2021 STATEWIDE EXECUTIVE SUMMARY AIRPORT PAVEMENT CONDITION INDEX (PCI) STUDY

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2021 PAVEMENT CONDITION INDEX (PCI) STUDY

Overview

The Federal Aviation Administration (FAA) developed the Airport Pavement Management System (APMS) with the intent to provide a consistent and systematic approach to identify pavement needing maintenance or rehabilitation. The North Dakota Aeronautics Commission (NDAC) developed a customized APMS according to FAA requirements.

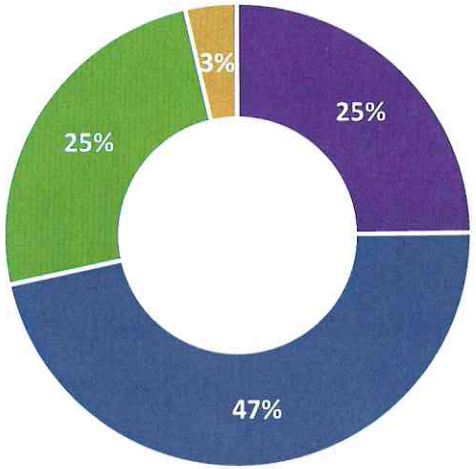
An APMS evaluates the current pavement condition and predicts a future condition based on the Pavement Condition Index (PCI). This allows the individual airports, the NDAC, and the FAA to monitor the condition of the airport pavements and budget for required maintenance to avoid excessive deterioration. The maintenance or rehabilitation timing is vital to support the crucial role airport pavement conditions play in safeguarding airport users.

The North Dakota APMS is provided in an electronic format to make the data readily available. The APMS is updated every three years to accurately reflect pavement conditions across the state's airports. PCI results are used to build 5- and 10-year capital improvement plans (CIPs) with each airport's respective city, county, or airport authority.

In 2021, Mead & Hunt along with Applied Pavement Technology and Martinez Geospatial conducted the update to the North Dakota APMS. As part of this update, the past three years of pavement history information was added to the online database, pavement inspections were completed, and functionality improvements were made to the website. This report includes the findings and recommendations of the APMS update. Full results can be found on the NDAC website, **WWW.AERO.ND.GOV**.

Pavement Inventory

In 2021, 72 airports were assessed. Of these, 54 were part of the National Plan of Integrated Airport Systems (NPIAS) and 18 were non-NPIAS. Of the 54 NPIAS airports assessed, 8 were commercial service and 46 were general aviation. Only NPIAS airports qualify for federal funding, so the FAA provided funding for the pavement inspections and reports for the NPIAS airports, while the NDAC solely funded the same work for the non-NPIAS airports. A PCI of 100 was assumed for all newly constructed pavement or pavement programmed to be reconstructed in the next year for airports statewide. Pavement inventory data includes area, age, surface type, and observed distresses. The map on page 5 identifies all North Dakota airports that were included in the 2021 APMS update.

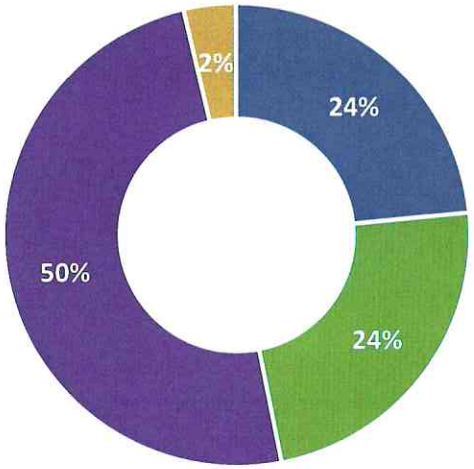


Area by Use

IN SQUARE FEET

Apron	14,778,584
Runway	27,842,448
Taxiway	14,747,081
T-Hangar	2,132,891

These airports represent 59.5 million square feet of concrete and asphalt pavement as summarized in the *Area by Use* and *Area by Surface Type* charts on this page. Pavement at the airports in the state **have an average age of 15 years for commercial service airports and 11 years for general aviation airports**. Throughout the years, the airports have performed preventive maintenance and carried out a series of rehabilitation/ reconstruction projects to eliminate foreign object debris (FOD) as well as sustain and extend the pavement life. The charts shown on the next page, *Pavement Area by Use* and *Area-Weighted Average Age by Use*, summarize the total square footage of pavements found in the state and the average age of those pavements based on use, broken out for the overall state system, commercial service airports, and general aviation airports.



Area by Surface Type

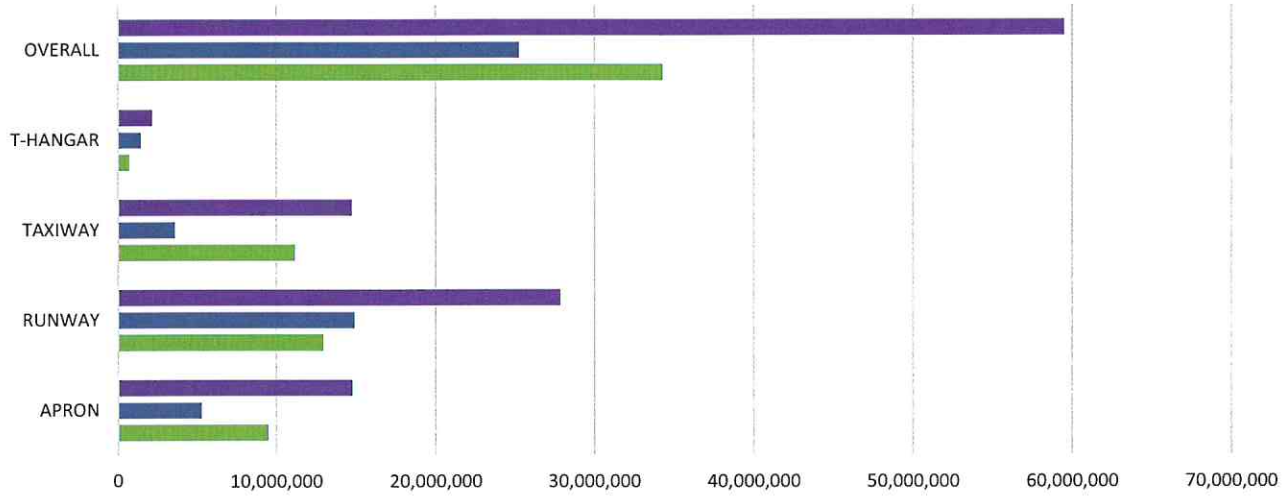
IN SQUARE FEET

Asphalt Concrete	14,236,905
Asphalt Over Asphalt Concrete	14,191,769
Portland Cement Concrete	29,942,102
Asphalt Over Portland Cement Concrete	1,129,228

Pavement Area by Use

IN SQUARE FEET

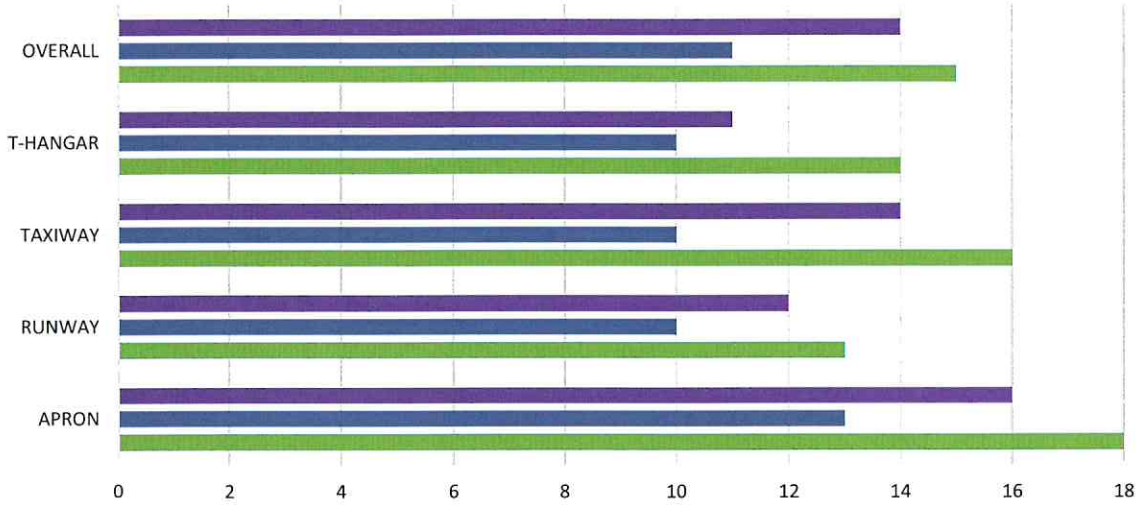
- Overall State Airport System
- General Aviation Airports
- Commercial Service Airports



Area-Weighted Average Age by Use

IN SQUARE FEET

- Overall State Airport System
- General Aviation Airports
- Commercial Service Airports

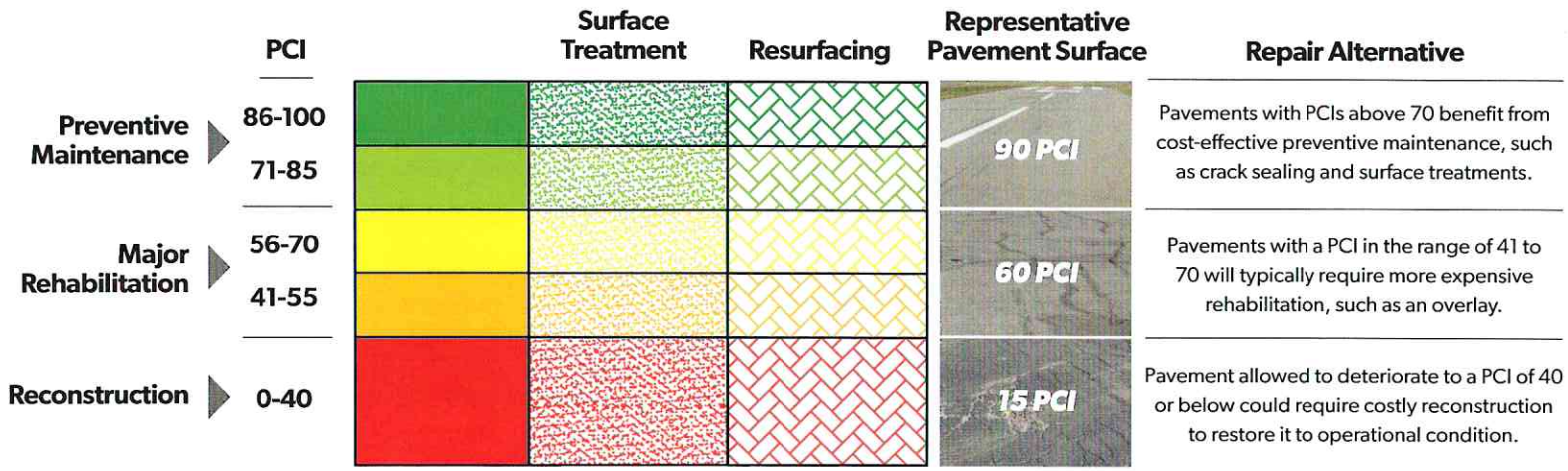


Pavement Evaluation

Pavement Evaluation Procedure

A PCI survey was conducted at each of the 72 airports inspected according to the procedures outlined in American Society for Testing and Materials (ASTM) Standard D5340, *Standard Test Method for Airport Pavement Condition Index Surveys* and the FAA's Advisory Circular 150/5380-6C, *Guidelines and Procedures for Maintenance of Airport Pavements*. A PCI survey consists of dividing pavement sections into a series of sample units, selecting random sample units for inspection, and collecting the distress data within the sample units to determine overall pavement deterioration. Pavement deterioration is based on quantifying the different types, the severity, and the number of distresses present in the sample section. This information is then used to formulate a composite index numerical value that represents the overall pavement condition. This value will range from 0 (failed) to 100 (excellent).

As part of the APMS, the PCI will be used to determine current pavement conditions, predict future conditions, develop a maintenance program, and identify the most cost-effective time frame to perform major rehabilitation. The PCI will also aid in tracking and determining causes of deterioration on a pavement. The correlation between a PCI number and a recommended repair is shown in the illustration below. Preventive maintenance consists of patching, crack sealing, and joint sealing. Pavement rehabilitation includes surface treatments and thin overlays. Pavement reconstruction refers to full-depth reconstruction and thick overlays. Surface treatments are used to address weathering and low-severity raveling. Nominal resurfacing is used to address medium- and high-severity raveling.

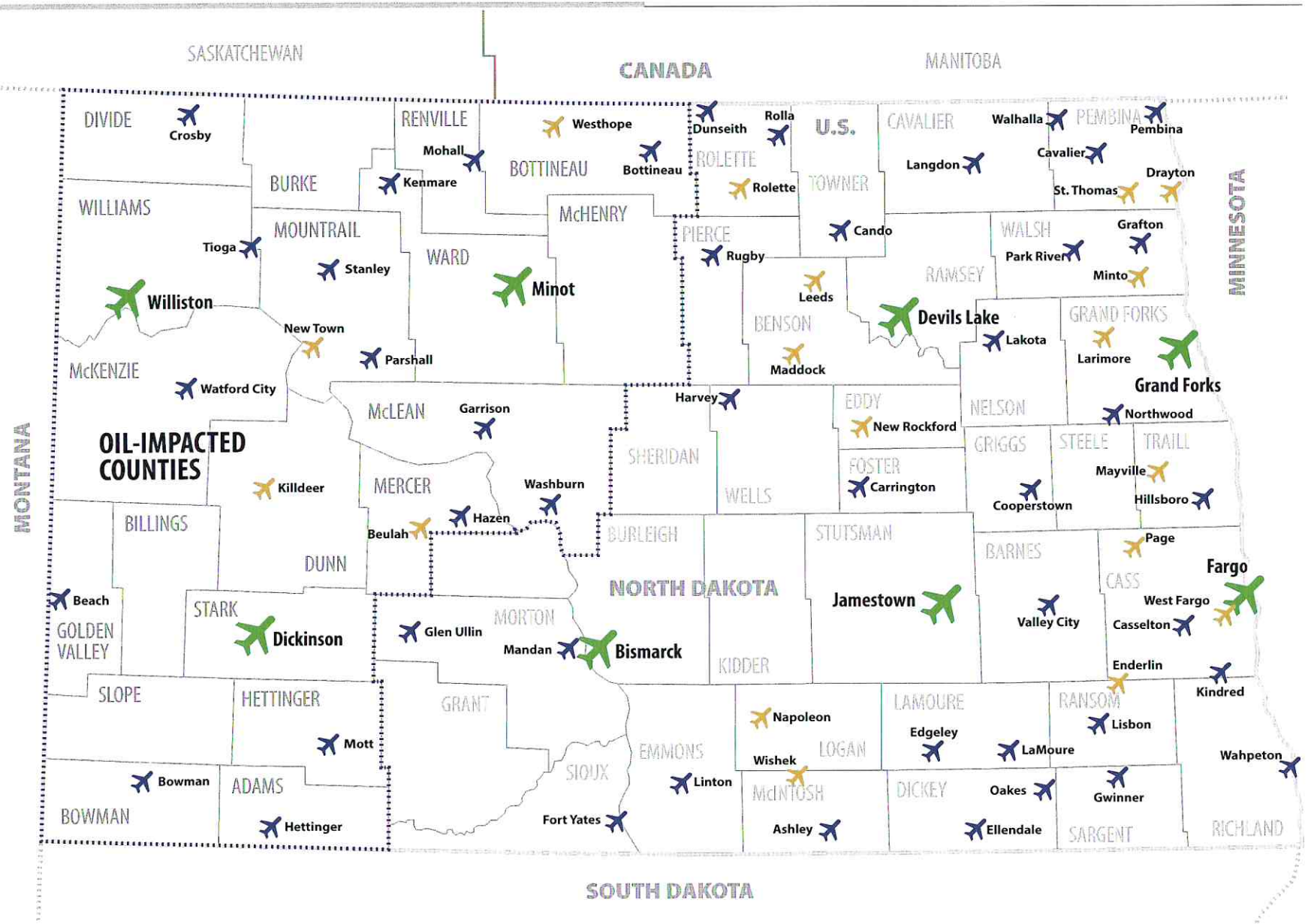


North Dakota Airports included in the 2021 Airport Pavement Management System Update

Commercial Service (Federal Funding)

General Aviation NPIAS (Federal Funding)

General Aviation Non-NPIAS (State Funding)



Typical Distress Types

The FAA Advisory Circular provides a list of specific distresses to be analyzed and recorded when inspecting pavement. Airports in North Dakota are a combination of asphalt concrete (AC) pavement and Portland cement concrete (PCC) pavement with there being slightly more AC pavement than PCC pavement. These two pavement types have unique pavement distresses and repairs. The following is a brief description of commonly observed pavement distresses at North Dakota airports.

ALLIGATOR CRACKING. Alligator (fatigue) cracking is a load-related distress caused by excessive tensile strains at the bottom of the AC layer or stabilized asphalt base layer from repeated aircraft loadings. Alligator cracking typically shows up on the surface as a series of parallel cracks, which eventually interconnect to form a pattern resembling the skin of an alligator.

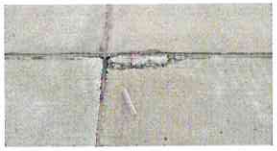
DURABILITY CRACKING. Durability cracking in PCC pavement usually appears as a series of parallel cracks adjacent to a joint or crack. This is caused by environmental factors such as freeze-thaw cycles and the concrete's inability to withstand them.

JOINT SEAL DAMAGE. Joint sealant damage is any condition that enables soil or rocks to accumulate in the joints or allows significant infiltration of water. Accumulation of incompressible materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protects the joints from accumulation of materials and prevents water from seeping down and softening the foundation supporting the slab. Typical types of joint seal damage are: (1) stripping of joint sealant, (2) extrusion of joint sealant, (3) weed growth, (4) hardening of the filler (oxidation), (5) loss of bond to the slab edges, and (6) absence of sealant in the joint.

PAVEMENT DISTRESS

LONGITUDINAL AND TRANSVERSE CRACKING. The predominant distress type found on asphalt pavements at North Dakota airports is longitudinal and transverse (L&T) cracking. This distress can be caused by any of the following: (1) separation of pavement at paving lane joints, (2) shrinkage of AC pavement due to temperature differentials in older or brittle pavements, or (3) reflection cracking from underlying faults in supportive layers of pavement or subgrade. Cracking is also a common distress type for PCC pavement. This distress is caused by a combination of load repetition, curling stresses, and shrinkage stresses.

RAVELING. As pavements age and are exposed to oxidation and other environmental stresses, they may experience a loss in the material making up the pavement matrix. Raveling is the dislodging and loss of coarse aggregate in the surface of a pavement. The pavement may be showing signs of aging and hardening and may result in the production of FOD.



SPALLING. Spalling in PCC pavement is the breakdown of the slab edges near the slab joint. Spalling is identified as occurring in the corner or along the joint of a PCC slab. Spalling is typically caused by the introduction of incompressible material in the joint, weaker pavement at the joint caused by overworking of the pavement during construction, traffic loading, or a combination of these.

Pavement Classification Number (PCN)

A PCN is a value that indicates the strength of a pavement as it relates to aircraft classification numbers, which are assigned to each type of aircraft. Aircraft traffic information as well as subgrade and pavement strengths are critical inputs in determining this value. Runway pavements at the commercial service airports were analyzed in 2012 to provide a PCN value as detailed in FAA Advisory Circular 150/5335-5B, *Standardized Method of Reporting Airport Pavement Strength – PCN*. Any updated PCN values provided by the airports for major runway construction projects completed since the 2012 analysis were calculated according to the updated FAA Advisory Circular, 150/5335-5C. The PCN is expressed as a five-part code. The first part of the PCN is a numerical value indicating the load-carrying capacity of the pavement. This numerical value is followed by four codes representing the following categories:

- **Pavement Type**
  - R = Rigid
  - F = Flexible
- **Subgrade Strength**
  - A = High (k-value ≥ 442 psi/in or CBR ≥ 13)
  - B = Medium (221 psi/in < k-value < 442 psi/in or 8 < CBR < 13)
  - C = Low (92 psi/in < k-value ≤ 221 psi/in or 4 < CBR ≤ 8)
  - D = Ultra Low (k-value ≤ 92 psi/in or CBR ≤ 4)
- **Maximum Allowable Tire Pressure**
  - W = High (no pressure limit)
  - X = Medium (146 to 218 psi)
  - Y = Low (74 to 145 psi)
  - Z = Ultra Low (pressure limited to 73 psi)
- **Pavement Evaluation Method**
  - T = Technical Evaluation
  - U = Using Aircraft Evaluation

The table below contains the most current PCN data available for each commercial service airport. A PCN denoted with a year behind it indicates the year it was calculated if more recently than 2012. A detailed PCN report for each commercial service airport can be found on the NDAC website, **WWW.AERO.ND.GOV**. Instructions for accessing the PCI Study section of the website are included on page 9 of this report. PCN information can be found under Airport Details.

PCN Results

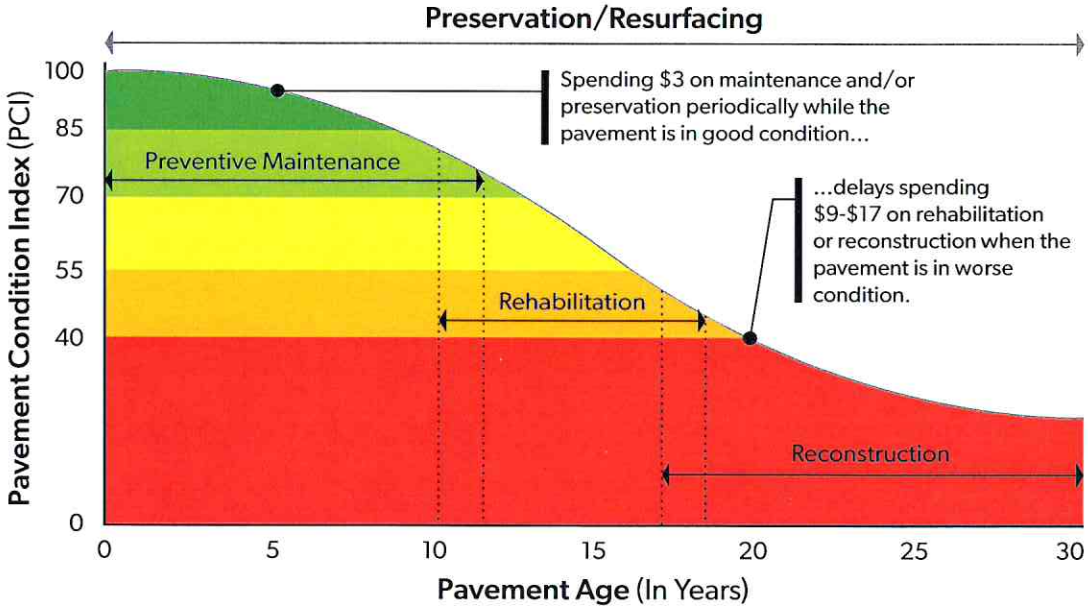
AIRPORT	BRANCH ID	PCN
Bismarck Municipal Airport	Runway 13-31	100 R/B/X/T (2018)
	Runway 3-21	26 F/A/W/T
Devils Lake Regional Airport	Runway 13-31	27 F/D/W/T
	Runway 3-21	26 F/D/W/T
Dickinson Theodore Roosevelt Regional Airport	Runway 14-32	25 R/B/W/T (2021)
	Runway 7-25	6 F/D/W/T
Fargo - Hector International Airport	Runway 18-36	95 R/C/W/T
	Runway 9-27	25 R/C/W/T
	Runway 13-31	17 R/D/W/T
Grand Forks International Airport	Runway 17L-35R	9 R/C/W/T
	Runway 17R-35L	35 R/C/W/T
	Runway 9L-27R	24 R/B/W/T
	Runway 9R-27L	10 R/C/W/T
Jamestown Regional Airport	Runway 13-31	79 F/C/W/T
	Runway 4-22	25 F/D/W/T
Minot International Airport	Runway 13-31	43 R/C/W/T
	Runway 8-26	34 F/D/W/T
Williston Basin International Airport	Runway 14-32	56 R/B/W/T (2018)
	Runway 4-22	4 F/C/Y/U (2018)

Analysis of Results

Critical PCI Values

For each year of the analysis, the future condition of each of the pavements was estimated. The next step was to determine whether preventive maintenance or major rehabilitation/reconstruction was the appropriate and most cost-effective method of maintaining pavement life. If a pavement was projected to be above the critical PCI values listed below, the pavement was recommended for preventive maintenance. Major rehabilitation/ reconstruction was recommended for any PCI value below the PCI critical thresholds. Surface treatments were identified for viable candidates that exhibited weathering and/or raveling. These were identified separate from the critical value analysis.

- **60 for general aviation taxiways and aprons**
- **65 for commercial service taxiways and aprons**
- **70 for general aviation runways**
- **75 for commercial service runways**



Interested in a Particular Airport's Pavement Condition & History?

For information on pavement distresses for a specific airport, visit the Interactive Data Exchange Application (IDEA) website by going to **WWW.AERO.ND.GOV** and navigating to "**Studies**" then "**Pavement Condition Index**" then "**Click Here.**" Once there, you can view a list of the distresses that were identified as well as a maintenance and rehabilitation plan for each airport. The IDEA site also contains photos of each airport along with an interactive version of the airport's PCI map.

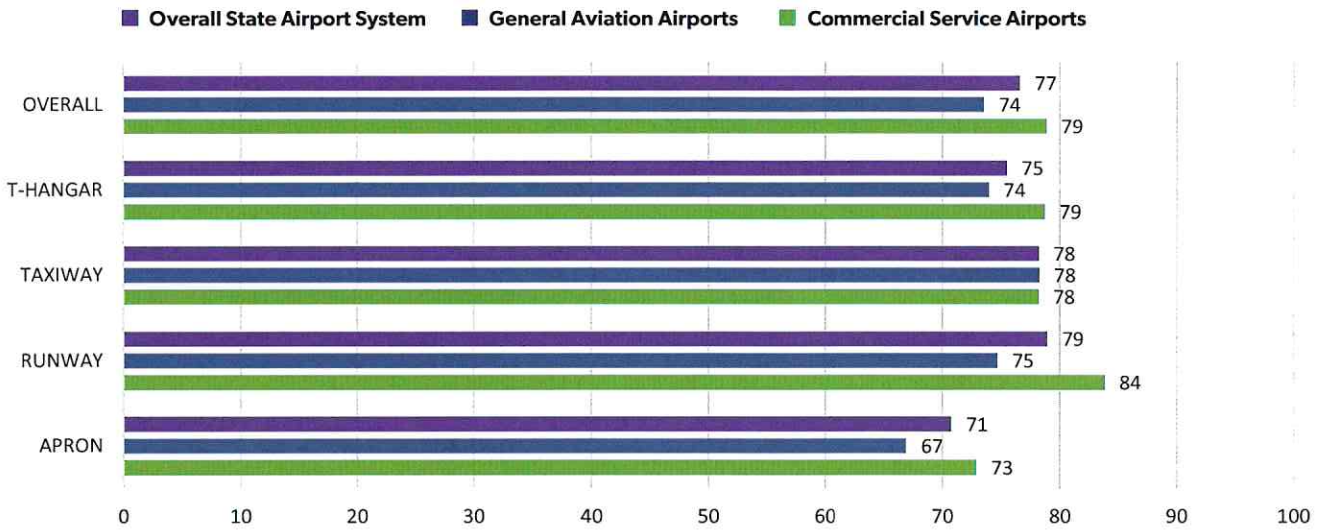
Overall Pavement Condition

Each airport was inspected, and an overall area-weighted pavement condition was assigned to each. The information collected at each airport is used to provide greater detail on the uses of pavements and the correlating PCI value associated with each use. The overall area-weighted PCI of all the airports included in this study is 77. The *Area-Weighted Average PCI Value by Use* chart shows the 2021 condition of the pavement broken out by use and airport classification.

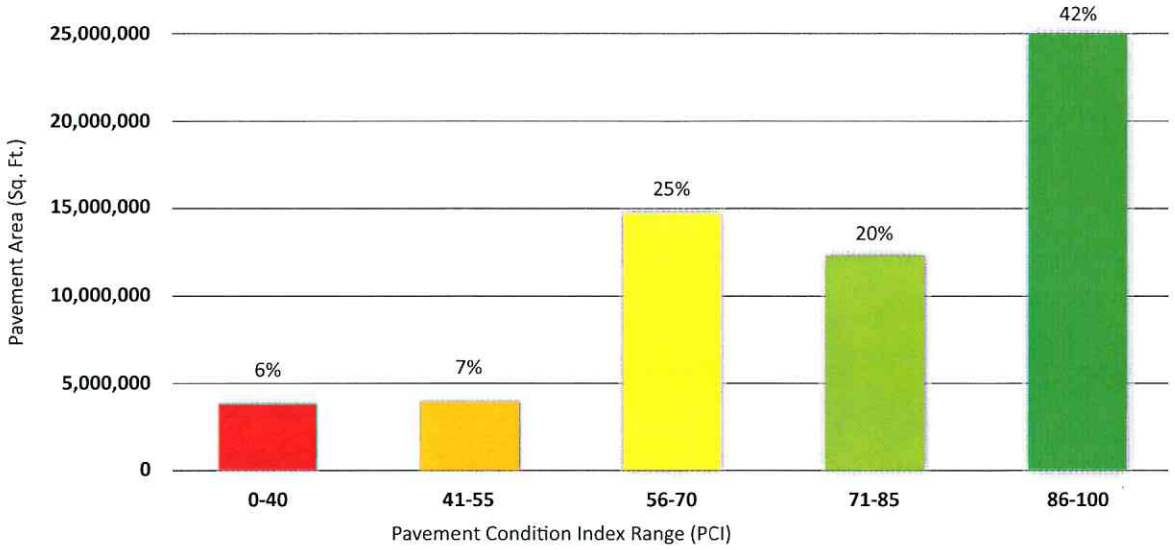
The *Total Statewide Pavement Area by PCI Range (All Airports)* chart depicts the amount of the state's airport pavement (in square feet) that falls into each PCI range. The *Overall Area-Weighted PCI* table on the next page provides the area-weighted PCI for each airport, which is comprised of all pavements on the airport.

Area-Weighted Average PCI Value by Use

BY PCI INDEX



Total Statewide Pavement Area by PCI Range (All Airports)



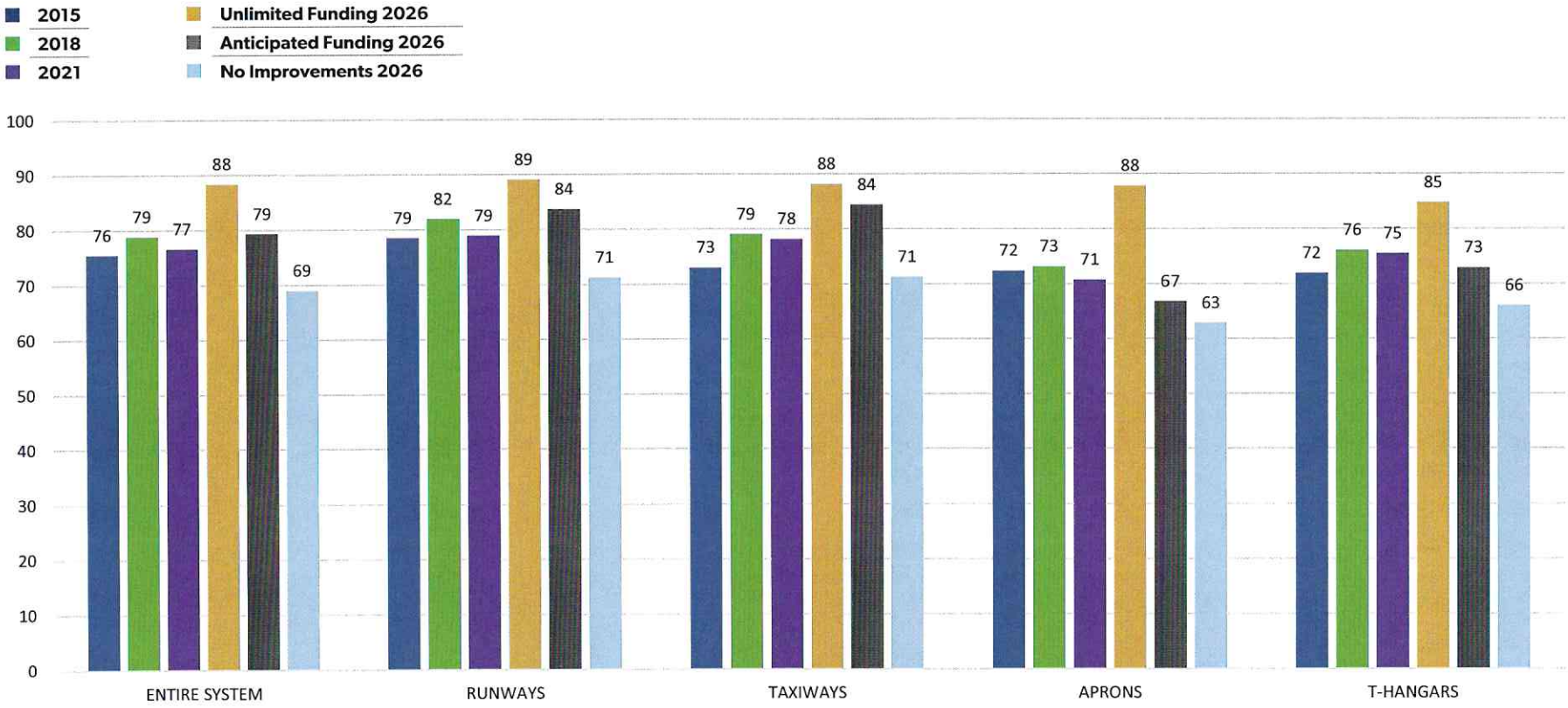
Overall Area-Weighted PCI

AIRPORT NAME	AREA-WEIGHTED PCI
Ashley Municipal	79
Beach	75
Beulah Municipal	69
Bismarck Municipal	76
Bottineau Municipal	63
Bowman Regional	97
Cando Municipal	91
Carrington Municipal	62
Casselton - Robert Miller Regional	55
Cavalier Municipal	61
Cooperstown Municipal	66
Crosby Municipal	71
Devils Lake Regional	66
Dickinson Theodore Roosevelt Regional	89
Drayton Municipal	79
Dunseith - International Peace Garden	32
Edgeley Municipal	64
Ellendale Municipal	60
Enderlin - Sky Haven	74
Fargo - Hector International	80
Fort Yates - Standing Rock	57
Garrison Municipal	88
Glen Ullin Regional	56
Grafton Hutson Field	64
Grand Forks International	76
Gwinner-Roger Melroe Field	91
Harvey Municipal	85
Hazen - Mercer County Regional	99
Hettinger Municipal	78
Hillsboro Regional	82
Jamestown Regional	70
Kenmare Municipal	90
Killdeer - Dunn County	80
Kindred - Robert Odegaard Field	75
Lakota Municipal	27
LaMoure Rott Municipal	70
Langdon - Robertson Field	77
Larimore Municipal	56
Leeds Municipal	25
Linton Municipal	72
Lisbon Municipal	72
Maddock Municipal	93
Mandan Regional - Lawler Field	81
Mayville Municipal	52
Minot International	74
Minto Municipal	76
Mohall Municipal	86
Mott Municipal	72
Napoleon Municipal	82
New Rockford - Tomlinson Field	55
New Town Municipal	79
Northwood Municipal - Vince Field	82
Oakes Municipal	88
Page Regional	48
Park River - W.C. Skjerven Field	62
Parshall-Hankins	68
Pembina Municipal - Thomas Nord Field	55
Rolette	55
Rolla Municipal	64
Rugby Municipal	64
St. Thomas Municipal	43
Stanley Municipal	71
Tioga Municipal	75
Valley City - Barnes County Municipal	80
Wahpeton - Harry Stern	90
Walhalla Municipal	69
Washburn Municipal	91
Watford City Municipal	97
West Fargo Municipal	57
Westhope Municipal	63
Williston Basin International	99
Wishek Municipal	61

Historic Pavement Condition

The APMS is updated every three years. It is important to track how the system as a whole is performing from update to update. Overall, the statewide airport system PCI will experience cyclical ups and downs for a variety of reasons including but not limited to large amounts of new pavement added to the system, timing and availability of project funding, and the types of distresses observed on pavements. The *Historical PCI and Projected Area-Weighted Average PCI by Funding Scenario* chart below provides a summary of the 2015 and 2018 historic PCI values; current 2021 PCI values; projected PCI values in 2026 if unlimited funding were available; projected PCI values in 2026 if only the anticipated state budget funding were available; and the projected PCI values in 2026 if no improvements were completed on the existing system.

Historical PCI and Projected Area-Weighted Average PCI by Funding Scenario



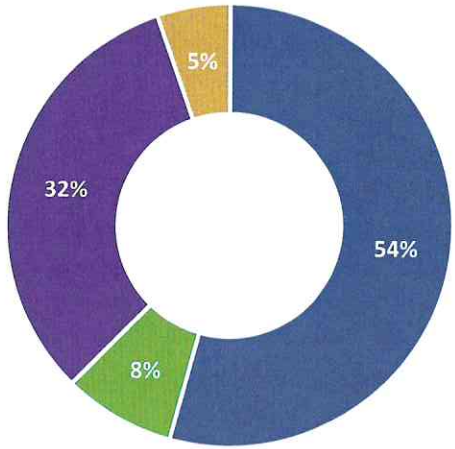
Pavement Condition Distribution

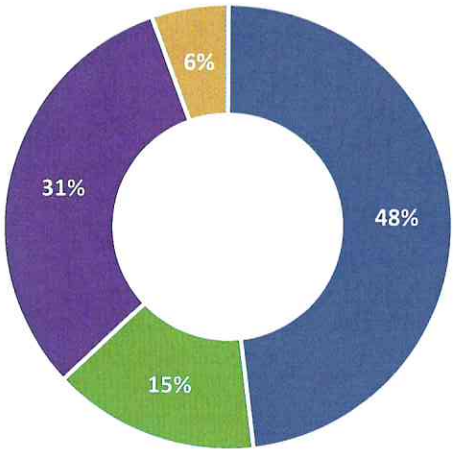
The overall state airport system chart below summarizes the data for the airports included in the 2021 APMS. Approximately 48 percent have PCIs indicating they will benefit from preventive maintenance actions, such as crack sealing, joint sealing, and patching. Roughly 15 percent would benefit from applying a surface treatment. Approximately 31 percent of the pavement infrastructure needs more extensive rehabilitation, while 6 percent needs reconstruction to restore the pavement. This same information is included in the commercial service and general aviation airports charts.

Commercial Service Airports

IN SQUARE FEET

Preventative Maintenance	18,588,257
Surface Treatments	2,776,351
Major Rehabilitation	11,062,940
Major Reconstruction	1,831,409





Overall State Airport System

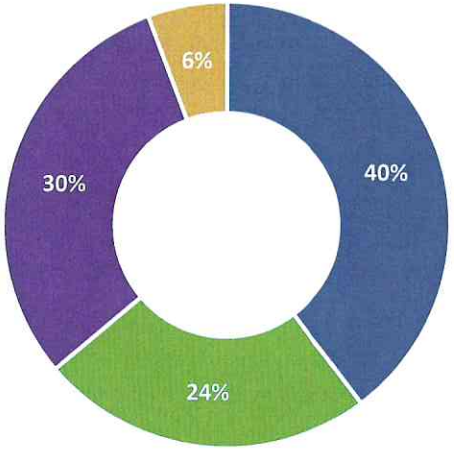
IN SQUARE FEET

Preventative Maintenance	28,613,741
Surface Treatments	8,847,337
Major Rehabilitation	18,741,180
Major Reconstruction	3,298,747

General Aviation Airports

IN SQUARE FEET

Preventative Maintenance	10,005,827
Surface Treatments	6,092,544
Major Rehabilitation	7,675,707
Major Reconstruction	1,467,970



Pavement Funding Assessment

Funding for aviation projects within the state is crucial to maintain a steady pavement condition and safeguard aviation users. If no funding is provided for pavement maintenance and repair, North Dakota's pavement system will experience a slow and steady decline in condition. This decline would create a need for more major rehabilitation or reconstruction projects, which in turn significantly increases future cost.

Using the information collected during the pavement inspection, a rehabilitation program for 2022 through 2026 was developed for every airport in the study. A five-year program was prepared with the goal of maintaining the pavement above the established critical PCI values listed earlier in this report. The program generates a major rehabilitation recommendation for pavement in the year they drop below their critical PCI.

If all projects identified in the PCI study were funded, an approximate total of $251 million would be needed during the next five years – $155.8 million for commercial service airports and $95.2 million for general aviation airports. The unlimited budget funding for individual airport needs through 2026 are summarized in the table shown to the right, *Five-Year Funding Plan*. This analysis is for 2022 through 2026 with an inflation factor of 7 percent for 2022 and 5 percent for 2023 through 2026 when calculating future cost of work. The unit costs used to estimate overall project costs are based on averages of recent projects completed throughout the state. These costs are averages and are not intended to be used for specific project planning purposes. Funding needs identified in an unlimited budget scenario are to maintain or rehabilitate existing infrastructure and do not include any additional needs or improvements made.

Five-Year Funding Plan

CLASSIFICATION	AIRPORT NAME	5-YEAR TOTAL FUNDING NEEDS
Commercial Service	Bismarck Municipal Airport	$25,116,554
	Devils Lake Regional Airport	$9,524,350
	Dickinson Theodore Roosevelt Regional Airport	$6,456,244
	Fargo - Hector International Airport	$44,809,411
	Grand Forks International Airport	$32,770,039
	Jamestown Regional Airport	$14,176,959
	Minot International Airport	$22,975,144
	Williston Basin International Airport	$8,310
Five-Year Commercial Service Total		**$155,837,011**
General Aviation (NPIAS)	Ashley Municipal Airport	$159,483
	Beach Airport	$1,216,216
	Bottineau Municipal Airport	$446,534
	Bowman Regional Airport	$23,158
	Cando Municipal Airport	$182,994
	Carrington Municipal Airport	$3,225,400
	Casselton - Robert Miller Regional Airport	$10,066,479
	Cavalier Municipal Airport	$3,109,093
	Cooperstown Municipal Airport	$2,553,111
	Crosby Municipal Airport	$2,096,754
	Dunseith - International Peace Garden Airport	$2,881,821
	Edgeley Municipal Airport	$314,701
	Ellendale Municipal Airport	$604,547
	Fort Yates - Standing Rock Airport	$2,109,695
	Garrison Municipal Airport	$185,804
	Glen Ullin Regional Airport	$2,079,056
	Grafton Hutson Field Airport	$4,150,409
	Gwinner-Roger Melroe Field Airport	$273,240
	Harvey Municipal Airport	$0

CLASSIFICATION	AIRPORT NAME	5-YEAR TOTAL FUNDING NEEDS
General Aviation (NPIAS)	Hazen - Mercer County Regional Airport	$4,065
	Hettinger Municipal Airport	$1,248,407
	Hillsboro Regional Airport	$1,842,097
	Kenmare Municipal Airport	$466
	Kindred - Robert Odegaard Field Airport	$2,517,186
	Lakota Municipal Airport	$4,935,751
	LaMoure Rott Municipal Airport	$1,193,169
	Langdon - Robertson Field Airport	$452,236
	Linton Municipal Airport	$573,362
	Lisbon Municipal Airport	$1,570,785
	Mandan Regional Airport - Lawler Field	$2,003,862
	Mohall Municipal Airport	$500,023
	Mott Municipal Airport	$172,735
	Northwood Municipal - Vince Field Airport	$487,111
	Oakes Municipal Airport	$75,888
	Park River Airport - W.C. Skjerven Field	$1,682,274
	Parshall-Hankins Airport	$1,231,308
	Pembina Municipal -Thomas Nord Field	$2,906,859
	Rolla Municipal Airport	$2,368,105
	Rugby Municipal Airport	$1,727,084
	Stanley Municipal Airport	$570,980
	Tioga Municipal Airport	$3,448,467
	Valley City - Barnes County Municipal Airport	$1,934,318
	Wahpeton - Harry Stern Airport	$1,583,491
	Walhalla Municipal Airport	$539,457
	Washburn Municipal Airport	$104,922
	Watford City Municipal Airport	$69,434
Five-Year General Aviation NPIAS Total		**$71,422,337**

CLASSIFICATION	AIRPORT NAME	5-YEAR TOTAL FUNDING NEEDS
General Aviation (Non-NPIAS)	Beulah Municipal Airport	$2,179,611
	Drayton Municipal Airport	$874,955
	Enderlin - Sky Haven Airport	$622,095
	Killdeer - Dunn County Airport	$76,236
	Larimore Municipal Airport	$1,819,077
	Leeds Municipal Airport	$2,659,593
	Maddock Municipal Airport	$31,357
	Mayville Municipal Airport	$2,494,975
	Minto Municipal Airport	$431,135
	Napoleon Municipal Airport	$69,714
	New Rockford - Tomlinson Field Airport	$2,730,033
	New Town Municipal Airport	$4,833
	Page Regional Airport	$1,308,043
	Rolette Airport	$602,018
	St. Thomas Municipal Airport	$2,370,438
	West Fargo Municipal Airport	$1,513,211
	Westhope Municipal Airport	$1,649,174
	Wishek Municipal Airport	$2,320,428
Five-Year General Aviation Non-NPIAS Total		**$23,756,926**
FIVE-YEAR STATEWIDE FUNDING TOTAL		**$251,016,274**

No or minimal five-year funding needs are due to the airport recently completing a pavement preservation project, construction, reconstruction, or rehabilitation.

Summary

This report summarizes the results of the pavement evaluation conducted in North Dakota as part of the state APMS database update for airports. This includes 8 NPIAS commercial service airports, 46 NPIAS general aviation airports, and 18 non-NPIAS general aviation airports. The system currently has 59.5 million square feet of pavement – 34.3 million square feet at commercial service airports and 25.2 million square feet at general aviation airports. **In 2018, the PCI value for the overall state airport system pavement network was 79. During visual pavement inspections in 2021, the current weighted PCI was found to be 77.** If no funding is provided, this PCI value will steadily fall to 69 by the end of 2026. If the funding anticipated in the state budget is provided, the 2026 overall PCI value of the system is anticipated to be 79. If all work identified were to be completed, the 2026 overall PCI of the system is anticipated to increase to a value of 88.

Approximately $251 million in funding would be needed over the next five years to complete all work that has been identified in the unlimited budget scenario. This includes approximately $155.8 million for commercial service airports and $95.2 million for general aviation airports. Additional information can be found by visiting the NDAC website, **WWW.AERO.ND.GOV**.

STATEWIDE EXECUTIVE SUMMARY AIRPORT PAVEMENT CONDITION INDEX (PCI) STUDY

For additional information, please visit WWW.AERO.ND.GOV

2021

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