, Nebraska has achieved its performance goals, outlined in Table 9, for bridges on the NHS and State Highway System as shown in Figure 15.

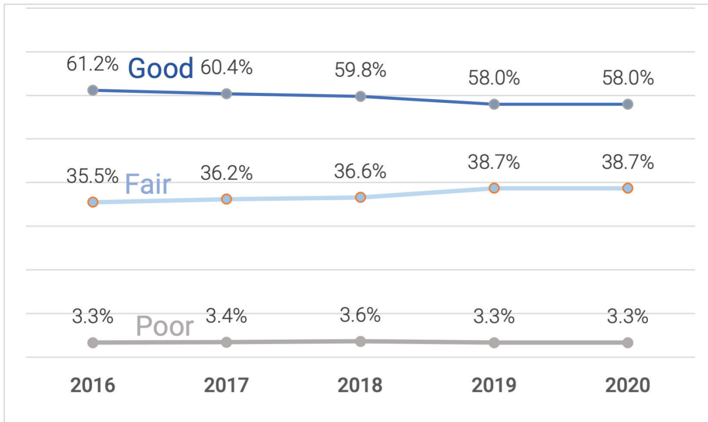


Figure 15 - Historical Trends for State System Bridges in Good, Fair and Poor Condition (includes most of NHS)

Current Nebraska bridge performance measures are available in the NDOT Annual Report[38]. This report does not include the 57 NHS bridges that are not owned by the State. Additional information about Nebraska State, Local, and NHS system bridge conditions can be found in the Bridge Condition Report on the NDOT Bridge Division webpage[39].

Bridges are determined to be good, fair, or poor condition, as described in Chapter 2, Section 2.5 of this report.

Major Bridge Components bridge deck, superstructure, substructure	
Good	Major bridge components are all in good condition or better.
Poor	One or more major bridge components are in poor condtion or worse.
Fair	All other bridges.

[38] The NDOT Annual Report can be found at: http://dot.nebraska.gov/news-media/annual-report/
[39] NDOT Bridge Division webpage can be found at: http://dot.nebraska.gov/business-center/bridge/

Nebraska's Policy on Bridges in a State of Good Repair

Description: Measurement of the progress towards keeping state-owned bridges in a condition of good repair.

Purpose: All bridges in Nebraska are safety inspected every two years and the condition information is stored in the Nebraska Bridge Inventory. This condition information is used by the Bridge Management section to determine cost-effective strategies to keep the bridges in good repair. The necessary work may include preservation, repair, maintenance, re-decking, rehabilitation or replacement.

Goal:

95%

Nebraska's state-owned bridges in good or fair condition.

Outcome:

97%

Nebraska's state-owned bridges are in good or fair condition.

Similar to pavements, states must set national performance measures targets for bridges. These targets will be used to determine if Nebraska is making significant progress toward meeting the national performance measures targets.

Performance targets for bridges include a minimum target for percent of bridge deck area in Good condition and a maximum target for percent of bridge deck area in poor condition. The targets for the preferred minimum of deck area in Good condition is based on historical trends and an evaluation of the anticipated future deterioration combined with the condition improvements that are expected due to the bridge construction program. The target for maximum acceptable deck area in Poor condition is based on the FHWA threshold of 10%. The threshold used for actual modeling of future bridge allocation needs is lower and is similar to the historical trend for percent of poor deck area on the State system of about 3%.

Table 8 shows the NDOT performance targets.

Table 8 - State Bridge Performance Measures and Targets

Asset Type	Performance Measure	Target
Bridge	Percent of the total deck area of bridges in the state on the National Highway System located on bridges that have been classified as poor condition	≤10
	Percent of bridges on the State system and NHS in good or fair condition	≥95

Table 9 shows Nebraska's national bridge performance targets for the NHS.

Table 9 - National Bridge Performance Targets

Asset Type	Performance Measure	2- & 4-Year Targets
Bridge	Percent of NHS bridges classified as in good condition	≥55
	Percent of NHS bridges classified as in poor condition (structurally deficient)	≤10

3.5.3 Locally-Owned NHS Performance Measures

The NDOT has coordinated with the state's four MPOs to help in the selection of performance measures for locally owned NHS routes. The NDOT held meetings in 2018, 2020, and 2022 with the MPOs to discuss the requirements and the performance measures Nebraska uses and why.

The inclusion of MPO's is critical to the entire transportation network in Nebraska. Their inclusion in discussions helped NDOT support the MPOs on language for the NDOT/MPOs LRTPs and TIPs. These relationships then helped the MPOs select their final PM2 performance measures following the acceptance of NDOT's performance targets.

Below are excerpts from the Lincoln and Omaha MPO LRTP's stating that they will be supporting NDOT PM2 performance measures. The Grand Island and South Sioux City MPOs do not own any NHS routes.

> Lincoln MPO 2050 LRTP Amended December 2021 – *"The Lincoln MPO has agreed to support the NDOT Statewide Performance Measure Targets to maintain Pavement Condition and Bridge Condition for the National Highway Performance Program (PM-2)."*
>
> MAPA's 2050 LRTP Amended October 2020 – *"MAPA has chosen to support the Targets submitted by the Iowa and Nebraska Departments of Transportation in their most recent baseline period performance reports. The MPO supports those targets by reviewing and programming all Interstate and National Highway System projects within its boundary that are included in the DOTs Transportation Improvement Programs."*

For more information, refer to Section 3.1.1.

NDOT will provide MPOs with a suggested 10-year pavement and bridge project candidate list for the local NHS routes as a tool to aid in their decision-making process. For an example of the pavement candidate list, see Figure 16.

District 1
Pavement Sections

Selected Projects Based on 10 Year Life Cycle Cost Analysis
Sorted by Hwy and Ref Post

Selected Candidate Years: 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032
Selected Strategies: All Strategies

HWY NUM	BEGIN REF. POST	END REF. POST	LANE DIR	LENGTH	LOCATION	PRIORITY RANK	CB RANK	STRATEGY	CANDIDATE YEAR	EST. COST	NSI BEFORE STRATEGY	NSI AFTER STRATEGY	PROGRAM YEAR
5228	100.31	101.53	A	1.28	ROSA PARKS WAY LINCOLN	11.02	0.73	RH-PCC	2023	$977,587	77.90	100.00	
5228	100.31	101.53	A	1.28	ROSA PARKS WAY LINCOLN	1.62	1.27	ML1AC	2027	$19,200	90.00	92.50	
5228	100.31	101.53	A	1.28	ROSA PARKS WAY LINCOLN	2.12	1.66	ML2AC	2031	$83,200	82.50	87.50	
5228	100.31	101.53	D	1.28	ROSA PARKS WAY LINCOLN	10.56	0.41	RH-PCC	2023	$977,587	86.98	100.00	
5228	100.31	101.53	D	1.28	ROSA PARKS WAY LINCOLN	1.62	1.27	ML1AC	2027	$19,200	90.00	92.50	
5228	100.31	101.53	D	1.28	ROSA PARKS WAY LINCOLN	2.12	1.66	ML2AC	2031	$83,200	82.50	87.50	
5228	101.53	101.84	A	0.31	ROSA PARKS WAY LINCOLN	10.76	0.69	RH-PCC	2023	$236,759	83.87	100.00	
5228	101.53	101.84	A	0.31	ROSA PARKS WAY LINCOLN	1.58	1.27	ML1AC	2027	$4,650	90.00	92.50	
5228	101.53	101.84	A	0.31	ROSA PARKS WAY LINCOLN	2.08	1.66	ML2AC	2031	$20,150	82.50	87.50	
5228	101.84	102.28	A	0.46	K STREET LINCOLN	11.83	1.45	RH-PCC	2023	$351,320	58.00	100.00	
5228	101.84	102.28	A	0.46	K STREET LINCOLN	1.58	1.27	ML1AC	2027	$6,900	90.00	92.50	
5228	101.84	102.28	A	0.46	K STREET LINCOLN	2.08	1.66	ML2AC	2031	$29,900	82.50	87.50	
5230	101.10	101.17	A	0.07	L STREET LINCOLN	2.26	1.62	RS-AC	2023	$40,950	65.00	100.00	
5230	101.10	101.17	A	0.07	L STREET LINCOLN	1.58	1.27	ML1AC	2027	$1,575	90.00	92.50	
5230	101.10	101.17	A	0.07	L STREET LINCOLN	2.08	1.66	ML2AC	2031	$6,825	82.50	87.50	
5230	101.17	101.87	A	0.70	CAPITAL PARKWAY WEST LINCOLN	10.56	0.54	RH-PCC	2023	$534,618	86.48	100.00	
5230	101.17	101.87	A	0.70	CAPITAL PARKWAY WEST LINCOLN	1.58	1.27	ML1AC	2027	$10,500	90.00	92.50	
5230	101.17	101.87	A	0.70	CAPITAL PARKWAY WEST LINCOLN	2.08	1.66	ML2AC	2031	$45,500	82.50	87.50	

Figure 16 - Example of Candidate List for NHS that Reside Inside of MPO's

CHAPTER 4

Performance Gap Identification

4.1 Overview

A performance gap is defined as the difference between existing and desired performance. Minimizing performance gaps for pavement and bridges at the lowest practicable costs is the goal of asset management and the key to improving mobility, safety and reliability of the system.

The best performance at a given funding level can only be achieved when allocations are properly made through project delivery and good allocation decisions. Understanding the ways in which existing funding levels will affect future asset management practices is also necessary for developing meaningful performance targets. For example, if effective asset management allocations are not made for preservation projects, future replacement costs will increase. Every year NDOT evaluates the funding projections and asset conditions to assess funding adequacy. At the time of the TAMP's publication, Nebraska met the pavement and bridge performance targets listed in Chapter 3. By meeting the performance targets, Nebraska Roads and Bridges are in a State of Good Repair (SOGR)[40]. There is currently no gap between performance targets and performance measures.

4.2 Defining Short- and Long-Term Planning Horizons

NDOT has developed, and continues to implement short and long term planning horizons to meet agency goals and communicate with stakeholders as projects develop. Implementation of the TAMP is a continuation of Nebraska's asset management process which has resulted in a SOGR. It is expected that with continued, current funding levels and allocation strategies that are in alignment with practices described in the TAMP, NDOT will be able to maintain a SOGR.

4.2.1 Short-Term Plan

NDOT's short-term planning horizons for asset management results in the Nebraska Surface Transportation Program Book and the Statewide Transportation Improvement Program (STIP). The Nebraska Surface Transportation Program is developed annually based on cash flow analysis, funding projections, funding allocations, a system-wide 10-year project candidate list based on Life Cycle Analysis, and project delivery schedules.

Each year, the pavement condition assessment and the POP application is used to generate a 10-year project candidate list. Each project is given a rank based on condition, benefit/cost, and a priority assessment (see Section 4.3.1 for more details). The project candidate list provides decision makers with the rank of each project, the optimum year of rehabilitation, a recommended rehab strategy, and an estimated cost. The optimum year is the year when the benefit to cost ratio of rehabilitating the pavement is at the maximum.

[40] For a definition of "State of Good Repair", see Appendix B.

Bridges that are confirmed candidates for replacement, but are low-risk and considered to have remaining service of 10 years or less, but do have service life value beyond the timeframe of the Surface Transportation Program are monitored and prioritized annually. Only minimal preservation would be performed on these bridges as needed for short term safety. Similarly, large-scale preservation work on high asset value bridges, also receives annual review for inclusion in the program. A risk-based approach to both replacement and preservation work is used to rank candidates[41].

Bridges within the limits of proposed Roadway projects are evaluated for maintenance and preservation needs. Roadway projects provide an opportunity for bridge work that keeps bridges in a state of good repair. Strategies for “opportunistic” bridge preservation and repair are evaluated for life cycle cost effectiveness at the typical frequency of roadway projects.

The STIP is the NDOT four-year Highway Improvement Program developed under Title 23 United States Code (USC), Section 135 Statewide Planning, (f) Statewide Transportation Improvement Program. It includes by reference the Transportation Improvement Programs (TIP’s) from the Omaha, Lincoln, Grand Island area and South Sioux City metropolitan planning Organizations (MPOs.)

The STIP is a programming tool that receives joint approval from FHWA and the Federal Transit Authority (FTA) annually. Projects included in the STIP are consistent with the Nebraska Long Range Transportation Plan, Freight plan, and the Nebraska Needs Study. Projects included in the MPO TIP’s must be consistent with their Long Term Transportation Plans. The STIP includes financial summary tables to demonstrate fiscal constraint. Projects that are funded in the TIP/STIP and constructed, implemented, operated or maintained using Federal dollars must conform to Federal, State or local regulations/statutes that are applicable based on the type of project, type of funding received, scope of work and/or impact to the natural or human environments. The STIP and TIP must be fiscally constrained, which is defined as a “demonstration of sufficient funds (Federal State, local and private) to implement proposed transportation system improvements as well as to operate and maintain the entire system through the comparison of revenues and costs.” Cost and revenue estimates for the TIP’s and STIP use the inflation rate(s) to reflect “year of expenditure dollars,” based on reasonable financial principles and information. If no data is available, a minimum of 4 percent per year is used.

Nebraska STIP Guidelines are available on the NDOT Website[42] and include more detail about NDOT’s role in MPO TIP develop and MPOs role in STIP development.

4.2.2 Long-Term Plan

In additional to the short-term planning horizon, NDOT also determines investment priorities and asset management activities over a 20-year planning horizon. There are many activities that influence long-term priorities and activities including stakeholder engagement, study of economic factors, and engineering analysis. The LRTP is developed for the purpose of providing a vision for transportation development in Nebraska 20 years into the future and defines methods for measuring and monitoring progress toward plan goals and objectives. Long-range transportation planning is a process that builds upon the past and studies the present to help prepare for the challenges of the future.

[41] For more information about bridge work candidate selection and ranking see Appendix C.
[42] Nebraska STIP Guidelines available at: https://dot.nebraska.gov/projects/publications/stip/

The projected funding levels that will be required to maintain performance standards for Nebraska's state transportation netwrok are reported in the 20-year Needs Assessment[43]. A 20-year network capacity analysis for multi modal transportation is done approximately every five years to assist in the development of needs and is reported in the federally required Long Range Transportation Plan (LRTP). The annual Needs Assessment quantifies the cost to eliminate all of the geometric and capacity needs while meeting performance goals for pavement and bridge conditions. Asset needs will never be completely eliminated due to annual deterioration. From Figure 17, the 2021, 20-year cost to eliminate the highway needs is approximately $21 billion.

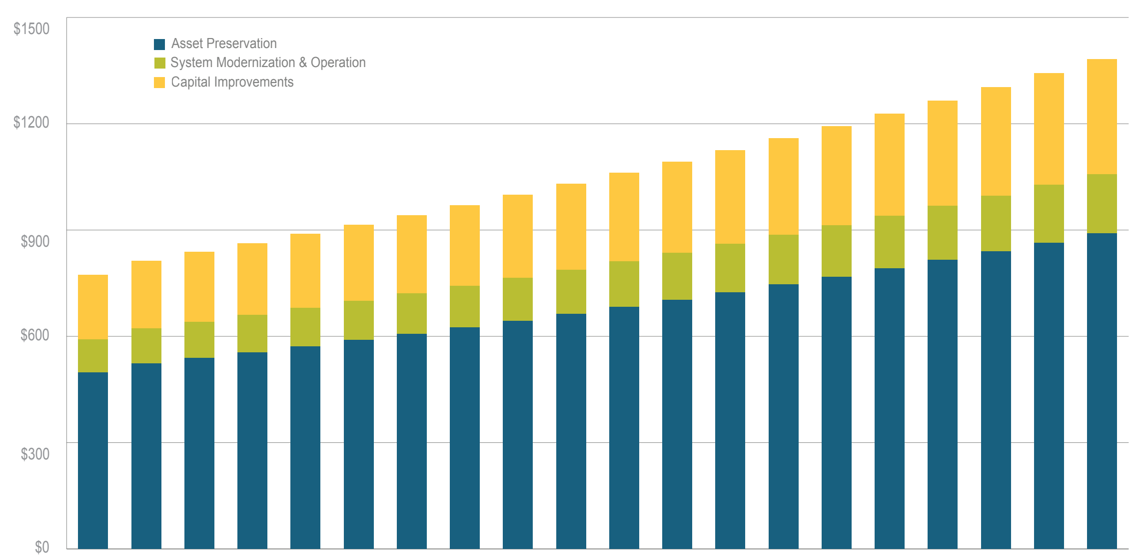
NDOT collaborated with the Metropolitan Area Planning Agency (MAPA) to complete the Metro Area Travel Improvement Study (MTIS) for the Omaha area. MTIS is a comprehensive transportation study that will help identify the long-term needs of the community. This multi-modal plan will:

- Develop a plan for the interstate and other major roadways in the region including NHS routes
- Prioritize projects for the short, mid, and long-term
- Consider existing funding sources through 2042

The technical analysis for this study will be used to update future long-range transportation plans for MAPA and the State.

NDOT recognizes the need to invest in preserving the existing system with well-timed maintenance cycles, and new strategies, technologies, and products that yield long-term benefits with less maintenance.

Future growth of demand on the NHS and the State Highway System is monitored and as described in Chapter 6. Project design standards are based on estimates of future traffic needs to maintain the effectiveness of the transportation system.



Fiscal Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	Total
20-Yr. Needs	$774	$813	$838	$863	$889	$915	$942	$970	$1,000	$1,030	$1,061	$1,092	$1,125	$1,159	$1,193	$1,228	$1,265	$1,303	$1,342	$1,382	$21,184
Inflation	5%	5%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	

Figure 17 - 2021 State Highway System Inflated Needs

[43] The Nebraska Needs Assessment can be found at: http://dot.nebraska.gov/business-center/financial-reports/

4.2.3 Sources and Future Needs to Address Performance Gap

Funding Needs

On an annual basis, NDOT generates a 20-year needs assessment report (Section 8.4.2) that identifies unconstrained needs. A performance gap exists between the unconstrained needs and NDOT's constrained budget. NDOT works to minimize this performance gap through processes described in Sections 3.3.1 and 3.3.2. These efforts have resulted in the Nebraska Highway System remaining in a state of good repair.

Structure Age

A significant number of bridges were built during the era of Interstate expansion. These bridges are now between 45 and 65 years old (Figure 5 and Table 10). When these structures were constructed, the service life was estimated at 50 years. Currently less than 2% of NHS bridge deck area is in Poor condition. The combination of preservation prone design standards and aggressive preservation practices has slowed deterioration and extended the service life beyond what was anticipated. On average NDOT has been replacing about 20 bridges per year and coupled with aggressive preservation efforts, this has kept percent of bridge deck area in poor condition to around 3%. The comparatively large number of older bridges in Fair condition shown in Table 10, raises concern that as these bridges reach poor condition, there will no longer be cost-effective repair strategies. As this occurs, the rate of bridge replacements, if not increased, would negatively impact NDOT performance targets. It is anticipated that there will be some reduction of replacement needs by extending structure's service life through preservation techniques when they are found to be life cycle cost effective.

Table 10 - Bridge Age and Condition (2/6/2023)

	Number				Area				Percent by Area		
Bridge Age	Good	Fair	Poor	All	Good	Fair	Poor	All	Good	Fair	Poor
0 to 5	123	2	0	125	848385.5	5216.0	0.0	853601.5	3.4%	0.0%	0.0%
5 to 10	79	0	0	79	794081.2	0.0	0.0	794081.2	3.2%	0.0%	0.0%
5 to <10	99	2	0	101	1588126.4	103360.4	0.0	1691486.8	6.4%	0.4%	0.0%
10 to <15	197	22	0	219	2196180.1	313911.2	0.0	2510091.3	8.9%	1.3%	0.0%
15 to <20	155	38	0	193	1163531.8	365779.1	0.0	1529310.9	4.7%	1.5%	0.0%
20 to <25	223	45	3	271	1657837.8	492216.1	114546.4	2264600.3	6.7%	2.0%	0.5%
25 to <30	219	71	3	293	1617905.0	884287.8	9507.0	2511699.8	6.5%	3.6%	0.0%
30 to <35	123	42	1	166	791803.6	488497.9	3542.0	1283843.6	3.2%	2.0%	0.0%
35 to <40	107	48	4	159	429287.9	446826.8	33194.2	909308.9	1.7%	1.8%	0.1%
40 to <45	134	64	9	207	616655.4	990065.9	40050.5	1646771.8	2.5%	4.0%	0.2%
45 to <50	97	61	5	163	813541.3	1189475.2	48490.5	2051506.9	3.3%	4.8%	0.2%
50 to <55	241	133	10	384	1237482.7	1197832.0	43884.4	2479199.1	5.0%	4.8%	0.2%
55 to <60	221	155	14	390	930861.2	1274597.9	98819.6	2304278.7	3.8%	5.2%	0.4%
60 to <65	105	63	20	188	316989.7	313241.4	70179.9	700411.0	1.3%	1.3%	0.3%
65 to <70	87	28	6	121	235927.4	186258.2	16058.2	438243.8	1.0%	0.8%	0.1%
70 to <75	37	20	5	62	76812.0	53700.7	32771.6	163284.3	0.3%	0.2%	0.1%
75 to <80	106	55	10	171	207140.9	236307.5	90640.5	534088.9	0.8%	1.0%	0.4%

4.3 Strategies Used to Address Performance Gap

NDOT analyzes and tracks the impact of recent investments, defines and identifies needs, establishes statewide priorities for projected revenue, and identifies strategies to ensure that resources are used efficiently and effectively.

As the State Highway System needs continue to increase, so do vehicle miles traveled and the cost of preserving and maintaining Nebraska's transportation system. NDOT continues to explore new technology and materials to reduce construction costs and extend pavement and bridge service life. Reduced costs and extended service lives result in savings that can be applied to additional projects.

Historically, NDOT has met performance goals for both pavement and bridges. Should conditions of these assets fall below NDOT targets an increased emphasis would be placed on the following strategies until the performance target is achieved:

- Unmet performance targets are identified, prioritized, and corrected as described in Sections 3.3.2 and 3.4.3
  - Unmet performance targets are identified by monitoring current data as reported in the Annual report
  - The 10-year system wide analysis that creates the project candidate list uses a ranking that prioritizes projects on the higher classified routes: interstates, freeways & expressways, and principal arterials, which make up the NHS. Program adjustments are made to include, prioritized projects and close performance gaps (see Section 4.3.1 for more details).
  - Higher standards for pavement and bridge designs on high priority routes, provides lasting performance maintains good conditions longer and reduces performance gaps.
  - Large bridges in high traffic areas are prioritized for preservation with deck protection systems to maintain good condition longer and reduce performance gaps at a lower cost. (Examples are asphalt overlay with waterproofing membrane and epoxy polymer overlays).
- Strategies to close or mitigate gaps may include the following:
  - Increased funding emphasis on assets that are on the NHS
  - Consider advancing projects that have a high impact on performance measures
  - Delay projects with lower life cycle benefit/cost impacts
  - Engage the public and lawmakers, communicate the performance gap and options (i.e.: new revenues and funding increases).
  - Modification of performance targets for some segments or corridors.

These Life Cycle Plans (LCP) show how different investment levels over a 10-year period can be used to develop shorter term investment strategies. Each of the analyzed life cycle plans result in NDOT meeting its state performance measure targets. (Table 11).

Life Cycle Plan 1	Maintain typical investment levels for pavements. This results in acceptable pavement condition at Year 10.
Life Cycle Plan 2	Decrease funding for pavements by 10%. This results in acceptable conditions at Year 10.
Life Cycle Plan 3	Increase funding for pavements. This results in acceptable conditions at Year 10.

Table 11 - Pavement Life Cycle Scenarios

Pavement Rating	LCP_1	LCP_2	LCP_3
Pavement Investment Level	Current	Decrease 10%	Increase 10%
Projected Pavement System Condition Year 10 (Nebraska Serviceability Index)	86.26	84.59	85.59
State Pavement Performance Targets	Meet	Meet	Meet

NDOT has had recent success securing additional funding at the State level via the Build Nebraska Act and Transportation Innovation Act

BUILD NEBRASKA ACT

In 2011, Nebraska's legislature passed the Build Nebraska Act (BNA) in response to current surface transportation needs. This 20-year funding mechanism reassigned 1/4 of 1 cent of the existing general state sales tax receipts to State and local highways and roadways. NDOT will use 85 percent of the reassigned funds for expansion and reconstruction of the expressway system and federally designated High Priority Corridors, construction of new highways, and other high priority projects for the State Highway System.

These funds, which first became available in the fall of 2013, are estimated to generate $1.2 billion over the 20-year period. The BNA will direct the remaining 15 percent to counties and municipalities for road and street purposes.

TRANSPORTATION INNOVATION ACT

In 2016, Nebraska's legislature enacted the Transportation Innovation Act (TIA), which provides new tools to accelerate project delivery such as design-build, which was previously not allowed by law. In addition, this new act provided an initial $450 million to fund the Transportation Infrastructure Bank through June of 2033. These funds will be available for projects that provide increased mobility, freight, and safety benefits.

4.3.1 Pavement Management Project Priority Assessment

NDOT has built a prioritization assessment into the POP Life Cycle Cost Analysis. Through this assessment, project candidates receive rankings based on Functional Classification, Population Density, Strategy Type, and Project Length. As a result, roadways on higher classified routes i.e. interstates, freeways & expressways, and principal arterials receive a higher ranking. These routes primarily make up the NHS; therefore, the NHS receives a higher priority for selection. This proactively helps deter gaps in performance and reduces the risks related to pavement deterioration.

This priority component was based on NCHRP Report 706[44]. The guidelines from the report and Nebraska's responses are shown in Table 12.

Table 12 - Nebraska's Pavement Management Priority Assessment

NCHRP 706 Proposed Guidelines for Risk Assessment	Nebraska's Priority Assessment
Establish Risk Tolerances	Allow lower condition ratings on less traveled routes
Impacts or Consequences	Type of improvement strategy and project length
Strategies or Countermeasures	Decision tree for the right action at the right time
Prioritize/Management Plan	Life Cycle Cost Analysis in POP with the new priority assessed B/C ratio
Measure or Monitor Effectiveness	Compare candidate list to the program list and performance measures

a. **Establish Risk Tolerance's –** To meet this guideline Nebraska decided to allow lower pavement condition ratings on less traveled routes. Two factors were developed to address this guideline. The first is based on National Functional Classifications, which would assign a higher value to higher classified routes as shown in Table 13. The second is based on the population density of the county the project is located in as shown in Table 14 and Figure 18.

Table 13 - System Factors for Classifications

System Factor	National Functional Classification
0.25	Interstate
0.20	Other Freeway/Expressways
0.15	Other Principal Arterials
0.10	Minor Arterials
0.05	Major Collectors
0.01	Minor Collectors/Locals

Table 14 - System Factors for Population Density

Population Density Factor	County Density *(See Map)*
0.1	High
0.05	Moderate
0.025	Low

[44] NCHRP Report 706 https://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_706.pdf

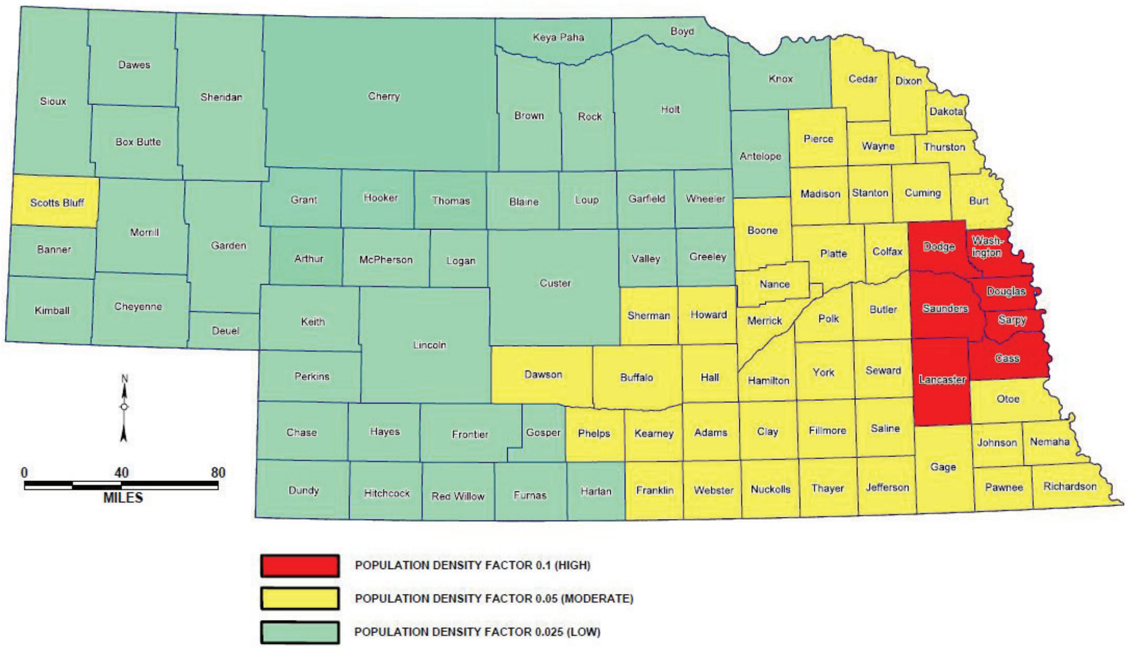


Figure 18 - Counties Qualify for Remote Residential Road Functional Classification

b. **Impacts or Consequences** – To meet this guideline Nebraska developed two factors based on the improvement strategy and length of project. Short maintenance projects would have a lower impact then major resurfacing projects that are of significant length. The first factor is based on the improvement strategy as shown in Table 15. The second factor is based on the project length as shown in Table 16.

Table 15 -
System Factors for Improvement Strategy

Improvement Strategy Factor	Strategy
0.2	Resurfacing/Rehabilitation
0.1	Thin lift overlays
0.05	Maintenance

Table 16 -
System Factors for Project Length

Project Length Factor	Length
0.1	> 3 miles
0.05	1 – 3 Miles
0.025	< 1 mile

c. **Strategies or Countermeasures** – For this guideline Nebraska used our existing decision trees, which select the right strategy at the right time. The decision trees shown in Figures 19 & 20 are part of the pavement management program POP. Table 17 shows the decision tree strategies and definitions.

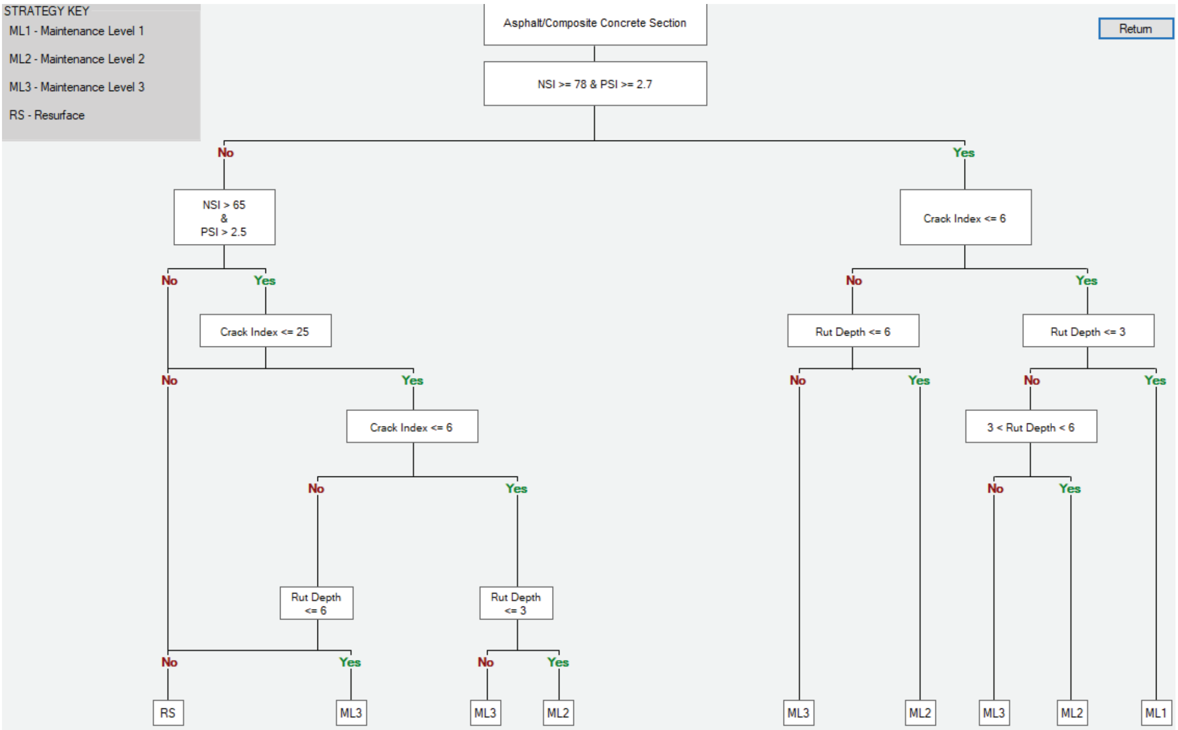


Figure 19 - POP Asphalt Decision Tree

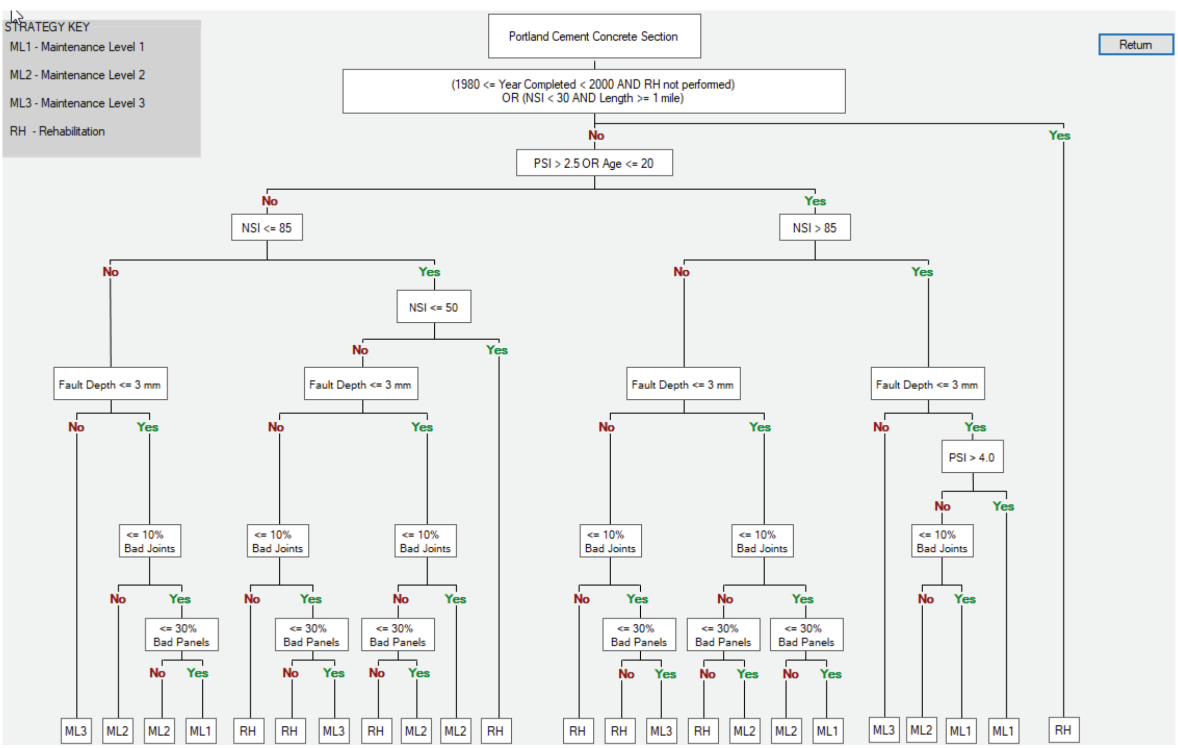


Figure 20 - POP Concrete Decision Tree

Table 17 - Pavement Strategy Definitions

ML1AC Maintenance Level 1	*Example:* Crack Sealing, Fog Sealing, Skin Patching
ML2AC Maintenance Level 2	*Example:* Armor Coats, Chip Sealing, Machine Patch, Mill and Armor Coat
ML3AC Maintenance Level 3	*Example:* Mill and Overlay, Thin Overlay
RSAC Resurface	*Example:* Resurfacing
ML1PCC Maintenance Level 1	*Example:* Joint and Crack Sealing
ML2PCC Maintenance Level 2	*Example:* Joint and Panel Repair with Sealing
ML3PCC Maintenance Level 3	*Example:* Diamond Grind, Panel and Joint Repair with Sealing

d. **Prioritize/Management Plan** – For this guideline, Nebraska uses the Life Cycle Cost Analysis in POP combined with priority assessment to rank project candidates for inclusion in the Surface Transportation Program. See Figure 22 for an example of a 10-year project candidate list with priority ranking.

e. **Measure or Monitor Effectiveness** – To measure and monitor the effectiveness of risk ranking, the candidate lists are compared to the program list. To date approximately 70 percent of the candidate projects are included in the Surface Transportation Program. NDOT also monitors the performance measures for NSI, which currently shows NDOT meeting targets.

4.4 Summary of Performance Gap Identification

The Program Book shows the 1 & 5-year plan, while the STIP shows a fiscally constrained 4-year plan. For the following years of the analysis (years 6-10), the POP and the bridge management systems, evaluate the needs based on the 10-year project candidate list. The cost of meeting those needs are reported based on the inputs described above. Investment strategies used to maintain system performance targets are evaluated using POP tools. Through utilizing POP and the bridge management tools, NDOT predicts the average condition and distribution of condition over the complete state highway and bridge network at various funding levels.

CHAPTER 5

Life Cycle Planning

5.1 Overview

NDOT's asset management practices are in place to extend the level of service of Nebraska's valuable pavement and bridges for as long as possible while minimizing associated costs and risks. These practices focus on all phases of an asset's life cycle, which is made up of design, construction, inspection, decision-making, maintenance, rehabilitation, and disposal or replacement. These phases are shown in Figure 21.

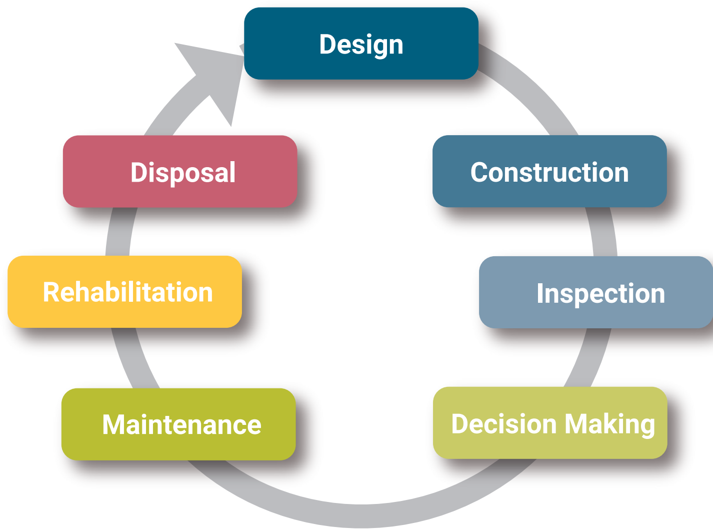


Figure 21 - Pavement and Bridge Life Cycle Phases

5.2 Pavement Life Cycle

5.2.1 Pavement Design

Pavements are designed in accordance with the Nebraska Pavement Design Manual[45], AASHTO Guide for Design of Pavement Structures[46], AASHTOWare Pavement ME Design[47], and NDOT policies and practices.

In addressing proposed Performance gaps, NDOT conducted a pavement Life Cycle Plan (LCP) for three scenarios, Section 4.3.

The three scenarios included: maintain funding, reduce funding by 10%, and increase funding by 10% for 10 years. POP analyzed all three funding scenarios and determined that the proposed pavement conditions were acceptable for all scenarios. However, further decreases in funding could result in unacceptable pavement conditions.

[45] The NDOT Pavement Design Manual can be found at: http://dot.nebraska.gov/business-center/materials/
[46] The AASHTO Guide for Design of Pavement Structures can be found at: https://bookstore.transportation.org/collection_detail.aspx?ID=87
[47] Further information on ME-Design can be found at: http://me-design.com/MEDesign/

5.2.2 Pavement Construction

Highway construction is performed according to the Contract, including the plans and special provisions, the Nebraska Construction Manual, Nebraska Standard Specifications for Highway Construction, and the Nebraska Material Sampling Guide. The plans for highway construction are developed according to the Nebraska Roadway Design Manual and the Nebraska Minimum Design Standards for Highways, Roads and Streets.

5.2.3 Pavement Inspection

Pavements are inspected annually for deterioration and distresses. Condition assessment values are loaded into NDOT systems for POP analysis. Refer to Section 2.4 for additional information.

5.2.4 Pavement Decision Making

The Roadway Asset Management section is responsible for providing the Interstate Task Force book, 10-year project candidate lists, and the condition maps for the highway system. This information is provided to Program Management, District Engineers, and their highway commissioners to assist in establishing future construction programs.

These reports are created using POP, which analyzes the projected deterioration of pavement sections for a 10-year period and selects the most efficient strategies based on the best benefit/cost ratios for each year for applied annual budgets. These analyses can be run for various highway systems including the NHS. The main benefit of NDOT closely adhering to the ranking of the projects that POP outputs is that NDOT can provide the greatest economic benefit to our taxpayers. See Figure 22 for an example 10-year project candidate list provided to Program Management and the District Engineers to help in the selection of the construction program. This same type of report is provided to local NHS owners to help in their selection of projects.

NDOT uses history graphs in POP to determine deterioration rates for ACC and PCC pavements and track the performance of rehabilitation strategies. NDOT currently incorporates four deterioration rates for ACC pavements: PSI, cracking, rutting, and NSI. Five deterioration rates are used for PCC pavements; PSI, faulting, joint condition, slab cracking, and NSI. These deterioration rates along with the age of the pavement and the current condition values are used to determine the optimum rehabilitation year. This is the year when the benefit to cost ratio of rehabilitation is at a maximum. Details can be found in the Pavement Management Systems Manual[48].

When ranking and selecting rehabilitation candidates, NDOT takes into account the Remaining Service Life (RSL) of a pavement. Nebraska's approach for deriving RSL is to project the time it will take in years for the pavement to deteriorate to a given threshold condition from its current condition state. This method is based on the assumptions that: (1) the current condition reflects the true quality of the pavement, and (2) the deterioration of the pavement is generally consistent over time. While neither assumption is wholly true, this method has proved to be a reasonable forecast of RSL when compared to the pavement management accomplished to date.

[48] Pavement Management Systems Manual: http://dot.nebraska.gov/business-center/materials/

District 1 — Selected Projects Based on 10 Year Life Cycle Cost Analysis
Pavement Sections — Sorted by Hwy and Ref Post

Selected Candidate Years: 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032
Selected Strategies: All Strategies

HWY NUM	BEGIN REF. POST	END REF. POST	LANE DIR	LENGTH	LOCATION	PRIORITY RANK	CB RANK	STRATEGY	CANDIDATE YEAR	EST. COST	NSI BEFORE STRATEGY	NSI AFTER STRATEGY	PROGRAM YEAR
001	2.38	7.31	B	4.93	ELMWOOD-MURDOCK	7.99	2.81	RS-AC	2026	$1,922,700	55.00	100.00	2026
001	7.31	12.91	B	5.61	MURDOCK-JCT N50	7.95	2.78	RS-AC	2025	$2,187,900	55.00	100.00	2024
002	456.63	456.80	B	0.17	S US77 INTERCHANGE	2.03	1.63	ML1PCC	2025	$16,320	91.38	96.38	2022
002	456.80	457.94	D	1.14	US77-9TH ST LINCOLN	2.07	1.63	ML1PCC	2026	$72,960	84.01	89.01	2022
002	457.94	462.31	A	4.36	9TH ST-56TH ST LINCOLN	8.05	2.46	RS-AC	2030	$1,700,400	56.00	100.00	2022
002	457.94	462.31	D	4.36	9TH ST-56TH ST LINCOLN	7.75	2.25	RS-AC	2029	$1,700,400	59.58	100.00	2022
002	462.31	464.89	A	2.56	LINCOLN EAST	8.05	2.65	RS-AC	2029	$1,478,912	54.44	100.00	2022
002	462.31	464.89	D	2.56	LINCOLN EAST	7.83	2.49	RS-AC	2026	$1,478,912	52.13	100.00	2022
002	464.89	471.44	A	6.55	LINCOLN-JCT N43	12.21	1.00	RH-PCC	2024	$5,002,497	65.18	100.00	2022
002	464.89	471.44	D	6.55	LINCOLN-JCT N43	12.33	1.08	RH-PCC	2024	$5,002,497	66.41	100.00	2022
002	491.92	503.76	A	11.85	SYRACUSE-NEBR CITY	12.95	1.36	RH-PCC	2024	$9,050,319	51.40	100.00	2021
002	491.92	503.76	D	11.85	SYRACUSE-NEBR CITY	12.77	1.24	RH-PCC	2023	$9,050,319	60.87	100.00	2021
002	503.76	504.15	B	0.39	JCT US 75	7.69	2.21	RS-AC	2029	$377,403	59.10	100.00	2021
002	505.74	508.16	A	2.42	NEBRASKA CITY SE	7.83	2.22	RS-AC	2030	$1,398,034	58.89	100.00	2021
002	505.74	508.16	D	2.42	NEBRASKA CITY SE	7.96	2.31	RS-AC	2030	$1,398,034	56.67	100.00	2021
004	122.60	126.54	B	3.93	DAYKIN WEST	8.40	2.80	RS-AC	2026	$1,532,700	55.00	100.00	
004	126.54	133.58	B	7.03	DAYKIN EAST	7.92	2.46	RS-AC	2028	$3,071,583	53.00	100.00	
004	133.58	144.03	B	10.45	PLYMOUTH WEST	7.89	2.44	RS-AC	2031	$4,565,866	58.27	100.00	
004	144.03	152.66	B	8.69	PLYMOUTH EAST	7.91	2.46	RS-AC	2031	$3,389,100	58.75	100.00	
004	167.47	179.55	B	12.08	JCT US136-LEWISTON	8.21	2.66	RS-AC	2027	$4,711,200	56.23	100.00	2023
004	182.89	191.97	B	9.09	TABLE ROCK WEST	8.45	2.83	RS-AC	2026	$3,545,100	55.00	100.00	2026
004	196.90	201.33	B	4.40	TABLE ROCK EAST	8.13	2.60	RS-AC	2024	$1,922,470	57.50	100.00	

Figure 22 - District Candidate List Example

5.2.5 Pavement Maintenance

District maintenance personnel operate the highway system and are the front line resource. They are responsible for situational awareness, and providing insight into which segments are performing well and which are having difficulty making the expected service life. Through routine inspections, district staff ensure the smooth operation of the system by addressing public concerns, damage control, travel incidents, inclement weather, emergencies, and providing alternate routes to maintain mobility during blockage. Regular inspections are necessary to monitor actual pavement life and to schedule future maintenance activities to provide cost effective pavement preservation or repair. The type of maintenance, as shown below, depends on the extent of the deterioration, the historical pavement information, previous work performed, and planned future work found in POP. This insures that NDOT does not double program activities and gets the most out of NDOT's dollars to meet the needs and expectations of the travelling public.

Pavement deteriorates with age and use, typically at an ever-increasing rate. The accumulation of each subsequent distress makes it easier for new distresses to develop. Maintenance strategies help slow the rate of deterioration by identifying and addressing specific pavement deficiencies that contribute to overall deterioration. Maintenance methods can be categorized into three types:

Preventative Maintenance	A planned strategy of cost-effective treatments to an existing roadway system that preserves the system, slows future deterioration, and maintains or improves the functional condition of the system. *Examples: crack sealing, dowel bar retrofitting, armor coating/chip sealing, fog sealing, rut filling (in some cases), and thin overlays.*
Corrective Maintenance	Performed after a deficiency occurs in the pavement, such as moderate to severe rutting, raveling, or extensive cracking. This may also be referred to as "reactive" maintenance. *Examples: structural overlays (more than one inch), milling, patching, and crack repair.*
Emergency Maintenance	Performed during an emergency, such as a blowup or severe pothole that needs repair immediately. This could also include temporary treatments that hold the surface together until a more permanent treatment can be performed.

Emergency maintenance differs in every situation, but is often related to safety and time, with cost not being a primary consideration. Likewise, materials that may not be acceptable for prevention or corrective maintenance may be the best choice for emergencies.

Preventative maintenance has been shown to be 6 to 10 times more cost-effective than a "do nothing" strategy[49]. The effectiveness of the treatment is directly related to the condition of the pavement. Conservatively speaking, $1 spent for preventive maintenance will provide the same pavement condition that costs $4-5 if rehabilitation is needed. By extending the life of a pavement until it needs rehabilitation, preventative maintenance allows NDOT to even out the budget for both maintenance and construction.

[49] Johnson, A., and Snopl, P. (2000). Best Practices Handbook on Asphalt Pavement Maintenance, University of Minnesota, Minneapolis, Minnesota.

The differences between preventive and corrective maintenance occur in the timing and cost. Corrective maintenance is reactive, meaning it is done after a road is in need of repair, so the cost is greater. Delays in corrective maintenance result in even larger costs since defects and their severity continue to increase. There are no clear boundaries between when a treatment is preventative versus corrective, or corrective versus emergency. The overlap between the three types of maintenance can be seen in Figure 23.

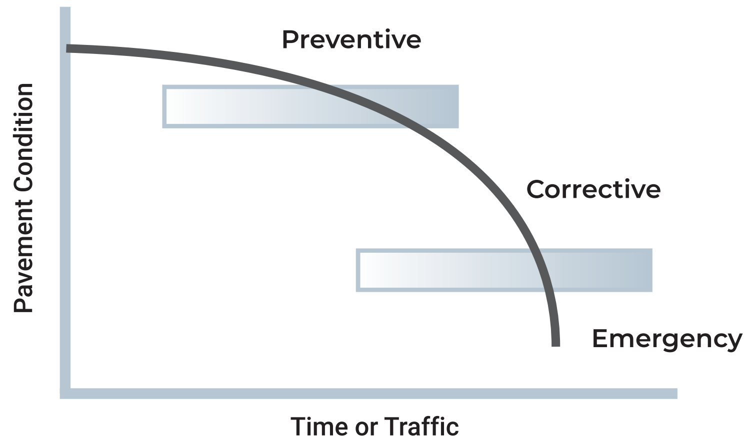


Figure 23 - Pavement Maintenance Strategy Overlap

An important aspect of pavement repair is the concept of excessive maintenance costs. It is possible to extend the life of a severely distressed pavement by providing extensive heavy maintenance, or rehabilitation, but this strategy requires a higher financial investment.

Recommended maintenance treatments for pavement can be found in NDOT's Pavement Maintenance Manual[50]. A brief breakdown of specific treatments, their associated costs, and the number of years these treatments extend the lifetime of the pavement is provided in Tables 18 & 19. These strategies and estimated costs per mile are built into the POP Life Cycle Cost Analysis and are updated annually. The average costs were calculated from the previous year's maintenance and construction activities.

Table 18 - ACC Pavement Treatment Costs and Expected Life

Treatment	Average Cost[1] (mile)	Expected Life (years)
Crack seal/fill	$1.25/lin.ft[2]	3 - 5
Fog seal	$8,000	1 - 4
Chip seal/armor coat	$33,000 - $45,000	3 - 6
Microsurfacing	$79,500	3 - 8
Mill (1")	$19,000	1 - 4
Cold-in-place recycle	$114,000	8 - 12
Hot-in-place recycle	$129,000	3 - 6
Thin hot mix overlay (1")	$105,000	5 - 8
(2" overlay)	$169,000	7 - 9
Thick overlay (4")	$299,000	8 - 15
Total reconstruction	$825,000	20+

[1]Costs shown are for a 24' roadway unless otherwise noted.
Estimates based on 2022 Data

[50] NDOT's Pavement Maintenance Manual http://govdocs.nebraska.gov/epubs/R6000/H048-2002.pdf

Table 19 - PCC Pavement Treatment Costs and Expected Life

Treatment	Average Cost[1] (mile)	Expected Life (years)
Crack & joint seal/fill	\$2.00 - \$4.00/lin.ft[2]	4 - 7
Partial/full depth slab/joint repair	\$275 - \$400/sq.yd.	1 - 4
Thin hot mix overlay (1½") 24'	\$137,000	3 - 6
Diamond grinding - 24'	\$48,500 - \$139,000[3]	3 - 8
Cross-stitching	\$20 - \$35/bar[4]	1 - 4
Thick hot mix overlay (4") - 24'	\$299,000	8 - 12

[1]Since some of the treatments are often limited to one-lane, costs shown are per lane-mile unless otherwise noted.

[3]Diamond grinding =\$48,500/lane-mile, diamond grinding + dowel bar retrofit = \$139,000/lane-mile. Both figures include all associated repairs and sealing.

[4]Cross-stitching bars placed at 2' intervals

Estimates based on 2022 Data

5.2.6 Pavement Rehabilitation

Historical evidence shows that pavements have a life ranging from 15 to 40 years, depending on the surface type, location in the state, and how much traffic they carry. Once a highway segment approaches the end of its service life, it becomes a candidate for rehabilitation.

Historically and currently, there are more candidates for major reconstruction or rehabilitation than can be included in the highway construction program. Highway segments may be excluded for various reasons, but these segments are reanalyzed with all other segments based on current condition for inclusion in the next year's 10-year project candidate list.

5.2.7 Pavement Disposal

When the cost of maintenance becomes too high or pavement reaches a poor level of serviceability, it is generally considered to have reached the end of its design life. At this point, the pavement must be disposed of, replaced, or reconstructed, resetting the life cycle deterioration process.

5.3 Bridge Life Cycle

NDOT has the goal to extend the service life of bridges and keep them in a state of good repair at a minimum life cycle cost. The life cycle of a bridge begins with design and construction. Life cycle costs of bridge ownership guides bridge design, construction and maintenance decisions.

5.3.1 Bridge Design, Construction, Resilience and Service Life

Bridges are designed in accordance with the Nebraska Minimum Design Standards[51], the Bridge Office Policies and Procedures Manual[52] and current AASHTO Design and Construction Guidelines[53].

Bridges may be subject to a variety of adverse events during their service life. Strikes from tall vehicles, fires from natural and man-made causes and floods from extreme hydraulic events can damage or destroy bridges. These risks are addressed through design standards that are developed to cost-effectively avoid or mitigate the most probable risks that may occur.

High-water events are the most common adverse circumstance for Nebraska bridges stemming from extreme weather. Flooding can remove the soil that supports bridge substructures (bridge scour) and carry water-born debris that may apply destructive loads to a bridge substructure or superstructure. Flooding and ice may impart additional lateral loads on bridge structures that need to be understood and accommodated in bridge design when appropriate.

Bridges over waterways are routinely designed for flooding events with a possibility of occurrence based on a 100-year analysis. High risk sites are designed for more extreme flooding events that could occur in a 500-year analysis. Historical data from channels is tracked with Nebraska's Natural Resource District model. This group of organizations maintains stream gauges and works to understand where frequent flooding risks are, and where conditions are changing as part of shifting extreme weather events. High risk locations are also analyzed with more detailed survey data and advanced hydraulic modelling methods, such as 2D hydraulic modeling. The proposed design, and scour countermeasure design are developed by considering hydraulic constraints, cost, risks, regulatory requirements, channel behavior, environmental impacts, engineering requirements and social concerns.

Bridge resilience is considered a combination of recovery time, probability of damage from an adverse consequence, and the resulting impacts to traffic conveyance. Bridge programming provides consideration of replacement of structures in poor condition, rehabilitation or repair of bridges based on inspection findings, and proactive preservation of bridge elements such as bridge deck protection (overlays). When programming a hydraulic bridge replacement, the history of the site is studied to understand past events. If the bridge spans a channel that is undergoing changes in conditions, additional hydraulic capacity will be considered. Strategies for design of rehabilitation and repairs similarly consider the location's history and projections of probability of damage from an adverse consequence. This serves to eliminate impacts to traffic conveyance and extend the service-life of a bridge impacted by an extreme weather event. The goal of appropriate design strategies, is to anticipate and alleviate flood-related recovery challenges. Recovery is a function of our internal practice to be prepared to respond quickly to damage. By acting quickly and having experience with rapid repairs and temporary bridges, NDOT can respond quickly to ensure the recovery time is short. By reducing the probability of adverse outcomes with risk-based design strategies and by being prepared to recover from damage quickly, system-wide bridge resilience is increased.

After construction, bridges are inspected before opening to traffic. While bridges are in service, they are typically inspected every 24 months.

The Information from bridge inspections is reported directly to the SQL server Data Warehouse by inspectors with a web-based installation of AASHTOWare BrM. NDOT uses in-house software to import and flag the recent inspection data for review candidates. The inspection reports are used to develop maintenance and repair strategies and to evaluate the effectiveness of previous design strategies.

Details about the Nebraska Bridge Inspection Program are published on the NDOT website[54].

[51] https://dot.nebraska.gov/business-center/lpa/boards-liaison/training/class-and-standards
[52] https://dot.nebraska.gov/business-center/bridge/
[53] https://bookstore.transportation.org/
[54] Nebraska Bridge inspection information: https://dot.nebraska.gov/business-center/bridge/inspection/

5.3.2 Bridge Maintenance, Rehabilitation, and Disposal

Like pavement, bridge condition declines over time due to general wear and tear as well as damage inflicted by the environment or users. Preventative and corrective maintenance practices are necessary to reduce the extent of repairs required to keep Nebraska's bridges in a state of good repair.

Historically, bridge-length concrete culverts have a lifespan of about 90 years and require minimal maintenance. For these reasons, concrete culverts are used whenever possible. When a larger structure is required, bridges are needed. Nebraska bridges have a similar service life to concrete culverts, but require more maintenance to remain in good repair.

A typical historical maintenance plan for a bridge is shown in Figure 24 and would involve the following:

YEAR 0
Build bridge, install asphalt overlay with waterproofing membrane

YEAR 15
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)*

YEAR 30
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)*

YEAR 45
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)* Other repairs to substructure and superstructure

YEAR 60
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)*

YEAR 75
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)*

YEAR 90
Repair or replace asphalt overlay and expansion joints *(waterproofing membrane remains in place)* Other repairs to substructure and superstructure

Figure 24 - Historical Bridge Maintenance Plan

In recent years, Nebraska has made changes to bridge preservation strategies. Current preservation methods are coordinated with paving projects and cause less disruption to the travelling public while keeping bridge decks in good condition longer. The two most common deck protection systems are Epoxy Polymer overlays (EPO) and Asphalt Overlays with Waterproofing Membranes (ACC&M). Both of these treatments have been found to be more cost effective than historical practices and perform well when applied at the frequency of roadway projects.

Figure 25 shows the typical cumulative present value costs for an average size Nebraska bridge when managed with historical and current preservation strategies.

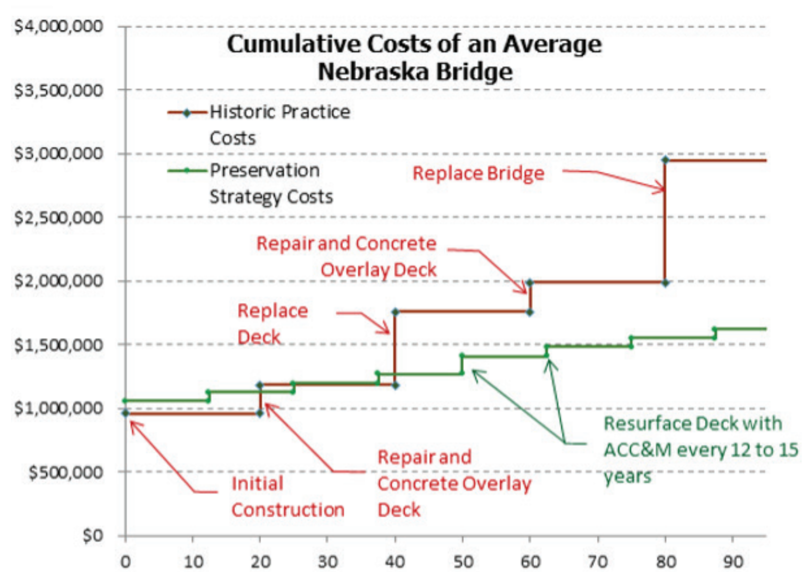


Figure 25 - Cumulative Cost of Average Bridge with Historic and Current Preservation Strategies

Larger repairs can sometimes be avoided by periodic maintenance. Bridge inspectors report bridges that may need review for maintenance actions.

Periodic maintenance for bridges includes the following:

- Cleaning expansion devices
- Sweeping decks
- Clearing plugged floor drains
- Removing debris from superstructure and bearings
- Removing debris rafts from bents, piers, and abutments
- Clearing trees from a channel
- Filling in erosion (on side slopes or banks, under approach slabs, and at culvert ends)
- Removing silt from culvert waterway openings
- Sealing cracks

5.4 Performance Summary

5.4.1 Pavement Life Cycle Cost Analysis

Within the POP software there is a life cycle benefit/cost analysis tool that is used to determine the most cost-effective pavement strategy to meet performance targets. This analysis compares strategy options (see Tables 15 & 16) by comparing the cost of each option, the available funding, predicted improvement in pavement condition, and the proper timing of each strategy to then identify the least costly alternative. This analysis is used to develop the long-term pavement preservation needs, which are documented in the 20-year NDOT Needs Assessment. To determine the highway segments that will be candidates in the Surface Transportation Program and for 10-year planning, a life cycle benefit/cost analysis with the priority assessment is used.

As part of the Life Cycle Cost Analysis (LCCA) and candidate list creation process, NDOT plans to program our POP software to create a list of roadway segments prone to extreme weather, specifically flooding. The creation of this list is discussed in greater detail in Section 7.9 Risk Mitigation for Extreme Weather and Resiliency.

5.4.2 Bridge Life Cycle Cost Analysis

Life Cycle Cost Analysis is used to choose between competing alternative strategies. To address the uncertainty associated with timing, cost, and effectiveness of various strategies, probabilistic analysis is used to check for the most likely outcomes from the combined factors that contribute to uncertainty. NDOT uses RealCost[55], an Excel-based LCCA tool that was developed by the FHWA. Common repair strategies are compared to find cost-effective categories of repair actions.

Alternative preservation strategies are investigated for long term life-cycle cost effectiveness. Aggressive preservation strategies that reduce deterioration rates can be shown to dramatically reduce the cost of bridge ownership (as discussed in Section 5.3.2).

On specific projects, LCCA is used for complex decisions when there is a large cost difference between competing alternatives. A typical case for project-specific LCCA would be to compare a shorter duration, lower cost repair to a longer duration, higher cost strategy. Bridges for which there is no cost-effective repair strategy become replacement candidates.

[55] Information about RealCost is available at: https://www.fhwa.dot.gov/infrastructure/asstmgmt/lccasoft.cfm

CHAPTER 6
Future Growth

6.1 Overview

NDOT employs effective asset management practices that consider how future user demand will affect the current system. Population growth, changes in traffic volume, and advancements in technology will have substantial impacts on the future condition of Nebraska's assets. As our state grows, our infrastructure must grow with it. It is important for Nebraska to be flexible and respond to the State's transportation needs now and in the future.

6.2 Future Growth

6.2.1 Population Growth

Eleven of Nebraska's counties are expected to experience population growth through the year 2040 according to United States Census forecasts. Most of the projected population growth is expected to occur in counties along I-80 and to the east, with much of the growth in the state's urbanized areas (see Figure 26). The same forecast data indicates Nebraska's total population will exceed two million by 2030.

Population growth, in turn, will increase the demand for jobs, homes, goods, and services. These demands will require additional planning, construction, and maintenance to ensure accessibility to living and working opportunities as well as increases in freight traffic volumes.

Commuters in urban areas are increasingly using alternative modes of travel, such as walking, biking, and transit services. The continued expansion of multiuse trails to serve pedestrians and bicyclists also encourage an increase in alternative modes of transportation for both work and non-work trips. The City of Lincoln is anticipating an increase in transit ridership of 5-10 percent due to changes in the routes and expanded hours. The City of Omaha is anticipating growth above and beyond their current 1 percent growth rate with the addition of their new bus rapid transit system called ORBT.

Additional transit services may need to be provided as Nebraska's population ages. By 2030, it is projected that an average of 20.4 percent of the total Nebraska population will be 65 and over.[56] The usage and demand for paratransit services is likely to grow with the aging population in Nebraska, particularly in rural counties where fewer systems currently exist.

Ultimately, an increase in population means more users on the roadways, more stress on the existing infrastructure, and the construction of new roadways and bridges. The need for expanded transportation system capacity will continue in eastern Nebraska, in urbanized areas, and along the I-80 corridor, as well as the need for improved systems operation, infrastructure renewal, system preservation, mobility, accessibility, and maintenance throughout the state.

[56] Source: UNO CPAR population projections. 2010 -2050.
Accessed: : https://digitalcommons.unomaha.edu/cgi/viewcontent.cgi?article=1257&context=cparpublications

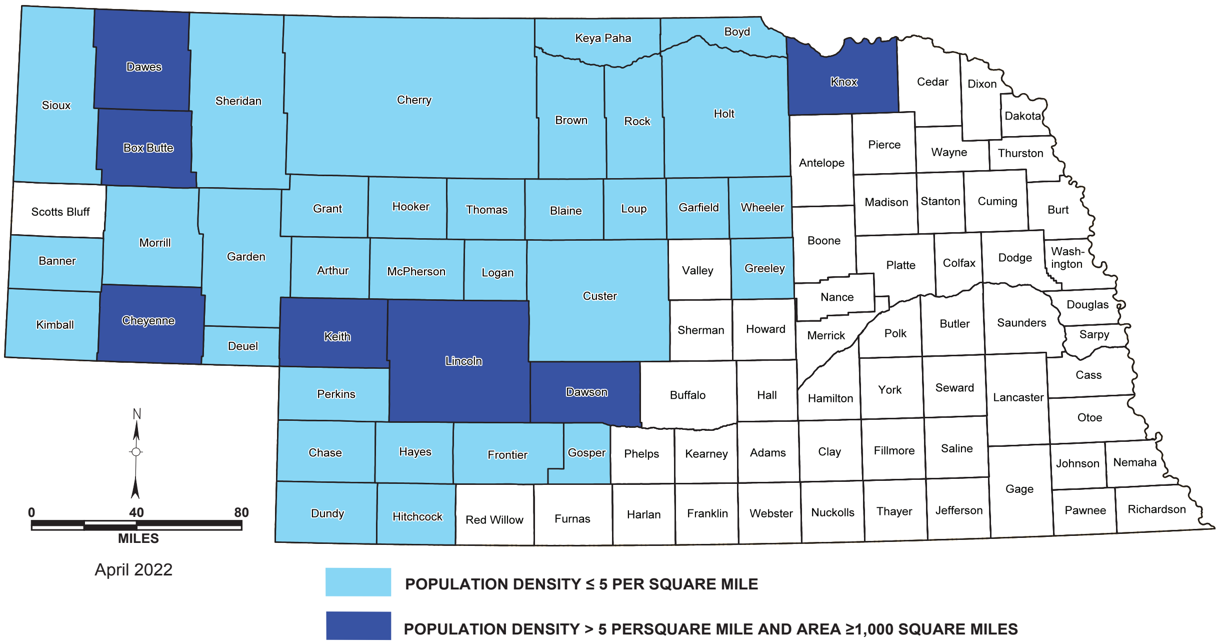


Figure 26 - Counties Qualify for Remote Residential Road Functional Classification

6.2.2 Freight Growth

The economic well-being of Nebraska, as well as the United States depends on efficient freight movement. Estimates from the Federal Highway Administration's Freight Analysis Framework (a Federal program that integrates data from a variety of sources to estimate freight flows) show that truck-based freight will increase from 280 million tons in 2017 to 386 million tons in 2045, representing a 38 percent increase. NDOT will take into account the increasing freight traffic on Nebraska's highways and the resulting impact on highway infrastructure. Overall, total freight movements for all modes of transport within the state will increase from 445 million tons in 2017 to 623 million tons in 2045. All figures shown excludes through movement travel. See Figure 27.

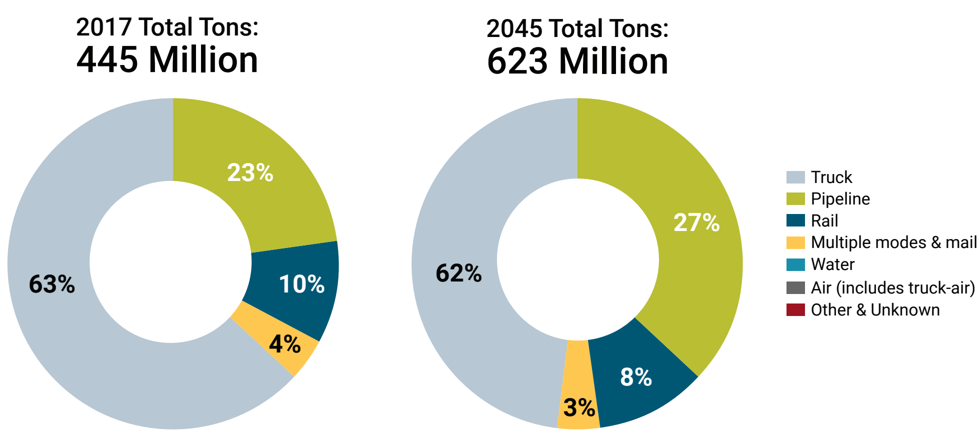


Figure 27 - NDOT Target Setting Considerations – Freight Movement

6.2.3 Vehicle Miles of Travel (VMT) Growth

The Nebraska highway and roadway network serves as the primary mode of transportation for both personal and freight travel within the state. The projected annual VMT growth provides an indicator of future demands on the State's Transportation System. The projected annual statewide VMT growth is approximately 1.0 percent, in comparison to the projected statewide population growth of just below 1.0 percent per year.

6.2.4 Annual Average Daily Traffic (AADT) Growth

NDOT uses its historic trend traffic data collected on an annual basis to forecast future Annual Average Daily Traffic (AADT) volumes for State and Federal highways within Nebraska. This process uses a 20-year trend of historic traffic data to predict future volumes for specific locations where traffic is collected within a highway project's limits. NDOT uses a linear projection of these observed trends on State and Federal highways and an average of linear and exponential trends on interstate facilities to provide forecasts (Figure 28).

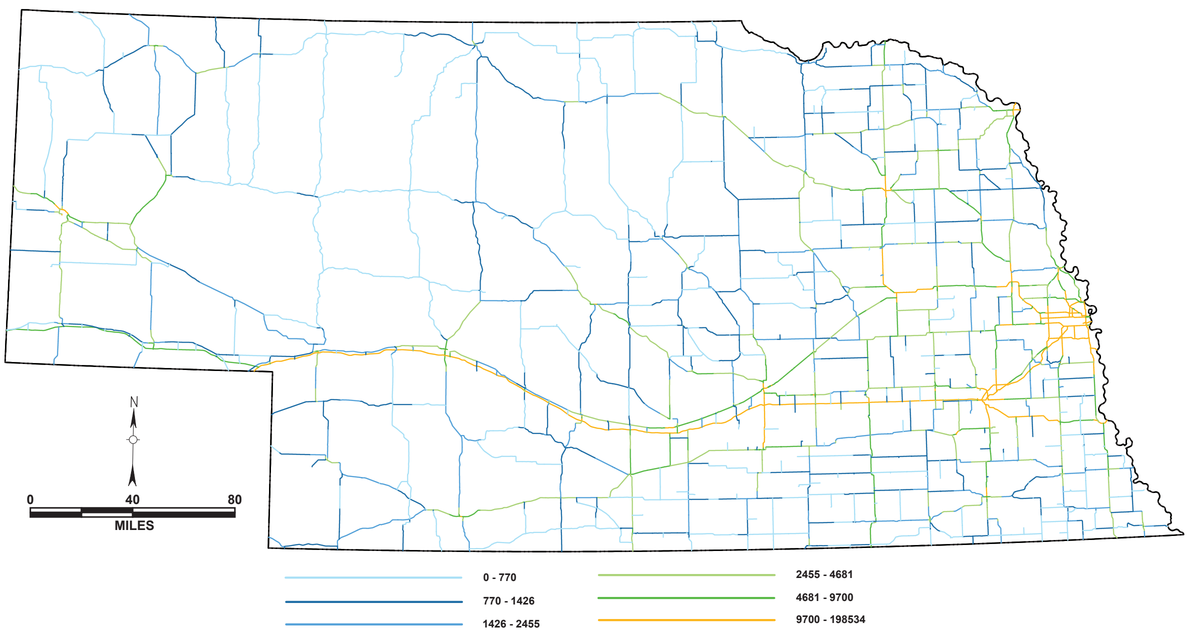


Figure 28 - Annual Average Daily Traffic – 2040 Forecast

These projected historic trends do not take into account land use changes or the future addition of major trip generators within a project study area. To assess the impact of these changes on a highway corridor, NDOT uses its Statewide Travel Demand Model to provide AADT forecast volumes for highway projects. This model uses projected population growth to generate trips that are compiled in a trip table, which is organized into traffic analysis zone (TAZ's). The Statewide Travel Demand Model is especially useful for projected traffic for highway projects that involve highway realignments or the presence of new planned urban developments along a highway corridor.

CHAPTER 7

Risk Management Analysis

7.1 Overview

The Federal Highway Administration defines risk as the positive or negative effects of uncertainty or variability upon agency objectives. Natural disasters, economic disruptions, and other unexpected events can reduce a transportation system's level or service as well as the agency's ability to achieve its goals. NDOT's approach to risk-based asset management involves identifying and understanding the potential threats to Nebraska's transportation system in order to successfully plan for system and program disruptions, develop mitigation strategies, and improve infrastructure resiliency. Although other potential risks were identified, NDOT has focused on its high priority risks for inclusion in the discussion of this chapter.

7.2 Risk Process

Although not formally defined in terms of risk, likelihood, consequence, and mitigation, NDOT has historically prioritized projects of high impact and consequence as a standard practice. A formal process to identify risks for NDOT began with a funding distribution team in 2010 after the 2008 funding shortfalls. Program strategies were identified to meet budget constraints with the use of a decision tree using If/Then logic. In 2012, NDOT completed its first Asset Management Plan, which identified condition, performance measures, expectations, and funding levels required to maintain the four main assets; Pavement, Bridges, Fleet, and Buildings, in a state of good repair. At this time, priority factors were also built into the Life Cycle/Cost Benefit Analysis for Pavements (see Section 4.3.1).

On January 17-18, 2018, NDOT held a Risk Identification Workshop to verify and expand on risks previously identified. This stakeholder group consisted of administration personnel, division heads, district engineers, and district operations personnel. The stakeholders were divided into small groups to identify the potential risks and the consequences to the condition and performance of Nebraska's highway system. These groups first identified 37 potential risks. Then the panel used the risk matrix in Table 20 to calculate the risk based on the groups consensus in regards to the impact and likelihood of the potential risks. Once the panel sorted the risks based on highest calculated risk, the small groups reformed and were given a set number of points to assign to the risks they saw as the highest priorities. The result of this process was that the entire group came to consensus on 11 high-priority risks. These 11 risks will be reviewed every four years alongside the TAMP.

During the fall of 2022, a second stakeholder group consisting of personnel from the Bridge, Roadway, Strategic Planning, Materials & Research, Program Management, and Controller divisions met to discuss risks related to extreme weather and resiliency. This group updated existing risks and ultimately reached a consensus over 15 high-priority risks, listed in Table 21 of the Priority Risk Registry.

Table 20 - Risk Matrix

Risk Matrix			Likelihood				
			Rare (1)	Unlikely (2)	Likely (3)	Very Likely (4)	Almost Certain (5)
			Less than once every 10 yrs.	Once between 3-10 yrs.	Once between 1-3 yrs.	Once a year	Several times a year
Impact	Catastrophic (-5)	Potential for multiple deaths & injuries, and substantial public & private costs.	Medium	Medium	High	Very High	Very High
	Major (-4)	Potential for multiple injuries, a substantial public or private cost, and/or foils agency objectives.	Low	Medium	Medium	High	Very High
	Moderate (-3)	Potential for injury, property damage, increased agency cost, and/or impedes agency objectives.	Low	Medium	Medium	Medium	High
	Minor (-2)	Potential for moderate agency cost and impact on agency objectives.	Low	Low	Low	Medium	Medium
	Insignificant (-1)	The potential impact is low and manageable with normal agency practices.	Low	Low	Low	Medium	Medium

7.3 System Risks

NDOT has identified several system/agency risks that could adversely affect infrastructure on the highway system. The potential impacts of each risk is described below:

- **Increase in Federal funding by 10 percent or more per year for 10 years –** Although welcomed, a large increase in available Federal funding would pose challenges for NDOT. Most importantly, the State would need an increase in State funding to provide the required 20 percent match for the Federal funds. Other challenges/risks include, needed staff and resources to produce the program, needed staff to inspect/build the program, materials availability, and number of qualified contractors. NDOT's Program Management and Government Affairs Divisions will monitor National and State legislative activities to identify potential risk.
- **Increase in State funding by 10 percent or more for 10 years –** Although welcomed, a large increase in available State funding would pose challenges for NDOT. Most importantly, the State would lose buying power if an increase in Federal funds does not accompany the increase in State funding to provide the required 80 percent match for the State funds. Other challenges/risks include, needed staff and resources to produce the program, needed staff to inspect/build the program, materials availability, and number of qualified contractors. NDOT's Program Management and Communications and Public Policy Divisions will monitor National and State legislative activities to identify potential risk.

- **Deterioration of equipment (age, repair vs. replacement cost, mileage/hours) or not having proper equipment –** Stagnant funding levels have required the State to keep equipment in service longer than the optimal time. Down time due to repairs, less efficient equipment, and not having the proper equipment can cause delays and affect the quality and cost of maintenance work. NDOT's Districts and Operations Division will monitor the fleet inventory through the Lucity asset management software.

- **Lack of qualified personnel (NDOT & Industry) –** Nationwide there is a perceived lack of qualified candidates for high-tech jobs in Science, Technology, Engineering, and Math (STEM) fields. This is magnified in Nebraska due to the low unemployment rate and wage differentials between the private sector and government. Being able to hire and retain qualified personnel for both NDOT and the industry is key to maintaining pavement and bridge assets in a state of good repair. NDOT's office of Civil Rights periodically runs reports on the demographics of the current workforce, applicant pools, applicant sources, and new hires to monitor the availability of qualified workers.

- **Reduction of staff –** The NDOT underwent a staff reduction from 2016 thru 2018. Reduction in design and support staff may lead to contracting with more consultants, which may increase costs. A reduction in maintenance staff will reduce the number of miles maintained leading to a decrease in the condition of bridges and pavements. A reduction in the number of construction inspectors may lead to decreased oversight, which could result in errors/change orders increasing the cost of projects. NDOT's Human Resources Division tracks staffing levels .

- **Capacity and reliability of computer network –** As technology advances, the pressure on the computer network infrastructure increases. As NDOT moves toward E-Construction and other applications, the reliability and capacity of the network will be of utmost importance to prevent downtime and delays. NDOT's technology staff and Nebraska office of the OCIO will monitor bandwidth usage, security, and suitability of software solutions for NDOT needs.

- **Regulations that increase loads on pavements –** Any legislation or regulation that allows increased truck axle loads would decrease pavement and bridge service life. Higher axle loads would increase the rate of deterioration, which would result in higher maintenance costs, higher construction cost to accommodate higher loads, and more frequent preservation treatments. NDOT's Communications and Public Policy Division will monitor National and State legislative activities and notify appropriate subject matter experts.

7.4 Programmatic Risks

NDOT has identified several programmatic risks that have the potential to affect the condition of the highway system on a project level as described below.

- **Decrease in State funding by 10 percent or more for a year –** This is a major impact and would cause NDOT to delay projects in the one-year program and possibly subsequent years. These events cause a ripple effect on the program unless an increase in State funding follows. Moving projects back increases maintenance and construction costs due to inflation, decreases the highway and bridge condition, which can take years to recover. It also reduces the available State match, normally 20 percent / 80 percent, for Federal funds which reduces the amount of projects that can be let. NDOT's Program Management and Communications and Public Policy Divisions will monitor National and State legislative activities to identify potential risk.

- **Decrease in Federal funding by 10 percent or more for a year** – Similar to a decrease in State funding, this is a major impact and would cause NDOT to delay projects in the one-year program and possibly subsequent years. Federal funding normally covers 80 percent of project costs and would decrease the spending power of State funds. Unless an increase in Federal funding follows, moving projects back increases maintenance and construction costs due to inflation, decreases the highway and bridge condition, which can take years to recover. NDOT's Program Management and Government Affairs Divisions will monitor National and State legislative activities to identify potential risk.

- **Extreme Weather (Fire, Tornadoes, or Snow)** – These natural disasters can have an impact on the overall condition of an asset.
  - Wildfires are isolated events during drought conditions, which can close roads and delay maintenance or construction for a short period.
  - Tornados are isolated events that traditionally occur in May or June, but now occur any time of the year. These events can close NDOT facilities or roads and delay maintenance or construction for a short period.
  - Large snow/ice events can be widespread and cause roads closures for short periods of time. Wintertime events do not normally affect maintenance or construction activities. NDOT has made significant investments in winter maintenance operations including the procurement of a Maintenance Decision Support System, the acquisition of dedicated weather operational expertise, and the development and refinement of a winter severity index[57]. These resources have improved NDOT's internal operations, coordination with its partners, and its statewide level of service.

  NDOT operation centers stay alert to potential weather events and wildfire risk ratings.

- **Extreme Weather (Flood)** – Widespread flooding can be a significant environmental risk to Nebraska's highway system. Flooding can wash out bridges and roadways and create closures for extended periods of time. Once this occurs, additional highway traffic is placed onto detour routes accelerating deterioration. Because of this detour, maintenance or construction resources may be diverted causing delays to scheduled work

  Four Flood task force groups were created after the historic floods of 2019. These groups are further described below:
  - A District task force was created to rate weather events and their impact on Nebraska roadways. This group includes NDOT's first-ever meteorologist to inform local Districts of potential flooding so they can mobilize the deployment of barricades for overtopped roadways more quickly than in the past.
  - An Operations task force created a public web application that displays reported overtopped roadways in real-time.

    In addition, a UNL research project[58] compiled data for five years to quantify the relationship between water obstructions and meteorological conditions that lead to flooding. By prior location of water obstructions with a higher potential of flooding, district personnel can provide improved emergency response time, thereby reducing injury and death to the traveling public.
  - A Technology task force created a specialty GIS map to report live data of damaged bridge and roadway locations to aid in NDOT's flood recovery process.
  - A Controller task force established a Standard Operating Procedure to streamline and document the tracking of hours, equipment usage, and contracts for emergency events.

[57] See the Road Weather Impact Based Decision Support Applications: Developing A Department of Transportation Winter Severity Index https://dot.nebraska.gov/media/117567/walker-dissertation.pdf

[58] An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways https://dot.nebraska.gov/media/117566/final-report-investigation-of-water-obstr-related-weather-may-2022.pdf

- **Deterioration models becoming outdated due to changing climates** – A changing climate can potentially cause NDOT assets to deteriorate faster and increase repair and reconstruction costs. A future research project could be initiated to examine the changing climate and its impact on deterioration rates.
- **Extreme Weather (Increasing Temperature)** – Increasing temperatures can cause buckling in concrete and rutting in asphalt, decreasing the lifespan of pavement. Pavement design models may need to be recalibrated in the future to incorporate the effects of significatingly higher temperatures. The use of sustainable construction materials by NDOT and others will help mitigate climate change.
- **Extreme Weather (High Hazard Dams)** – According to the Nebraska Department of Natural Resources (NeDNR), there are over 3,000 dams in the State of Nebraska, of which 154 have been classified as having a "high hazard potential," see Figure 29. A high hazard potential is defined as when the failure or misoperation of the dam results in probable loss of human life. Failure or misoperation may also cause serious damage to homes, industrial or commercial buildings, four-lane highways, major railroads, or cause shallow flooding of hospitals, nursing homes, or schools.

  From NeDNR's dam inventory, NDOT identified highways downstream from high hazard dams and the approximate reference posts of those highways. In some instances, multiple highways are located downstream from a high hazard dam. NDOT will continue to monitor high hazard dam locations and downstream assets in the future.

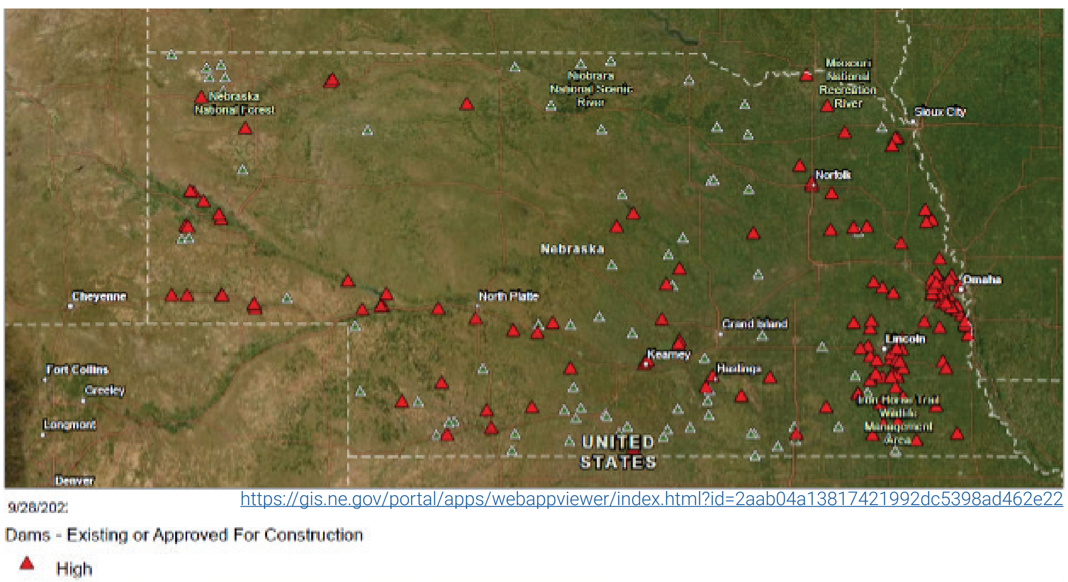


Figure 29 - Nebraska Dam Inventory – High Hazard and Failed Dams

- **Premature failure of pavement or accelerated deterioration of bridge** – can reduce an asset's level of service and result in higher maintenance costs or an emergency type of project. Due to timing, emergency repairs must be made with State funds. This reduces the amount of funds for matching Federal funds, which could delay projects scheduled elsewhere and lead to increased maintenance/construction costs. District maintenance personnel will monitor and report on any large scale or sudden pavement or bridge deterioration that occurs between regularly scheduled inspection cycles.

7.5 Priority Risk Registry

The following priority risk register contains the Risk events, the potential consequence, the likelihood of each risk occurring, and mitigation strategies to address the risk. See Table 21.

Table 21 - Priority Risk Registry

Risk Event		Consequence		Likelihood		Mitigation or Response
Description	**Type**	**Description**	**Appraisal**	**Description**	**Appraisal**	**Description**
Decrease in state funding by 10 percent or more for a year.	Program	A reduction in BNA, TIA, or Road ops funds would reduce the amount of federal funds we could match and could cause project delays, maintenance cost increase, pavement and bridge condition drop.	major -4	Historically State funding has been stable.	unlikely 2	Reduce Construction Program. Delay Construction Lettings. Apply for discretionary grants. Convert 100 percent state funded projects to use Federal Aid. Continued communication with lawmakers about the consequences of reduced funding.
Decrease in federal funding by 10 percent or more for a year.	Program	Could cause project delays, maintenance cost increase, pavement and bridge condition drop.	major -4	Historically Federal funding has been stable.	unlikely 2	Reduce Construction Program. Delay Construction Lettings. Apply for discretionary grants. Continued communication with lawmakers about the consequences of reduced funding.
Increase in federal funding by 10 percent or more for 6 years.	Agency	Would improve pavement and bridge conditions faster than existing funding.	significant benefit 2	IIJA will be done in 2026, and legislatures are discussing an increase in infrastructure funding	likely 3	Have projects ready before the planned funding.
Increase in State funding by 10 percent or more per year for 6 years.	Agency	Would improve pavement and bridge conditions faster than existing funding.	significant benefit 2	IIJA will be done in 2026, and legislatures are discussing an increase in infrastructue funding	rare 1	Have projects ready before the planned funding.
Deterioration of equipment (age, repair vs replacement cost, mileage/ hours) or not having proper equipment	Agency	Unable to perform maintenance in a timely manner which would increase deterioration of pavements and bridges.	major -4	Stagnant state funding levels have forced us to keep equipment in service longer than optimum.	very likely 4	Communicate consequences with lawmakers. Prioritize maintenance program. Potentially contract out more maintenance work.

Risk Event		Consequence		Likelihood		Mitigation or Response
Description	**Type**	**Description**	**Appraisal**	**Description**	**Appraisal**	**Description**
Lack of qualified personnel (NDOT and the industry).	Agency	Unable to inspect, maintain, develop, and build projects.	major -4	Lack of interest in transportation (STEM) is leading to a lack of qualified personnel for both NDOT and the industry.	very likely 4	Continue to provide outreach programs to high schools and colleges. Continue to provide paid training and education.
Reduction of staff.	Agency	Unable to inspect , maintain, develop, and build projects.	major -4	NDOT is currently experiencing a reduction in staff.	likely 3	Contract out more work. Streamline process.
Capacity and reliability of computer network.	Other	Flow of information shuts down, reduces efficiency and reduces production.	major -4	As NDOT moves toward e-construction and more technological advances, a reliable computer network is paramount.	unlikely 2	Continue to invest in equipment and infra-structure.
Regulations that increase loads on pavements.	Agency	Pavement and bridges deteriorate faster.	moderate -3	Nebraska legislature has continued to propose bills to increase the legal load limits.	very likely 4	Continue to educate public and lawmakers of consequences. Continue to work with AASHTO to provide national perspectives of impacts. Potentially increase design factors to handle higher loads.
Premature failure of pavement or accelerated deterioration of bridge.	Program	High impact to roadway users. State funds are used for these repairs which reduces the amount available for federal fund matching.	moderate -3	Have experienced premature pavement failures.	likely 3	Continually improve deterioration modeling. Apply necessary funds to fix failure, which may delay other planned projects.
Extreme weather (fire, tornadoes, or snow)	Program	Roads are closed or damaged.	major -4	Nebraska has experienced extreme flooding, localized wild fires, and large snow events in the last 10 years.	likely 3	Maintain alternative route plans, COOP, coordination plans with emergency responders, FEMA and NEMA.
Extreme Weather (flood)	Program	Flooding and deterioration of road and bridges, resulting in adverse impacts that include the overtopping of assets.	major -4	Water obstruc-tions occur more often during the spring, summer, and fall seasons and more in the northern and eastern parts of Nebraska. An average of 13 water obstruc-tions annually.	almost certain 5	Flood task force (district flood threat process, operations locating overtopping locations in 511 (research project), set-up GIS for asset damage, documenta-tion of new obstruc-tions due to flooding in an archive).

Risk Event		Consequence		Likelihood		Mitigation or Response
Description	Type	Description	Appraisal	Description	Appraisal	Description
Outdated deterioration models due to changing climates	Program	Future research project could be initiated to examine the changing climate and its impact on deterioration rates.	major -4	Possible but not likely, low occurrence.	rare 1	Research with a pilot project to determine deteroriation rates.
Extreme Weather (increasing temperature)	Program	With increasing temperatures, buckling in concrete and rutting in asphalt will cause the lifespan of the roadway pavement to decrease.	major -4	Possible but not likely, low occurrence.	rare 1	Adjust pavement designs.
Extreme Weather (high hazard dams)	Program	Failure or misoperation may also cause serious damage to homes, industrial or commercial buildings, four-lane highways, major railroads, or cause shallow flooding of hospitals, nursing homes, or schools.	Cata-strophic -5	Possible but not likely, low occurrence.	rare 1	NDOT will continue to monitor high hazard dam locations and downstream assets in the future.

7.6 Pavement Management Priority Ranking

As noted in Section 4.3.1, NDOT has built a priority ranking into the POP Life Cycle Cost Analysis. Through this assessment, project candidates receive rankings based on Functional Classification, Population Density, Strategy Type, and Project Length. As a result, roadways on higher classified routes i.e. interstates, freeways & expressways, and principal arterials receive a higher ranking. These routes primarily make up the NHS; therefore, the NHS receives a higher priority for selection. This proactive process helps prevent gaps in performance and reduces the risks related to pavement deterioration.

7.7 Bridge Management Risk Assessment

For an overview of risk-based bridge project development, please see Section 3.4.2.

These three groups of bridges undergo risk assessment:

- Bridges that have been determined to be candidates for replacement or major rehabilitation are prioritized considering risks associated with scour, condition, load rating, and average daily traffic. Prioritized candidates are assigned a recommended programming year. Annual reviews are conducted to consider new candidates for major work and to confirm the programming year. Decisions about programming year are made with the intent to avoid costly short-term repairs prior to replacement.

- Roadway projects often present an opportunity to provide both major bridge work as well as bridge preservation without significant additional disruption to traffic as compared to separate projects to provide for bridge needs. Combining bridge work with roadway projects mitigates impacts to the traveling public by reducing time that roads and lanes are closed to traffic. Preservation actions reduce the likelihood and consequences of higher cost repairs in the future.
- High asset value bridges in good condition are high preservation priorities. High traffic volume bridges impact mobility if they are out of service. Large bridges have higher costs to replace. Large bridges with high traffic volume are considered high asset value bridges. Bridges without deck protection systems are ranked according to ADT x Deck Area and their rank increases as the bridge nears the end of the window of effective preservation opportunity. Some preservation actions, such as installation of deck protection systems have a limited window of effective opportunity. Risk associated with not protecting a bridge increases as the bridges approach the end of their service life when greatest benefit can be achieved by preservation. See Figure 30.

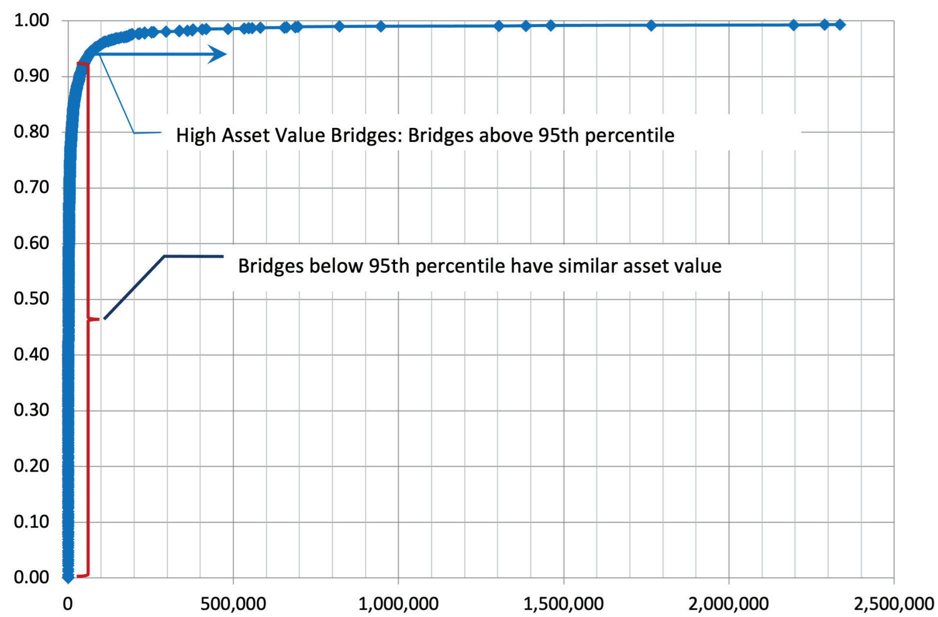


Figure 30 - Cumulative Distribution of Asset Value for State Highway Bridges

Bridges that are of high asset value are the big bridges with high traffic.
Asset Value = Bridge Area x Future Traffic

For more information about preservation of high asset value bridges, see the Bridge Management Deck Policy[59].

[59] Bridge Management Deck Policy guidelines can be seen in Appendix C.2.2

7.8 Evaluation of Facilities Requiring Repair Due to Emergency Events

A review of past projects using Emergency Relief (ER) funding has concluded that no roadway segments or bridges have required repair or reconstruction activities on two or more occasions since 1997 as required by 23 CFR Part 515 Final Rules §515.7(c)(6) and 23 CFR Part 667 Final Rules §667.1. This will be reviewed every four years prior to submittal for compliance review. To document ER projects for review, a feature was developed in the Pavement Optimization Program POP). This feature alerts NDOT when a past ER segment of pavement or bridge is to be repaired or reconstructed. This list is beneficial in meeting federal regulations and is shown in Figure 31.

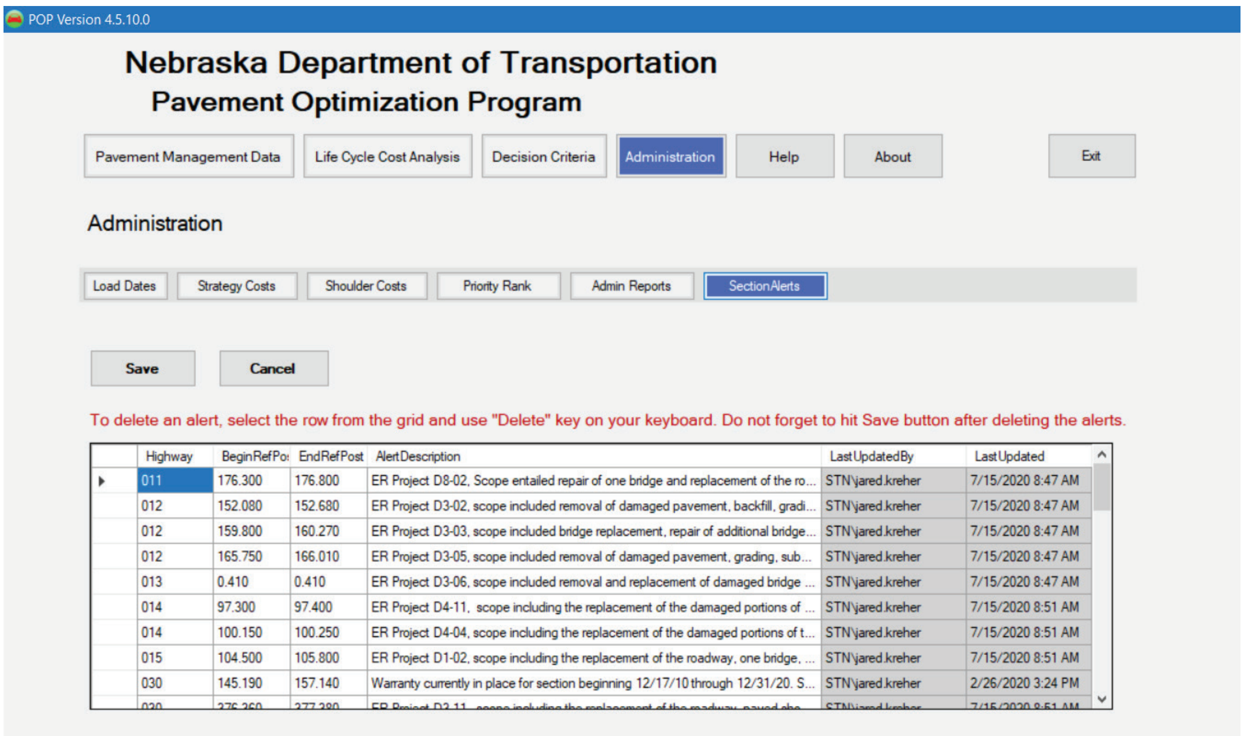


Figure 31 - Pavement Optimization Program

7.9 Risk Mitigation for Extreme Weather and Resilience

System and program preparedness are essential to a risk management plan. Resilience of the State's infrastructure depends on the proper use and management of an asset throughout its service life.

System resiliency also requires the mitigation of everyday disruptions. If safe and uncongested alternative routes are not available when routine inconveniences occur, a deficiency in resiliency is indicated. Severe weather, traffic accidents, construction, and road closures are routine events that can increase travel time and reduce the safety of drivers. System resiliency allows NDOT to maintain mobility for the traveling public.

NDOT employs several strategies to maintain resilience, improve the operating efficiency of the State's Transportation System, and reduce the duration of incident response and clearance times. Example strategies include the monitoring of high-hazard dam locations, new tools to assess impacts of flood and streamline responses, Intelligent Transportation Systems (ITS), maintain a statewide Continuity Operations Plan, and coordinating incident management plans with law enforcement and emergency responders.

To further develop NDOT's extreme weather risk mitigation as part of the LCCA and candidate list creation process, NDOT plans to create a list of roadway segments and bridges prone to flooding to be incorporated into NDOT's LCCA program called POP. The list calls out state asset locations with either a flooding history or a high potential for flooding. Something similar to the UNL study, An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways[58], could be a possible data source for this flooding list. By maintaining and periodically reviewing this list inside of POP, NDOT staff will be able to mitigate these flood risks when these roadway segments and bridge projects appear in the yearly candidate lists.

For bridges, location-specific design strategies are used to mitigate risk and increase resilience. For example, structures over waterways that are known to have seasonal ice-effected flooding are designed with extra clearance to accommodate ice flow. Span lengths and height of bridges over waterways are scaled to accommodate runoff based on analysis of high-water history and the probability of high-water events during a bridges service life. Embankment deterioration, should it occur, is monitored and mitigation strategies may be employed if needed

7.10 Sustainability at the NDOT

The NDOT is making tremendous strides in terms of sustainable highway construction materials. Through research and innovation, NDOT has significantly reduced its materials related carbon footprint over the last 20 years. This reduction in carbon and other greenhouse gas emissions serves as NDOT's contribution to combating global climate change and it's growing impacts.

Portland Cement Concrete

NDOT maintains over 10,000 miles of pavement and over 3,500 bridges. Approximately 17% of NDOT pavements are Portland Cement Concrete and all bridges are primarily, if not completely, constructed of reinforced concrete. In addition, the NDOT is 12 years into a 30-year program to reconstruct and expand Interstate 80 across the state as well as completing the final segments of a 4-lane Expressway System using Portland Cement Concrete.

Portland Cement, the most critical component of concrete, has one of the highest carbon footprints of all construction materials. NDOT Materials & Research has required the use of Supplementary Cementitious Materials (SCMs) since the early 2000's. SCM's include Fly Ash (a bi-product of coal combustion), slag (a by-product of steel manufacturing) and calcined clay. Although the primary purpose of requiring SCMs was to mitigate concrete deterioration caused by Alkali Silica Reaction (ASR), it also reduced the amount of cement required to produce concrete by 25%. Not only did the partial replacement of manufactured cement with a by-product result in a lower carbon footprint, it also resulted in a more durable and long-lasting pavement. The reduction in cement content on NDOT projects over the past 20 years has resulted in an estimated savings of over 442,000 tons[60] of carbon dioxide (CO_2), the largest component of greenhouse gasses by far. This number will only increase in the future with the recent approval of a cement containing 38% SCMs.

In addition to over 20 years of SCM use, the NDOT has more recently partnered with the concrete industry to further decrease cement contents by implementing the use of limestone cements. Limestone cements replace up to an additional 12% of cement with limestone dust and is quickly becoming the industry standard. NDOT once again took the lead by completing strength and durability testing and adoption of limestone cements in 2010, over a decade before the industry began its transition toward this more sustainable product.

Finally, any concrete pavements constructed by the NDOT are placed on a drainable base typically consisting of recycled crushed concrete or asphalt millings. The use of recycled material further reduces mining, processing, and trucking emissions that would have been required to import a virgin granular material.

Hot Mix Asphalt

Similar to concrete, NDOT has made tremendous strides in curbing greenhouse emissions related to the production of Hot Mix Asphalt pavements over the last 15 years. In fact, NDOT has led the nation, and the world, in the amount of Recycled Asphalt Pavement (RAP) utilized in new asphalt surfaces and pavements. Approximately 83% of NDOT's pavements are full depth asphalt or concrete with an asphalt surface. Beginning with its first High Rap Base (HRB) mixes in 2006, incorporating up to 50% Recycled Asphalt Pavement (RAP), to its modern high performance mix Types SLX and SPR that contain 35% and 50% RAP respectively, NDOT has recycled over 10 million tons of RAP in the last 14 years alone. Utilizing a high RAP content dramatically reduces the amount of asphalt binder (a fossil fuel) needed as well as the mining, processing and trucking of new aggregate thereby reducing overall greenhouse emissions. In addition to an impressive recycling program, NDOT also mandates the use of Warm Mix Asphalt additives which reduces the energy needed to produce asphalt and ultimately compact it. In addition, any asphalt pavement that is milled from the roadway and not re-incorporated into the new asphalt is typically re-used as a granular base for concrete pavement, similar to recycled concrete.

Soils

In addition to concrete and asphalt pavements, the NDOT also utilizes a significant amount of by-products, fly ash specifically, to stabilize weak soils and dry saturated soils. By using by-products for beneficial purposes, the NDOT has improved the longevity of our pavements while diverting a significant waste stream from landfills.

[60] Estimate based on total cement in concrete produced and 0.9 lb of CO_2/lb of cement. https://www.cement.org/docs/default-source/th-paving-pdfs/sustainability/carbon-foot-print.pdf

Recycled Content

As previously discussed, NDOT utilizes a significant amount of recycled construction materials from fly ash in cement, to crushed concrete in foundation course, to RAP in new asphalt. To partially quantify NDOT's recycling efforts on a project basis, a recycle badge is created and placed on the title sheet of every project plan set. Although this badge does not encompass all of NDOT's sustainability efforts, it does quantify the majority of recycled materials used on each project.

On a more global basis, the following shows a summary of recycled material used on all NDOT projects constructed in FY-2022:

Project Raw Materials (Tons)
59,690

Post Consumer Recycle Content
33%

Post Consumer Recycle Content in Project Raw Materials (Tons)
19,836

Estimated Value of Post Consumer Content Recycled
$804,891

In conclusion, the construction industry is a significant source of carbon and other greenhouse gas emissions. The NDOT recognizes its role in the construction industry and embraces the opportunity to make a difference in the global effort to curb emissions and minimize the impact of climate change and its impact on extreme weather.

Project Raw Materials (Tons)
3,530,896

Post Consumer Recycle Content
34.8%

Post Consumer Recycle Content in Project Raw Materials (Tons)
1,230,025

Estimated Value of Post Consumer Content Recycled
$77,148,114

CHAPTER 8 Financial Plan and Investment Strategies

8.1 Overview

NDOT's infrastructure investment priorities consider Federal requirements and state laws, revenue trends, level-of-service provided by the transportation system, and input from the public and stakeholders. NDOT forecasts state and federal revenue annually to aid in the preparation and publication of the surface transportation program. For state revenue sources, NDOT Controller Division staff confer with economists and tax collection staff with the Nebraska Department of Revenue to maintain historical trend data for motor fuel consumption (i.e. taxable gallons) and motor vehicle sales. For motor vehicle registration revenue, NDOT partners with the Nebraska Department of Motor Vehicles to maintain historical trend data for registration fees paid in Nebraska. The trend data and economic analysis provided by these and other sources are utilized to develop short and long range estimates of these primary state revenue sources. NDOT uses the bulk of its funds to preserve existing roads and bridges. A small percentage of funds are used to expand the transportation system.

8.2 Funding Sources

Nebraska's transportation program is financed by two major funding sources – State and Federal funds. Revenues are distributed to NDOT through mechanisms and formulas established by law, at both the State and Federal level.

8.2.1 Federal Funds

Federal funds are derived from user revenues paid into the Federal Highway Trust Fund. The fund's revenues consist primarily of federal motor fuel tax and fees charged on heavy vehicles. Funding is provided to the states through an annual appropriation process and distributed by means of formula allocations as defined by law. For state fiscal 2022, federal highway revenues are estimated at $447 million.

8.2.2 State Funds

8.2.2.1 State Highway Trust Funds

The State Highway Trust Fund is used for the maintenance and construction of the state highway system. State highway trust funds are derived from three primary highway user revenue sources: (1) fuel taxes, (2) sales taxes on new and used motor vehicles and trailers, and (3) motor vehicle registration fees. Approximately $239 million of the state highway trust fund revenue is set aside for routine highway maintenance, administration, capital facilities, supportive services, carrier enforcement, transit, rail and construction overhead. The remaining revenue and the existing available fund balance are available for the state highway construction program and system preservation.

State Highway Trust Fund revenues are shared between NDOT and Nebraska's local public agencies (i.e. cities and counties). For instance, in 2022 approximately 65% of the estimated motor fuel tax is designated for NDOT and the remainder for LPAs in Nebraska. With motor vehicle sales tax and registration revenue, 53% is dedicated to NDOT and 47% is shared by cities and counties.

Other local revenue sources for the LPAs, such as property tax, wheel tax and local option sales tax, complement their State Highway Trust Fund revenue allocations.

8.2.2.2 Build Nebraska Act

Beginning in 2013, the Nebraska Legislature provided increased funding to NDOT with the Build Nebraska Act (BNA). The BNA is used for the construction of the state expressway system and federally designated high priority corridors, with the remaining funds for surface transportation projects of highest priority. One quarter of one percent of general state sales tax revenue is designated for BNA funding. The average annual estimate of BNA revenue is nearly $100 million. Eighty-five percent of the projected BNA revenue is for state surface transportation projects, estimated at approximately $85 million annually. The remaining 15 percent is for local roads and streets, estimated at approximately $15 million annually.

8.2.2.3 Transportation Infrastructure Bank (TIB)

The Transportation Innovation Act (TIA) was enacted by the Nebraska Legislature in 2016. TIA created the Transportation Infrastructure Bank fund which receives annual revenue from fuel taxes generated by LB 610 (2015) and received a one-time transfer of $50 million from the State Cash Reserve Fund. The annual fuel tax revenue dedicated to TIA is estimated at $29 million going forward. TIA revenue is to be used for three purposes: (1) accelerate highway construction improvement projects on the state highway system; (2) promote innovative solutions to accelerate the repair and replacement of deficient bridges on the county road system; and (3) finance transportation improvements to connect new businesses and business expansions to the transportation network.

NDOT's monthly and annual financial reports, which identify funding sources and revenue allocation, can be found on NDOT's website[61]. See Figure 32.

[61] NDOT's monthly and annual financial reports are available at: http://dot.nebraska.gov/business-center/financial-reports/

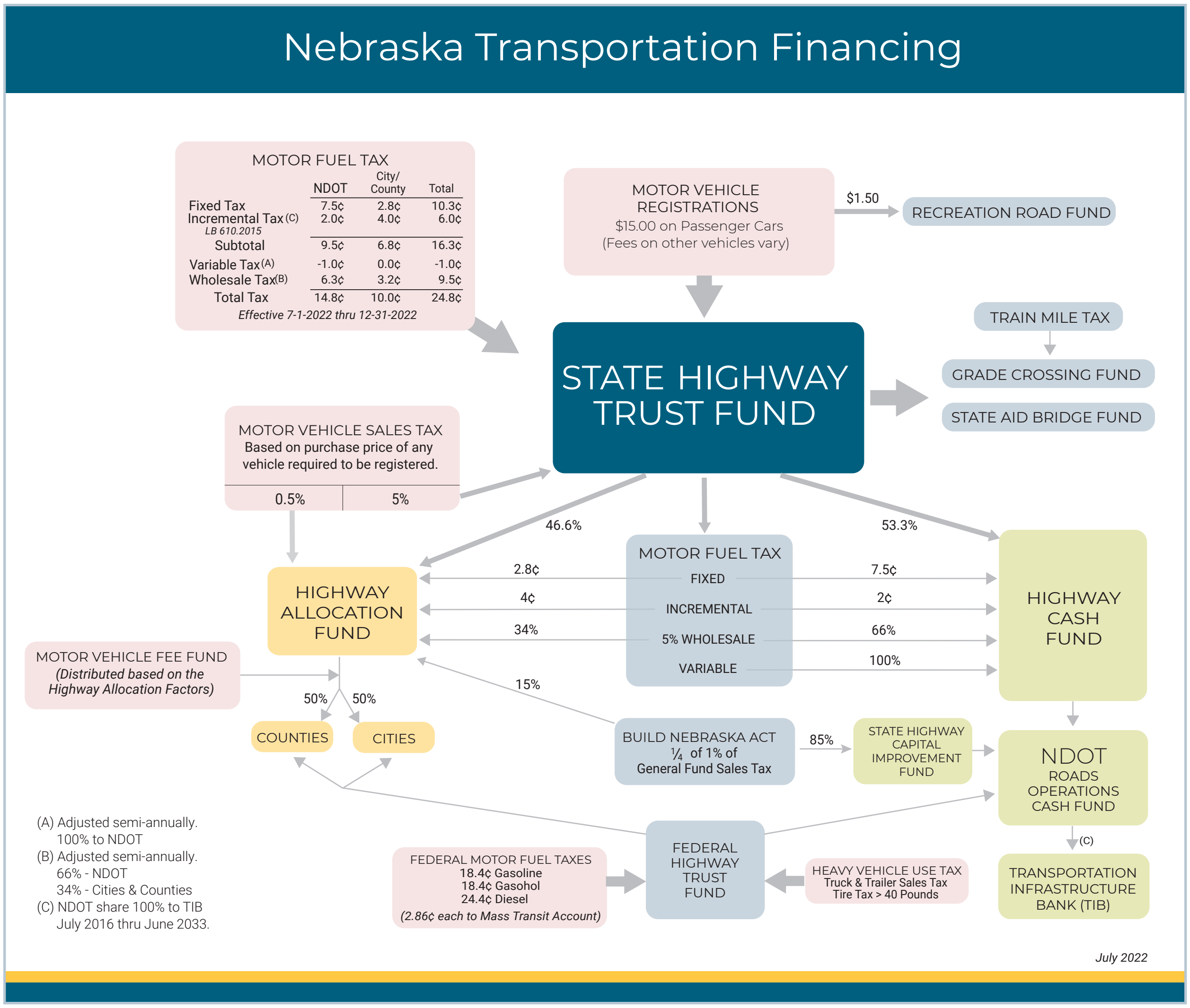


Figure 32 - Nebraska Transportation Financing

8.3 Financial Management

Following the creation of the annual needs analysis in 1988, NDOT established a policy to ensure that State Highway Construction funding was distributed based on needs. Each year, NDOT completes an assessment of the highway system comparing roadways and bridges with established criteria. This evaluation is based upon conformance with design standards, output from the Bridge Management System (BMS) and the Pavement Management System (PMS). These assessments establish the dollar value of the needs in each district and statewide. Each of the eight districts receives a construction program size based upon the percentage of the statewide needs located within the district. As a result, majority of revenues received are dedicated to asset preservation.

NDOT's Asset Management Strategic Goal is to operate, maintain, upgrade, and expand physical assets effectively throughout their life cycle. To achieve this goal NDOT uses a general rule of rehabilitating approximately 500 miles of pavement per year or 1/20th of the highway system. Bridges in these locations also receive preservation treatments. This would ensure that roadways and bridges get some type of preservation treatment at least every 20 years, which keeps the system in a SOGR. For pavements, a SOGR is considered to have an NSI between 70 and 100. Setting a goal of 100 is unrealistic and would not be cost effective, so NDOT strives for an average NSI between 75 and 85 for the entire State Highway System.

State revenues used for Capital Improvement are limited to Transportation Innovation Act or Build Nebraska Act funding sources. Capital improvement candidates are prioritized and selected for projected funding, based on engineering and economic impact, stakeholder input, and geographical inclusion.

NDOT annually publishes a Surface Transportation Program Book, which summarizes the construction program financing, projects, NDOT work type, and estimates. Projects are organized by those scheduled for construction within one year and those that are planned for construction in the following five years. The most current program book is posted annually on NDOT's website[62].

The STIP reflects the first four years of federally funded and regionally significant projects included annually in the Nebraska Surface Transportation Program Book.

The Freight Plan also correlates with planned investments on identified corridors. The FAST Act was the first bill to require that the Freight Plan contains a fiscally constrained list of freight projects. The requirement was also included in the Infrastructure Investment Jobs Act (IIJA). In order to qualify for Federal freight funding under National Highway Freight Program (NHFP) Funding, projects must:

- Be located on or improve freight movement on the National Highway Freight network, which includes the interstate system, and the critical urban and rural freight corridors identified in the plan.
- Be listed in a fiscally constrained Freight Movement Plan including information on other funding sources and matching funds.

[62] NDOT's Program Book is available at: https://dot.nebraska.gov/projects/publications/

8.4 Financial Reporting Requirements

8.4.1 Governmental Accounting Standards Board; Statement 34 (GASB34)

NDOT annually reports a financial statement in compliance with Governmental Accounting Standards Board (GASB) Statement Number 34: Basic Financial Statements – and Management Discussion and Analysis – for State and Local Governments. Statement No. 34 was issued in 1999 to establish financial reporting standards for U.S. State and Local Governments. **The three most significant additions to the governmental financial report are the management's discussion and analysis (MD&A) section, government-wide financial statements, and major fund reporting.**

- The **MD&A** is intended to make the financial report easier to understand and more meaningful for a broader audience. The management's analysis explains the changes in finances from prior to current fiscal years and identifies key issues that have or will affect the overall financial health of the government.
- **Government-wide financial statements** include statements of net assets and activities that detail a government's financial bottom line.
- **Major fund reporting** requires the largest or most significant fund to be reported individually in a separate column and the non-major funds to be grouped together in a single column. This requirement is intended to improve transparency compared to the former method used to aggregate and report funds according to type.

8.4.2 Annual State Highway Needs Assessment Report

In 1988, NDOT was assigned the task of annually reporting on the needs of the State Highway System to the Nebraska State Legislature (Neb. Rev. Stat. § 39-1365.02). Since that time, NDOT has made steady progress identifying and addressing the dynamic needs of the State Highway System. To address Nebraska's needs, each year, NDOT determines how much it will cost to eliminate the needs of the highway system. The needs include, removing geometric deficiencies, improving pavements and bridges to meet performance goals, improving mobility, and addressing capacity needs. These costs are computed in today's dollars and are inflated over a 20-year period to determine NDOT's 20-year needs.

Modelling of future allocations to meet bridge performance targets involves application of deterioration models to bridge components to incrementally reduce bridge conditions year by year. This deterioration is offset by construction activities that improve bridge conditions for bridges that meet criteria to be considered as work candidates. Various funding levels are tested and various funding distribution between repair or replacement strategies is investigated in an iterative process until a funding level that provided acceptable network condition is found[63].

8.4.3 Annual BNA/TIA Report

In 2011, with the passing of the Build Nebraska Act (Neb. Stat. § 39-2701) and in 2015, the Transportation Innovation Act (Neb. Stat. § 39-2801), NDOT is required to present the details of the programs contained in these acts to the Nebraska State Legislature. See Sections 8.2.2.2 and 8.2.2.3 for more details.

[63] For a detailed description of Modeling Future Bridge Needs see IHEEP 2018 "Modeling Future Bridge Needs and Interactive Maps to Facilitate Decisions" https://dot.nebraska.gov/media/117919/2018-iheep-asset-management-focus-group.pdf

8.5 Asset Management Fund Allocation

The NDOT construction program size is approximately $500-$700 million per year. Each fall, NDOT uses a combination of a delivery schedule risk assessment, asset condition, projected revenues, candidate list based on 10-year life cycle, and project estimates to determine how much of the construction program will be dedicated to Asset Preservation, System Modernization, and Capital Improvement. Investment strategies are developed involving trade-offs among assets based on the results of required analyses including performance gaps analysis, life cycle planning, and risk management, as well as a discussion of available revenues. Trade-off tools in POP are used to evaluate the effect of potential funding scenarios to recommend year-by-year distributions that will produce the greatest benefit in highway and bridge network conditions.

8.5.1 Needs Assessment

In 1988, the Nebraska State Legislature assigned the task of annually reporting on the needs of the State Highway System to the Nebraska Department of Transportation (NDOT) (Neb. Rev. Stat. §39-1365.02). Since that time, the NDOT has made steady progress identifying and addressing the dynamic needs of the State Highway System. To address Nebraska's needs, each year, NDOT determines how much of the construction program will be dedicated to asset preservation, system modernization, or capital improvement. These decisions are made based on condition of our existing system, project deliverability, revenue, and allocation projections. Costs are computed in today's dollars and are inflated over a 20-year period to determine NDOT's 20-year needs.

The 20-year needs of the State Highway System are divided into three categories. See Figure 33.

- Asset Preservation – Maintenance of the system.
- System Modernization – Safety, geometric, or mobility improvements that do not add capacity to the roadway.
- Capital Improvements – Improvements that add capacity or support economic growth.

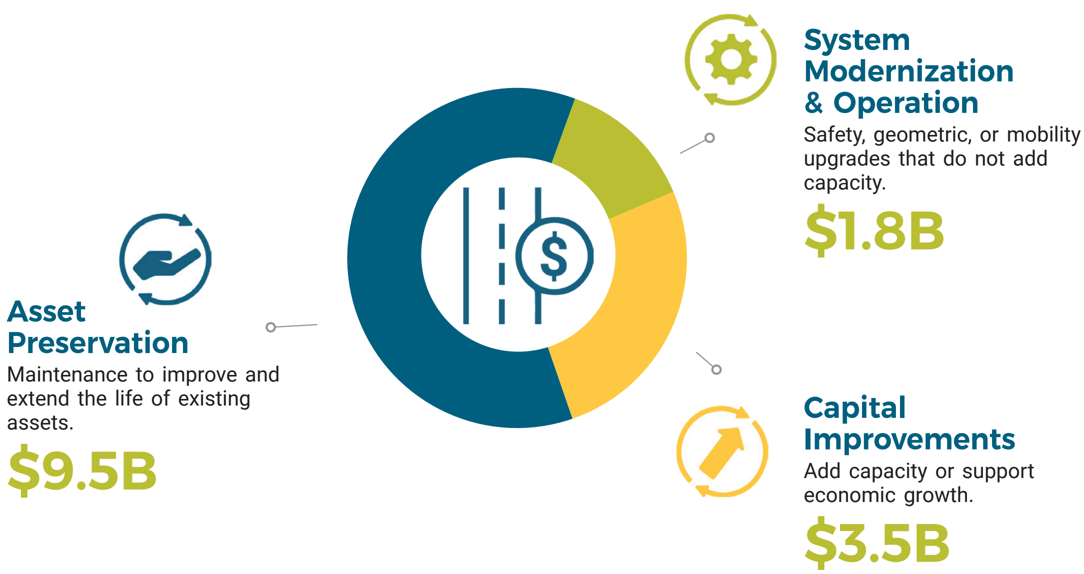


Figure 33 - 2021 Needs Categories

Some highway projects may have aspects that fall into more than one category or all three; however, no costs are double counted in this report. What follows is a brief description of how the needs are determined for each category.

A 2021 Summary of the 20-year Needs Assessment suggests 64 percent of the needs represent Asset Preservation, 12 percent represent System Modernization and 24 percent represent Capital Improvement.

8.5.2 Asset Preservation

Many different factors affect pavement and bridge preservation needs, including the previous year's work, extreme environmental conditions, traffic volumes, traffic loads, and yearly maintenance. NDOT continues to explore new technology and materials that may lead to improved pavement and bridge performance and may extend the life of pavements and bridges. The projected 20-year asset preservation needs, in 2023 dollars, are estimated at 64 percent of the budget and include Pavement and Bridge Preservation:

8.5.2.1 Pavement Preservation

The entire State Highway System is rated each year in order to evaluate its overall pavement condition. Distress factors such as cracking, faulting, rutting, and ride quality are inserted into formulas that have been developed to calculate the overall condition of the roadway, called the Nebraska Serviceability Index (NSI). This NSI rating is then used in a benefit/cost analysis tool to identify the right preservation treatment at the right time to maintain the highway system at a specified pavement condition level. Preservation treatments include, but are not limited to, crack/joint sealing, armor coats, milling, resurfacing, and replacements.

8.5.2.2 Bridge Preservation

Similar to pavements, bridges are inspected for safety and condition. Every bridge in Nebraska is typically inspected every two years. NDOT uses a bridge needs program that takes into consideration factors such as condition, deterioration rate, age, traffic, and cost/benefit to determine when to apply the proper treatments at the proper times. Preservation includes preventative maintenance, repair, re-decking, rehabilitation, and replacement of bridges that meet the required width. Bridges continually deteriorate so bridge needs are not static but change yearly. NDOT is doing more systematic preservation such as asphalt overlays with waterproof membranes, expansion joint replacements, and thin epoxy/polymer overlays to keep our good bridges in good condition for longer periods of time. The timing of solutions for bridge needs varies, but efforts are made to plan bridge construction at the same time as the adjacent pavement and road construction.

8.5.3 System Modernization

System modernization is associated with roadway improvements that do not increase capacity. These needs are associated with deficiencies such as pavement width, shoulder width, vertical curves, and bridge width. Interstate roadway or bridge deficiencies, as defined by Nebraska's minimum design standards, are included in the needs assessment. The non-interstate rural system modernization needs are defined using the standards shown in Figure 33. The projected 20-year system modernization needs, in 2023 dollars, for the interstate, rural, and municipal highways are estimated at 12 percent of the budget and include the following:

8.5.3.1 Roadway Modernization

Roadway modernization describes changes made to existing roadways to correct certain deficiencies based on set criteria, see Figure 34. Such changes as widening lanes and shoulders, straightening curves, and cutting down hills make roadways safer to travel. All highway plans are reviewed to ensure that NDOT's database contains the most current geometric information. The roadway system modernization needs are compiled by calculating the construction costs, including resurfacing and right-of-way costs, required to correct the deficiency. These costs are updated annually.

The State currently operates and maintains approximately 39 miles of gravel highways. The costs to surface and bring these roadways up to current standards are based on annual construction costs. Modernization needs for rural intersections are determined by the need to improve intersections due to high traffic volumes and a documented crash history. The costs associated with these needs are based on the average cost per intersection improvement times the number of intersections that would either meet the 20-year traffic volume or crash history criteria. In addition to the costs to remove deficiencies, costs for other roadway improvements, such as lighting and traffic signal needs, are determined based on an average of previous years' costs.

Criteria to identify non-interstate roadway geometric deficiencies are grouped into six Average Daily Traffic (ADT) categories.

36,000 & greater
(six or more lanes warranted)

10,000 - 35,999
(four lanes warranted)
- 12' surfaced lane width
- Outside shoulder 8' of the 10' shoulder paved
- Inside shoulder 3' of the 5' shoulder paved

4,000 - 9,999
- 12' surfaced lane width
- 8' shoulder width w/6' paved

2,000 - 3,999
- 12' surfaced lane width
- 6' shoulder width w/2' paved

Stopping sight distance
- No vertical crest curve >20 mph below posted speed limit
- No vertical sag curve >25 mph below posted speed limit

750 - 1,999
- 12' surfaced lane width
- 3' shoulder width

Under 750
- 11' surfaced lane width
- 2' shoulder width

Stopping sight distance
- No vertical crest curve >20 mph below posted speed limit
- Existing vertical sag curve condition allowed

Figure 34 - Criteria to Identify Geometric Deficiencies

8.5.3.2 Bridge Modernization

Modernization needs for bridges are determined by the need to widen bridges and remodel bridge rails to meet current standards. The costs associated with these needs are based on the bridge's condition at the time of improvement and can include remodeling bridge railings, widening an existing bridge, or replacing a bridge with a wider bridge.

8.5.4 Capital Improvements

Capital improvement needs are associated with those projects that add vehicle capacity or provide infrastructure for economic development. The projected 20-year capital improvements needs, in 2023 dollars, are estimated at 24 percent of the budget, and include the following:

8.5.4.1 Roadway Expansion

Roadway expansion is a broad category, which includes costs for future bypasses, new roads, interchanges, additional lanes, upgrading freeways, and the completion of the expressway system. The needs associated with roadway expansion are determined as follows:

- The costs for projects selected for design and construction under Build Nebraska Act (BNA) and Transportation Innovation Act (TIA) between 2018 and 2033 are determined using historical material and project costs, planned length and scope.
- The costs for expanding the interstate to six lanes between Lincoln and Grand Island includes all pavement, interchanges, and bridge work. The six-lane interstate needs are determined by projecting when the traffic density will reach level-of-service (LOS) D, as defined in the Highway Capacity Manual.
- The costs for the widening or reconstruction of urban state highways are based on historical cost per mile values, which are then used to calculate the needs. The urban capacity needs, for cities with a population greater than 5,000, are determined by identifying those roads with a fair to poor pavement condition and Average Daily Traffic (ADT) that requires additional lanes. The urban bridge needs are extracted from the bridge needs program output and are included in this category.
- The costs for planning and research to investigate new strategies and to develop the projects mentioned above are also included.
- The costs for grade separations, which include all on-system, at-grade railroad crossings that are expected to warrant a grade separation due to a projected exposure factor of 75,000 or greater within the next 20 years.

8.6 Asset Value

The current value for state-owned NHS pavements is approximately $6.6 billion. The annual investment required to maintain the interstate system at its current condition is approximately $94 million and the investment needed to maintain the non-interstate, state-owned NHS in its current condition is approximately $136 million. The current value of the NHS bridges is approximately $3.8 billion[64], which requires an annual investment of approximately $29 million[65] to maintain in the current condition.

8.7 Annual Asset Allocation Development

The Asset Allocation process is a cyclical process conducted annually to determine investments strategies by work type for future years.

Table 22 - Annual Asset Allocation Development

Season	Activity
Summer	Conduct Risk Assessment Gather Data for Condition Assessments of Highways and Bridges
Fall	Update Revenue Projections Generate Asset Candidates Based on 10-Year Life Cycle Set Preliminary Construction Program Size Set Preliminary Allocations for the following work types*: • Highway Preservation and Modernization *e.g. 1"-6" Resurfacing* • Bridge Preservation and Modernization *e.g. 2-3" Resurfacing, Deck Repair, Remodel Bridge Rail* • Interstate Preservation and Modernization *e.g. 1"-4" Resurfacing* • Capital Improvement *New alignment or added capacity* • Routine Surface Maintenance *Crack Seal, Chip Seal, Patching*
Winter	Refine project estimates, schedules and revenue projections Conduct Annual 20-Year Needs Assessment and Gap Analysis
Spring	Conduct Annual 20-Year Needs Assessment and Gap Analysis
Summer	Update Planning and Program Documents to reflect new decisions
* Table 23 shows a correlation between NDOT's work types and the FHWA work types	

[64] Bridge value based on replacement cost at $230 per square foot
[65] Bridge maintenance cost based on average annual expenditures 2017-2021

Work types used by NDOT as shown in Table 23 differ from the work types defined by the FHWA shown below:

- Initial Construction
- Maintenance
- Preservation
- Rehabilitation
- Reconstruction

A correlation between these two sets of work types can be seen in Table 23. NDOT classifies most projects as preservation, which is the department's main priority, see Section 8.5.2. Preservation projects along with the Districts routine surface maintenance are intended to maintain the highway system in a SOGR. Preservation projects are programmed bases on pavement condition and are reviewed during the project development process to address any other deficiencies according to the Board of Public Roads Classifications and Standards, Minimum Design Standards[66], see Section 8.5.3. If deficiencies (e.g. lane width, shoulder width, bridge width) are identified, this work may be included in the project. If so, the preservation project may include segments of other work types (i.e. rehabilitation, reconstruction) within the project. Ultimately, the main focus of these projects is to preserve the pavement. NDOT's three types of Preservation and Modernization work would incompass the FHWA work types Preservation, Rehabilitation, and Reconstruction.

NDOT projects classified as Capital Improvement are those projects that add vehicle capacity or provide infrastructure for economic development, see Section 8.5.4. These projects would align with the FHWA work type Initial Construction.

Routine Surface Maintenance projects are usually performed by the district maintenance forces but may be let to contract. This work would align with the FHWA work type Maintenance.

Table 23 - Work Type Correlation

NDOT Work Types	Description (Typical)	FHWA Work Types
Highway Preservation and Modernization (Rehabilitation/Reconstruction)	Pavement repair with 1" to 6" resurfacing	Preservation/ Rehabilitation/ Reconstruction
Bridge Preservation and Modernization (Rehabilitation/Reconstruction)	Deck Repair, Remodel Bridge Rail, 2-3" Resurfacing	Preservation/ Rehabilitation/ Reconstruction
Interstate Preservation and Modernization (Rehabilitation/Reconstruction)	Pavement repair with 1" to 6" resurfacing	Preservation/ Rehabilitation/ Reconstruction
Capital Improvement	Highways on new alignment, Addition of lanes, Urban reconstruction	Initial Construction
Routine Surface Maintenance	Crack seal, Chip seal, Patching	Maintenance

[66] Board of Public Roads Classification and Standards, Minimum Design Standards can be found at: https://dot.nebraska.gov/business-center/lpa/boards-liaison/nbcs/downloads/

Between FY-2019 and FY-2021, NDOT allocated these funding levels per work type.

Routine Surface Maintenance of Highways & Bridges	Highway Preservation & Modernization (Rehabilitation/ Reconstruction)	Bridge Preservation & Modernization (Rehabilitation/ Reconstruction	Interstate Preservation & Modernization (Rehabilitation/ Reconstruction	Capital Improvement or Expansion of Highways & Bridges
$42-$53M	**$240-$259M**	**$66-$107M**	**$69-$90M**	**$114-$458M**

Pavement and Bridge Management tools mentioned in Chapter 4 and life cycle cost analysis mentioned in Chapter 5 is used to minimize life cycle cost and increase the percentage of pavements and bridges in good condition. This allows NDOT to achieve the best pavement and bridge conditions in the future, thereby supporting progress toward achieving the national goals in accordance with 23 U.S.C. 150 (b). These investments have proven to support our asset performance goals, and satisfy the investments levels summarized in Section 8.6 needed to keep NHS assets in their current condition.

8.8 Summary of Financial Plan Development and Investment Strategies

NDOT's financial plan projects revenues and prioritizes investments over a 10-year period to meet bridge and highway performance targets. NDOT annually conducts a gap analysis through the Needs Assessment and performs a risk-based life-cycle planning analysis to predict costs to maintain assets in a state of good repair.

Historically, NDOT's strategy has been to invest more in asset preservation than any other work type. This approach has cost effectively maintained pavements and bridges in a state of good repair as shown by state performance measures and targets in the NDOT Annual Report[67]. NDOT anticipates this investment strategy will also continue to achieve national performance goals provided that the public commitment to roadway infrastructure is maintained.

The 10-year projected investment plan by work type (see Figure 35) is based on revenue projections displayed in Figure 36. The investment plan for FY2020-FY2028 is based on the assumption that the State will experience stable revenues and that construction inflation rates remain consistent between 3-5 percent per year. These projections support NDOT goals to meet performance measure targets and maintain the system in a state of good repair (SOGR). NDOT's historical investment strategies have emphasized preservation and maintaining a SOGR.

[67] NDOT's Annual Report can be found at: https://dot.nebraska.gov/news-media/publications/

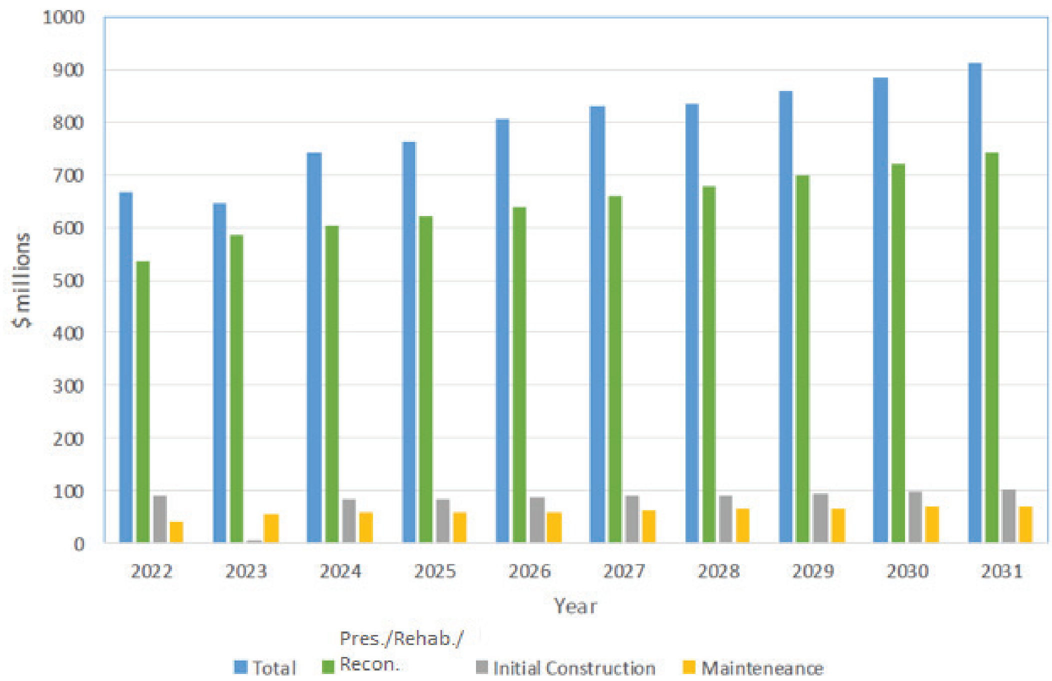


Figure 35 - 10-Year Investment Plan for FHWA Work Types Based on Projected Revenue

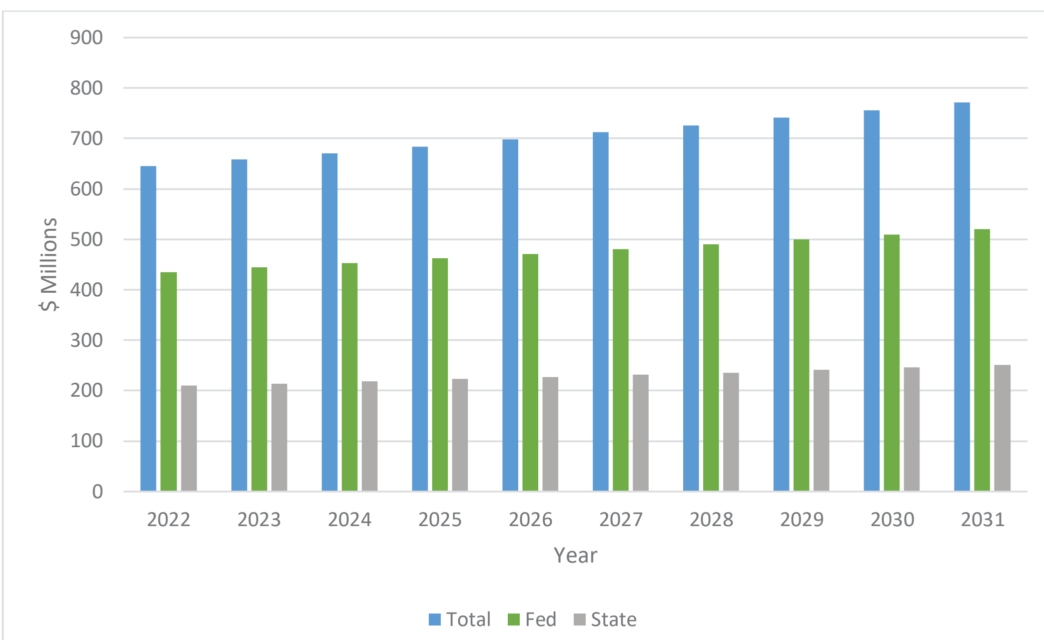


Figure 36 - 10-Year Projected Revenue for Construction

Appendix A References

These are the major references located throughout the TAMP report.

1. "Annual Report"
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/news-media/publications/

2. Pavement Optimization Program
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/business-center/materials/

3. State of Nebraska Pavement Management Systems
   Nebraska Department of Transportation
   https://dot.nebraska.gov/business-center/materials/

4. Bridge Inspection Program Manual
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/business-center/bridge/inspection/

5. "Vision 2032: Nebraska's Long-Range Transportation Plan"
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/projects/publications/

6. "Nebraska Surface Transportation Program Book"
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/projects/publications/program-book-2023/

7. "State Highway Needs Assessment"
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/business-center/financial-reports/

8. "NCHRP Report 632: An Asset-Management Framework for the Interstate Highway System"
   2009. National Cooperative Highway Research Program.
   http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_632.pdf

9. "Transportation Innovation Act & Build Nebraska Act Report"
   Nebraska Department of Transportation.
   https://dot.nebraska.gov/business-center/financial-reports/

10. "Surface Distress Manual"
    Nebraska Department of Transportation.
    https://dot.nebraska.gov/media/6329/surfacedistresssurveymanual.pdf

11. "Data Quality Management Program Manual"
    Nebraska Department of Transportation.
    http://dot.nebraska.gov/business-center/materials

Appendix B Glossary

Asphalt Cement Concrete (ACC) - ACC pavement (also referred to as bituminous pavement) is a flexible pavement that is composed of mineral aggregate that is bound together with asphalt, poured in layers, and then compacted.

Asset - The physical transportation infrastructure (e.g., pavement and bridges) or resources that adds value to an agency (e.g., equipment and materials, human resources, etc.).

Asset Management - A strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well-defined objective.

Asset Preservation - Maintenance of the transportation system.

Bituminous Pavement - A pavement comprising an upper layer or layers of aggregate mixed with a bituminous binder, such as asphalt, coal tars, and natural tars for purposes of this terminology; surface treatments such as chip seals, slurry seals, sand seals, and cape seals are also included.

Bridge - A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercoping of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

Capital Improvement - An improvement that adds capacity or supports economic growth

Corrective Maintenance - Maintenance performed after a deficiency occurs in the pavement, such as moderate to severe rutting, raveling, or extensive cracking.

Crack - Fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement. Cracks generally develop after initial construction of the pavement and may be caused by thermal effects, excess loadings, or excess deflections.

Culvert - A structure designed hydraulically to take advantage of submergence to increase hydraulic capacity. Culverts, as distinguished from bridges, are usually covered with embankment and are composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert. Culverts may qualify to be considered "bridge" length.

Distress - A condition of pavement structure that reduces serviceability or leads to a reduction in serviceability.

Emergency Maintenance - Maintenance performed during an emergency situation, such as a blowup or severe pothole that need repair.

Faulting - Difference in elevation across a joint or crack. Faulting commonly occurs at transverse joints of PCC pavements that do not have adequate load transfer.

International Roughness Index (IRI) - A scale for determining the roughness quality of a pavement surface.

Joint - A pavement discontinuity made necessary by design or by interruption of a paving operation.

Level of Service (LOS) - A qualitative measure that refers to the quality of traffic management, which is related to transportation system users' perception of asset condition or agency services.

Life Cycle - The length of time that encompasses all stages of an asset: construction, operation, maintenance, rehabilitation, reconstruction, or disposal.

Life Cycle Cost - Is the sum of all recurring and non-recurring costs over an asset's lifespan. Life Cycle Cost Analysis helps determine cost-effective asset management activities and investments.

Nebraska Serviceability Index (NSI) - A value on a scale of 0 to 100 with 0 the worst and 100 the best condition. It represents the condition of the pavement at the time of measurement. This value is used for development of remaining life values.

National Bridge Inspection Standards (NBIS) - Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a State bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads.

Performance Gap - The difference between existing and desired performance.

Performance Measure - An indicator (usually qualitative) of the quality and serviceability of a transportation system or a specific asset to its users.

Portland Cement Concrete Pavement (PCC) - The rigid concrete layer of a pavement structure that is in direct contact with traffic.

Present Serviceability Index (PSI) - This is a numerical value indicating the ride quality of the pavements. PSI is a function of roughness IRI, cracking, and rutting. It is on a scale of 0 to 5 with 0 being the worst condition and 5 the best.

Preservation - The application of treatments at the proper time to prevent or correct the deterioration of an asset in order to extend its service life.

Maintenance - A planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, slows future deterioration, and maintains or improves the functional condition of the system without increasing the structural capacity.

Rehabilitation - The use of several treatments to correct physical or functional defects that reduce the serviceability of an asset. Rehabilitation activities are generally more extensive than repair and may involve replacing the defective parts of an asset but not the entire structure.

Remaining Service Life - The projected time it will take a pavement to deteriorate from its current condition to a threshold value. Used to calculate optimum year for rehabilitation.

Repair - A treatment, to a less extensive degree than rehabilitation activities that is applied to an asset to correct a physical or functional defect that reduces an asset's Level of Service.

Replacement - The disposal of an existing asset and substitution of a new asset in the same location to serve the same functional requirements or additional requirements.

Risk - The positive or negative effects of uncertainty or variability upon agency objectives.

Routine Maintenance - Non-urgent maintenance activities that are performed on a scheduled basis.

Rutting - Longitudinal surface depressions in the wheel path of an HMA pavement, caused by plastic movement of the HMA mix, inadequate compaction, or abrasion from studded tires. It may have associated transverse displacement. Rutting is measured only on bituminous pavements.

Serviceability - The ability of a pavement to provide a safe and comfortable ride to its users.

State of Good Repair (for Bridges) - A bridge is considered to be in a state of good repair if it is in good or fair condition as determined by 23 CFR Part 490 § 490.409

- *Good Bridges* – when the major bridge components are all in good condition or better.
- *Poor Bridges* – when one or more of the major bridge components are in poor condition or worse.
- *Fair Bridges* – all other bridges
- *Major Bridge Components* – Bridge Deck, Superstructure, Substructure

State of Good Repair (for Pavements) - Pavement is considered to be in a state of good repair if the Nebraska Serviceability Index values meets performance targets.

System Modernization - Safety, geometric, or mobility improvements that do not add capacity to the roadway.

Appendix C Bridge Management Documentation

C.1 Overview

NDOT Bridge Division's Bridge Management section was created in January of 2015. Prior to that time, bridge management decisions were made by a committee that did periodic review of bridge work candidates. The Bridge Management section is tasked with developing the bridge work program for bridges that will be included on projects as described in Sections 3.4 and 5.3.

The Bridge Management section monitors and maintains bridge inventory and condition data, construction scheduling information and a record of bridge construction programming decisions in the Record of Decision (ROD). The ROD is an Excel spreadsheet that has been customized with macros to facilitate bridge management processes. Inspection and construction scheduling data changes as new inspections occur and as project programming progresses toward project delivery. Data is kept current by scheduled data updates that import data from a SQL server database. The ROD also contains hyperlinks to bridge plans and inspection photos.

This appendix contains some of the primary documentation and guidance that is used for Bridge Management decisions and policies.

C.2 Strategy Selection

C.2.1 Major Work: Replacement, Rehabilitation and Re-decking

Before bridge inspection data is imported into the ROD, it is analyzed by a decision tree that does an automated review of the data for major work candidates. A schematic of the automated review decision tree is shown in Figure 36. Bridges that are not flagged for Replacement, Rehabilitation or Re-decking may be repair candidates.

C.2.2 Bridge Deck Policy

As described in Section 5.3.2, NDOT recognizes the cost effectiveness of deck protection systems. By far, the preferred deck protection system is a rubberized asphaltic membrane under an asphalt overlay. This treatment has been found to greatly reduce the deterioration rate of the concrete bridge deck underneath the membrane.

Background: A bridge preservation success

Between 1973 and 1975, there were 24 bridges that are known to have received asphalt and waterproofing membrane prior to opening for traffic. They are known as AMODs – Asphalt and Membrane on Original Deck[68].

- Two have since been removed due to poor condition of timber piling
- 22 remain in service with their original 1970's concrete deck under the overlay
- Membranes have remained in place on 21 of them
- One had the asphalt overlay replaced with a concrete overlay

[68] For a detailed case study see "Bridge Asphalt Overlay with Waterproofing Membrane Effectiveness Study" https://dot.nebraska.gov/media/116390/vcs-report-us-75-77-cn-32309-final.pdf. The Appendix C of this study also provides background on the effectiveness of concrete overlays.

It is not known why this method of deck preservation was employed or why the practice was discontinued.

There has been no reason to do repairs on the AMOD bridge decks, so they have remained in-service without attracting much attention.

Original construction documents have been found for some, but not all of the AMODs.

All appear to have used pre-formed fabric backed membranes.

- Some called for two layers of fabric to be placed, one longitudinally and one transversely
- All were applied on steel-troweled concrete bridge decks
- This sets them apart from other known pre-formed membrane placement
- The smooth surface is thought to provide a better opportunity for uniform membrane thickness

A control group of comparable bridges was sought to compare to the AMOD performance.

- similar in age
- original deck concrete still in place
- without protective overlay of any kind
- similar deck thickness
- similar ADT
- ideally built on the same project with same concrete mixes
- geographically proximal
- Chloride tests were done but mostly found to be inconclusive
    - AMODs were uniformly low, but many of the unprotected decks had low chlorides too
- Inventory data shows that Nebraska bridge decks typically transition from NBI Condition 9 to 4 in about 25 years
- The control group has and average deck condition of six.
    - Are these average bridges?
    - The ideal control group had already been replaced or reconstructed
- Excluding the AMODs, 252 bridges were built between 1970 and 1976
    - 42 still have their original decks
    - 40-year survival rate for non-AMOD deck is about 17 percent
- The 40-year survival rate for AMODs is 100 percent
- Field visits to the AMODs and the control group bridges have been highly persuasive
- Inspection photos usually capture problems
    - Inspection photos of the bottom of AMOD bridge decks were rare or nonexistent

The specifications for Asphalt overlays with waterproofing membrane are under ongoing review. The intent to provide a cost effective deck protection system that performs as well as the historical precedent.

Figure 37 describes the various types of bridge deck overlays and the criteria and costs for their use.

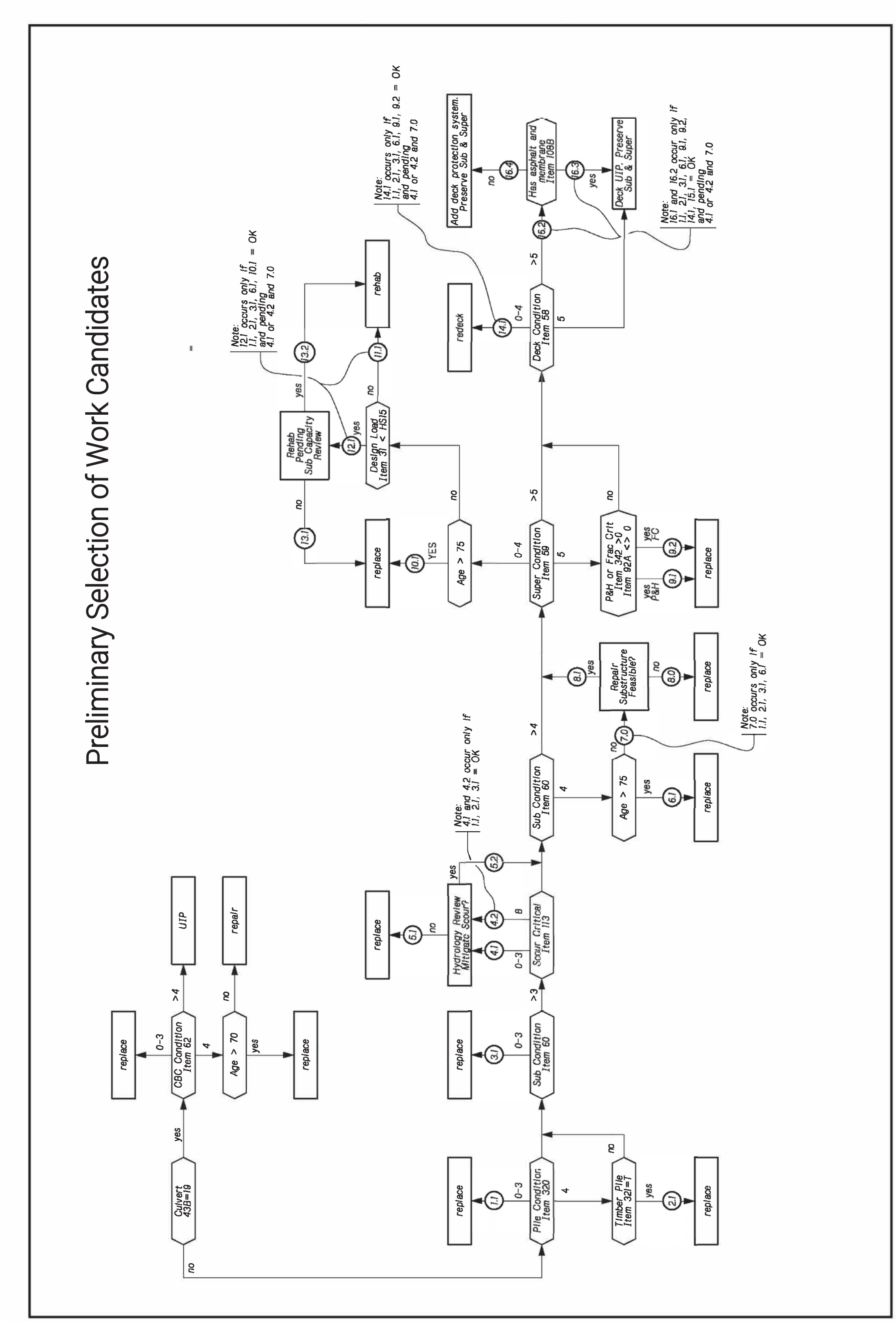


Figure 37 - Decision Tree for Major Bridge Work

NDOT Bridge Deck Overlay Policy

Type	Applicability	Lifespan (years)	Cost ($/SF)	Criteria	Commentary
Epoxy Polymer Overlay	0-10 years (Deck Age)	7 to 12	$10.00 Significant increase in cost from prior years for seveval reasons	Deck condition 7 or better (NBI). ≤ 5% defective deck. Cannot be placed on concrete or cementitious patch material less than 28 days old. EPO's should not be used on decks with extensive cracks or decks that are or might experience ASR prior to installation.	Avoid EPO's when movement related cracks are present. Some early EPO's were implemented as a strategy to extend the life of decks with concrete overlays experiencing cracking or some delamination. Bridges with concrete overlays are no longer candidates for EPO based on cost effectiveness. Not intended to perform as a healer/sealer flood coat treatment.
Deck Surface Treatment (Flood Coat)	0-10 years (Deck Age)	7 per Manufacturer's published literature	$3.50	Used on good decks that are not candidates for Asphalt Overlays and Waterproof Membranes Deck condition 7 or better (NBI) with ≤ 5% defective deck. Cannot be placed on concrete or cementitious patch material less than 28 days old.	Deck preparation to CSP 3. Allowable methods include power sweeping, light shot blast, or high-pressure water blasting. Cost includes deck preparation. Cost of deck repairs not included.
Asphalt Overlay (fabric membrane)	Anytime	10± (asphalt) 20+ (membrane)	$5.20 (3.90 + 1.30)	Use on New Decks is now current practice. Only cost effective strategy if joints are in need of replacement also. Not for use on bridges that exceed 4.5% superelevation. Not ideal for horizontally curved bridges.	Strategy involves life cycle that leaves membrane in place thru one milling of asphalt, replace membrane on subsequent milling project. Cost includes primer, membrane and (smoothness req.) Deck preparation not required on new decks. Cost of deck repairs not included. Cost of asphalt, tack coat not included.
Asphalt Overlay (hot bituminous membrane)	Anytime	10± (asphalt) 20+ (membrane)	$3.90	Same as (fabric membrane) Same as (fabric membrane) Hot liquid membranes can be used as a substitution for fabric membranes.	Strategy involves life cycle that leaves membrane in place thru one milling of asphalt, replace membrane on subsequent milling project. Cost includes membrane placement. This method does not require deck preparation for smoothness. Cost of deck repairs not included. Cost of asphalt, tack coat not included.
Asphalt Overlay (cold liquid membrane)	Anytime	10± (asphalt) Indefinite (membrane)	$6.24	Primarily used on high asset value bridges. Used on Interstate bridges, to prolong the future traffic interruption associated with membrane replacement. It is believed that the cold liquid membrane could have a service life of well beyond 50 years if not indefinite.	Lifespan might be indefinite if 3" overlay used. Successive overlays would require milling 2" of original 3" and placement of 2" of new asphalt without interference with the membrane. Cost includes primer, base coat and top coat membrane layers. Cost of deck repairs not included. Cost of asphalt, tack coat not included.
Silica Fume Overlay	Rarely	15 to 20 (ridability) 0-5 (protection)	No recent cost Data available, last used in 2014	Use ONLY when Asphalt is not available on project of interest. Not cost effective, especially if the superstructure is expected to have a significantly longer service life than the overlay. < 2.0 lbs./CY chloride content in bridge deck.	A large number of bridges in NE that received a concrete overlay, exhibited early cracking of the overlay. The worst overlay for cracking has been SFO. In general, SFO's are not recognized to provide long-term protection from chloride intrusion. Cost includes up to 20% partial depth repairs (deck area).

Figure 38 - NDOT Bridge Deck Overlay Policy

C.3 Bridge Project Timing

C.3.1 Un-Programmed Work

Bridge replacement candidates are ranked successively by the following criteria:

1. Substructure Condition
2. Superstructure Condition
3. Deck Condition
4. Scour
5. Load Rating
6. ADT

Additionally, an engineering review is conducted using inspection photos, inspection notes, condition data history and load rating. The goal of the review is to suggest a programming year that will avoid the need for costly end-of-service-life repairs but keep the bridge in service as long as possible. The result of the review is a suggested programming year for a replacement project. District Engineers, in coordination with NDOT Project Programming staff, review project scheduling and incorporate the new replacement work suggestions. When feasible, bridge work is done in coordination with roadway work to minimize inconvenience to the travelling public. NDOT Bridge Management section monitors the cost to the bridge program and appeals for additional funding or suggests trade-offs when needed to meet budget and performance target constraints.

C.3.2 Programmed Work

Bridge Candidates for major work and preservation are prioritized and a programming priority group is determined by engineering review. Figure 39 shows guidance for prioritizing bridge work candidates.

BRIDGE PRIORITIZATION					
GROUP A - High Priority		GROUP B - Medium Priority		GROUP C - Low Priority	
A0.	Special Consideration as noted.	B0.	Special Consideration as noted.	C0.	Special Consideration as noted.
A1.	Replacements, Rehabs, Redecks of Girder Bridges with Deck 3 *(or weak 4)* .	B1.	Replacements, Rehabs, Redecks of Girder Bridges with Deck 4.	C1.	Replacements, Rehabs, Redecks of Girder Bridges with Deck 5 or higher.
A2.	Preservation of bridges ≤ 15 years old (at the time of construction). Overall condition 7 or better.	B2.	Preservation of bridges between 15 and 20 years old (at the time of construction). Overall condition 7 or better. Year Built 2002 to 2007.	C2.	Bridge Replacements - pile condition is predominant defect if pile condition is poor to severe and iterim pile repairs are performed.
A3.	Bridges with pile preservation as predominant need.	B3.	Bridge Replacements - pile condition is predominant defect and pile condition is poor to severe (example: approx. 50% in Condtion State 3 or 4 or concerns about adjacent no-value pile).	C3.	Bridge Replacements - pile condition is predominant defect and pile condition is fair to poor (example: approx. 50% in Condtion State 2 or 3).
A4.	Bridge Replacements with ≥ 12 in. Grade Raise, that can't be delayed ≥ 10 years that are part of roadway projects with pavement reconstrucion.	B4.	Approaches with turndown construction proposed of mid-life bridges.	C4.	Bridge Replacements with ≥ 12 in Grade Raise, that could be delayed ≥ 10 years that are part of roadway projects could have the scope changed to UIP and create a Bridge-Only project.
A5.	Bridge Replacements - pile condition is predominant defect and pile condition is severe.	B5.	Bridge Replacements, Scour Critical that are not candidates for mitigation.	C5.	Bridge Replacements, Scour Critical that could be delayed with mitigation.
				C6.	Approaches on short bridges. Consider omitting this strategy on future projects due to cost effectiveness.
				C7.	Acc+M, FAIR bridges.
				C8.	Acc+M, decks older than 20 years regardless of condition. Year Built 2002 or earlier.

Figure 39 - Prioritization of Bridge Work Candidates