EMMETSBURG MUNICIPAL AIRPORT
PAVEMENT MANAGEMENT REPORT

Prepared For:
Iowa Department of Transportation
Office of Aviation

Prepared By:
Applied Pavement Technology, Inc.

IOWA DOT
Office of Aviation

April 2016

EMMETSBURG MUNICIPAL AIRPORT
PAVEMENT MANAGEMENT REPORT

PREPARED FOR:

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF AVIATION

PREPARED BY:

APPLIED PAVEMENT TECHNOLOGY, INC.

IN ASSOCIATION WITH:

ROBINSON ENGINEERING COMPANY

April 2016

The preparation of this document was financed in part through an Airport Improvement Program grant from the Federal Aviation Administration (Project Number 3-19-0000-022-2015) as provided under Section 505 of the Airport and Airway Improvement Act of 1982, as amended. The contents do not necessarily reflect the DOT's official views or the policy of the FAA. Acceptance of this report by the FAA does not in any way constitute a commitment on the part of the United States to participate in any development depicted therein nor does it indicate the proposed development is environmentally acceptable in accordance with appropriate public laws.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIXES

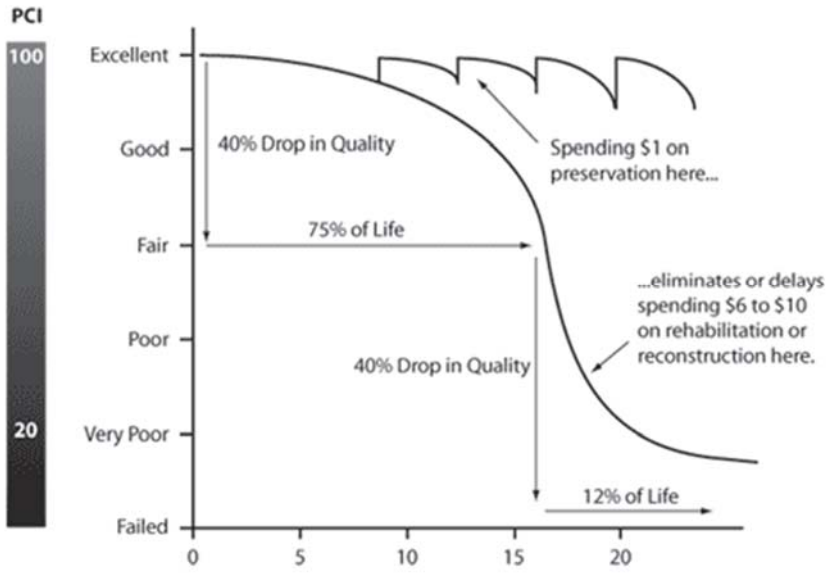
INTRODUCTION

Applied Pavement Technology, Inc. (APTech), with assistance from Robinson Engineering Company, updated the airport pavement management system (APMS) for the Iowa Department of Transportation, Office of Aviation (Iowa DOT). During this project, pavement conditions at Emmetsburg Municipal Airport were assessed in November 2015 using the Pavement Condition Index (PCI) procedure.

During a PCI inspection, the types, severities, and amounts of distress present in a pavement are quantified. This information is then used to develop a composite index that represents the overall condition of the pavement in numerical terms, ranging from 0 (failed) to 100 (excellent). The PCI provides an overall measure of condition and an indication of the level of work that will be required to maintain or repair a pavement. The distress information also provides insight into what is causing the pavement to deteriorate, which is the first step in selecting the appropriate repair action to correct the problem.

Programmed into an APMS, PCI information is used to determine when preventive maintenance actions (such as crack or joint sealing) are advisable, and also to identify the most cost-effective time to perform major rehabilitation (such as an overlay or whitetopping). The importance of identifying not only the type of repair, but also the optimal time of repair is illustrated in Figure 1 (taken from http://www.fhwa.dot.gov/pavement/preservation/ppc0621.cfm). This figure shows that there is a point in a pavement's life cycle where the rate of deterioration increases. The financial impact of delaying repairs beyond this point can be severe.

Figure 1. Pavement condition versus cost of repair.

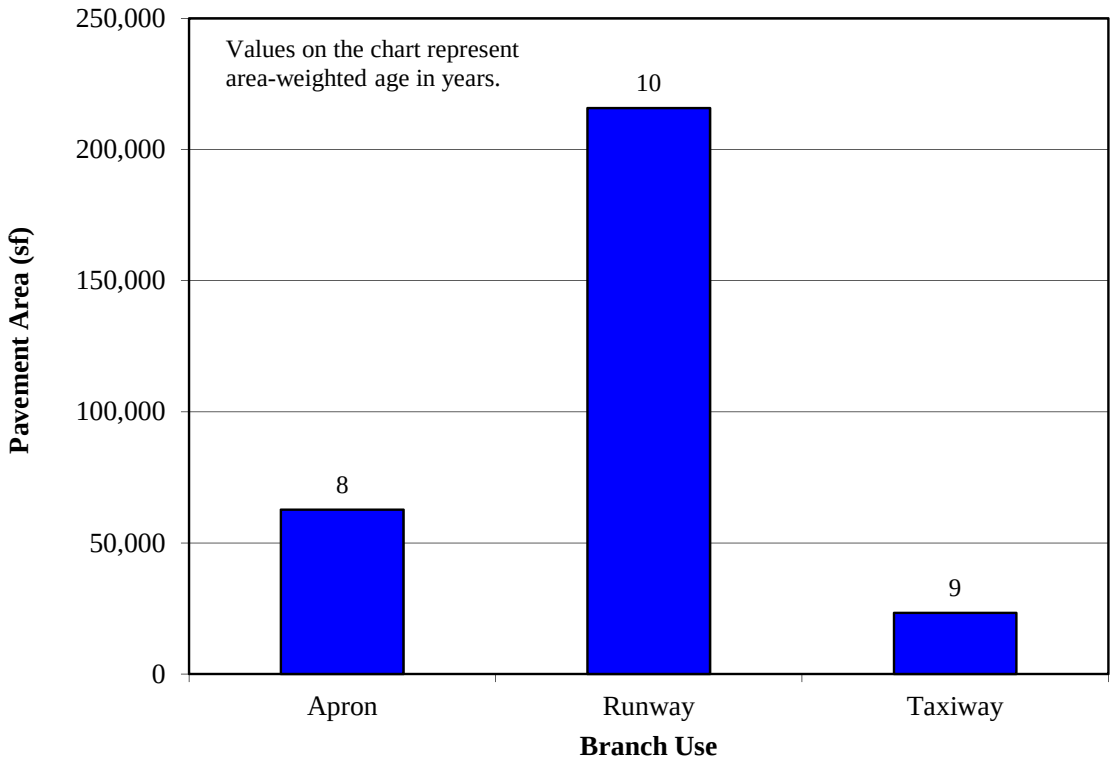


The pavement evaluation results for Emmetsburg Municipal Airport are presented within this report and can be used by the Iowa DOT, the Federal Aviation Administration (FAA), and Emmetsburg Municipal Airport to prioritize and schedule pavement maintenance and rehabilitation (M&R) actions at the airport. In addition to this report, the web-based Interactive Data Exchange Application (IDEA) containing the pavement management information collected during this project was updated, and may be accessed from Iowa DOT's website.

PAVEMENT INVENTORY

Approximately 301,767 square feet of runway, taxiway, and apron pavements were evaluated at Emmetsburg Municipal Airport, as illustrated in Figure 2. This figure also shows the area-weighted age in years of the pavements.

Figure 2. Pavement inventory.

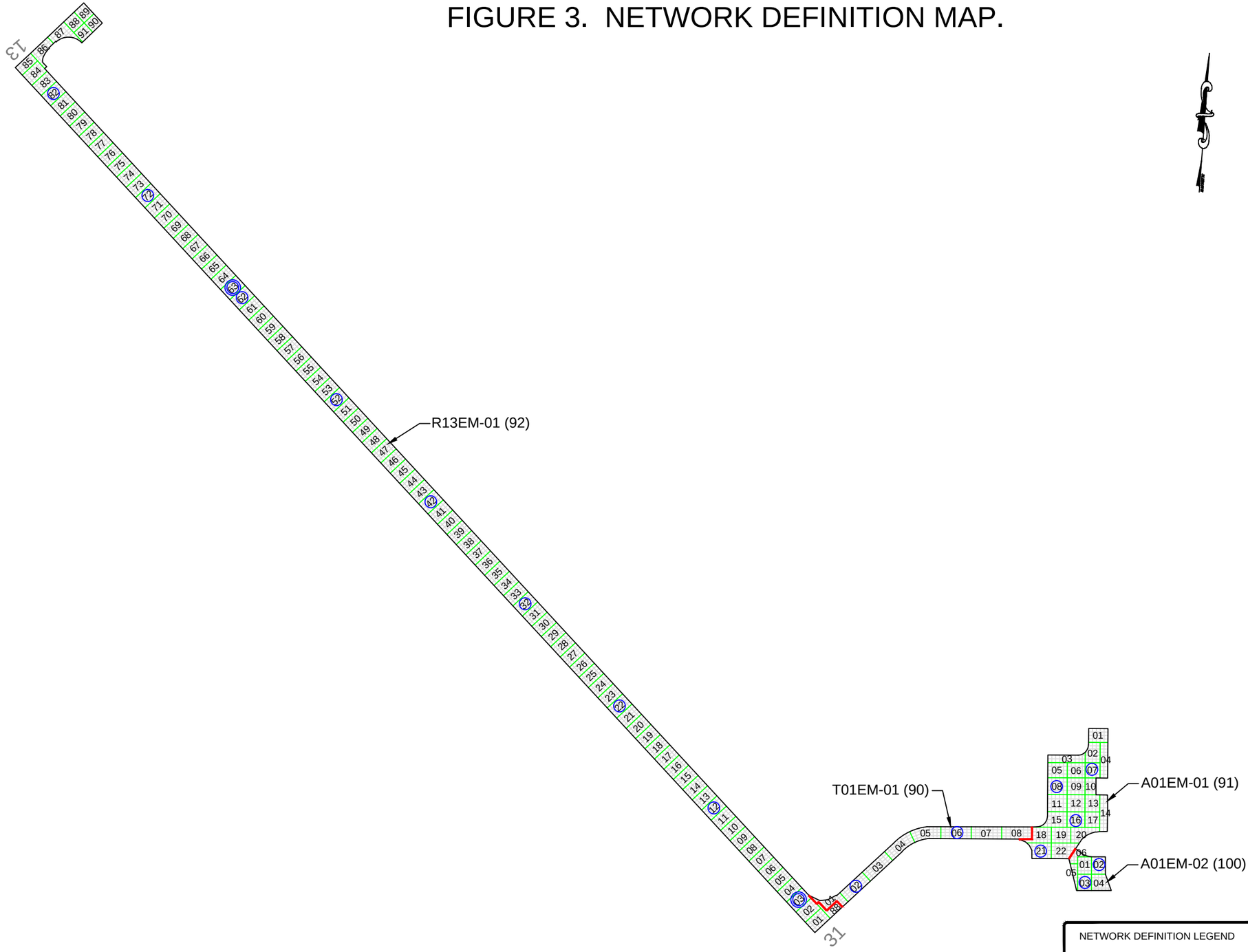


The pavement network at Emmetsburg Municipal Airport was divided into branches, sections, and sample units for pavement management purposes. A branch is a single entity that serves a distinct function. For example, a runway is considered a branch because it serves a single function (allowing aircraft to take off and land). Taxiways and aprons are also separate branches.

Each branch was further divided into sections. Sections are defined as parts of the branch that share common attributes, such as cross-section, last construction date, traffic level, and performance. Using this traditional approach, if a runway was built in 1968 and then extended in 1984, it would be comprised of two separate sections.

To estimate the overall condition of a pavement section, each section was subdivided into sample units. Portions of these sample units were evaluated during pavement inspections, and the collected information was extrapolated to predict the condition of the section as a whole. Figure 3 provides a map that details how the pavement network was divided into management units and identifies the sample units that were evaluated during the pavement inspection at Emmetsburg Municipal Airport.

FIGURE 3. NETWORK DEFINITION MAP.



NETWORK DEFINITION LEGEND

- BRANCH IDENTIFIER
- SECTION IDENTIFIER
- PCI VALUE

R13EM-01 (100)

- SECTION BREAK LINE
- SAMPLE UNIT BREAK LINE
- SLAB JOINT
- 03 SAMPLE UNIT NUMBER
- 03 SAMPLE UNIT INSPECTED
- 03 ADDITIONAL SAMPLE UNIT

applied pavement TECHNOLOGY
115 W. Main Street, Suite 400
Urbana, IL 61801
Tel: (217) 398-3977
Fax: (217) 398-4027

AGENCY: Iowa Department of Transportation, Office of Aviation			
LOCATION: Emmetsburg Municipal Airport, Emmetsburg, Iowa			
PAGE TITLE: Network Definition Map			
PROJECT DATE: OCT. 2015	CREATION DATE: OCT. 2015	PROJECT MANAGER: LJR	JOB NUMBER: 2012-001-AM04
DRAWING SCALE: 1"=300'	LAST MODIFIED DATE: DEC. 2015	REVISED BY: ABF	DRAWN BY: KEW
FILENAME: Emmetsburg.dwg		LAYOUT NAME/NUMBER: NET. DEF.	PAGE NUMBER: 3

PAVEMENT EVALUATION

Pavement Evaluation Procedure

APTech inspected the pavements at Emmetsburg Municipal Airport using the PCI procedure described in:

- FAA Advisory Circular (AC) 150/5380-6C, *Guidelines and Procedures for Maintenance of Airport Pavements* (http://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5380-6C.pdf)
- FAA AC 150/5380-7B, *Airport Pavement Management Program (PMP)* (http://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5380-7B.pdf)
- ASTM D5340-12, *Standard Test Method for Airport Pavement Condition Index Surveys*

The PCI provides a numerical indication of overall pavement condition, as illustrated in Figure 4. The types and amounts of deterioration are used to calculate the PCI of the section. The PCI scale ranges from a value of 0 (representing a pavement in a failed condition) to a value of 100 (representing a pavement in excellent condition).

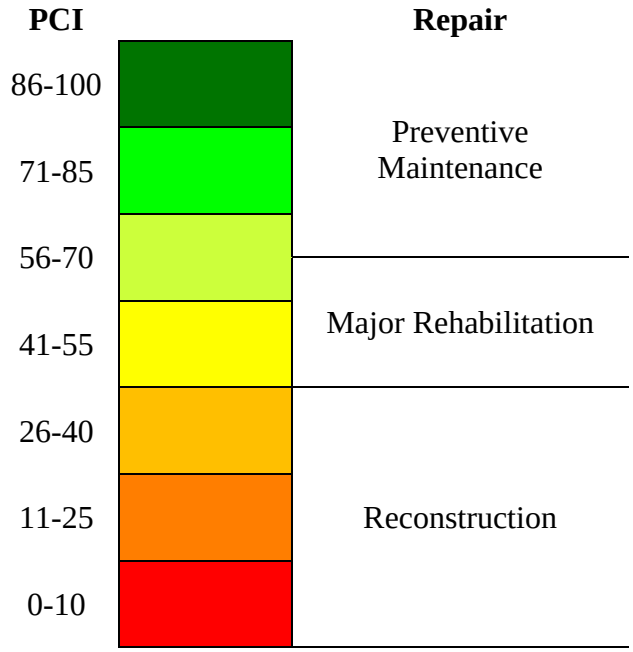
Figure 4. Visual representation of PCI scale.

Typical Pavement Surface[1]	PCI
	100
	60
	15

[1]Photographs shown are not specific to Emmetsburg Municipal Airport.

In general terms, pavements with relatively high PCIs that are not exhibiting significant load-related distress will benefit from preventive maintenance actions, such as crack sealing or joint resealing. As the PCI drops, the pavements may require major rehabilitation, such as an overlay or whitetopping. In some situations where the PCI has dropped low enough, reconstruction may be the only viable alternative due to the substantial damage to the pavement structure. Figure 5 illustrates how the appropriate repair type varies with the PCI of a pavement section.

Figure 5. PCI versus repair type.



The types of distress identified during the PCI inspection provide insight into the cause of pavement deterioration. PCI distress types are characterized as load-related (such as alligator cracking on asphalt-surfaced pavements or shattered slabs on portland cement concrete [PCC] pavements), climate/durability-related (such as weathering [a climate-related distress type on asphalt-surfaced pavements] and durability cracking [a durability-related distress type on PCC pavements]), and other (distress types that cannot be attributed solely to load or climate/durability). Understanding the cause of distress helps in selecting a rehabilitation alternative that corrects the cause and thus eliminates its recurrence.

Appendix A identifies the distress types considered during a PCI inspection and describes the likely cause of each distress type. It should be noted that a PCI is based on visual signs of pavement deterioration and does not provide a measure of structural capacity.

Pavement Evaluation Results

The pavements at Emmetsburg Municipal Airport were inspected on November 7, 2015. The 2015 area-weighted condition of Emmetsburg Municipal Airport is 92, with conditions ranging from 90 to 100 (on a scale of 0 [failed] to 100 [excellent]). During the previous pavement inspection in 2012, the area-weighted PCI of the airport was 93.

Figure 6 summarizes the overall condition of the pavements at Emmetsburg Municipal Airport and Figure 7 presents area-weighted condition (average PCI adjusted to account for the relative size of the pavement sections) by branch use. Figure 8 is a map that displays the condition of the evaluated pavements. Table 1 summarizes the results of the pavement evaluation. Appendix B presents photographs taken during the PCI inspection, and Appendix C contains detailed information on the distresses observed during the visual survey. Appendix D includes detailed work history information that was collected during the record review process.

Figure 6. Overall condition at Emmetsburg Municipal Airport.

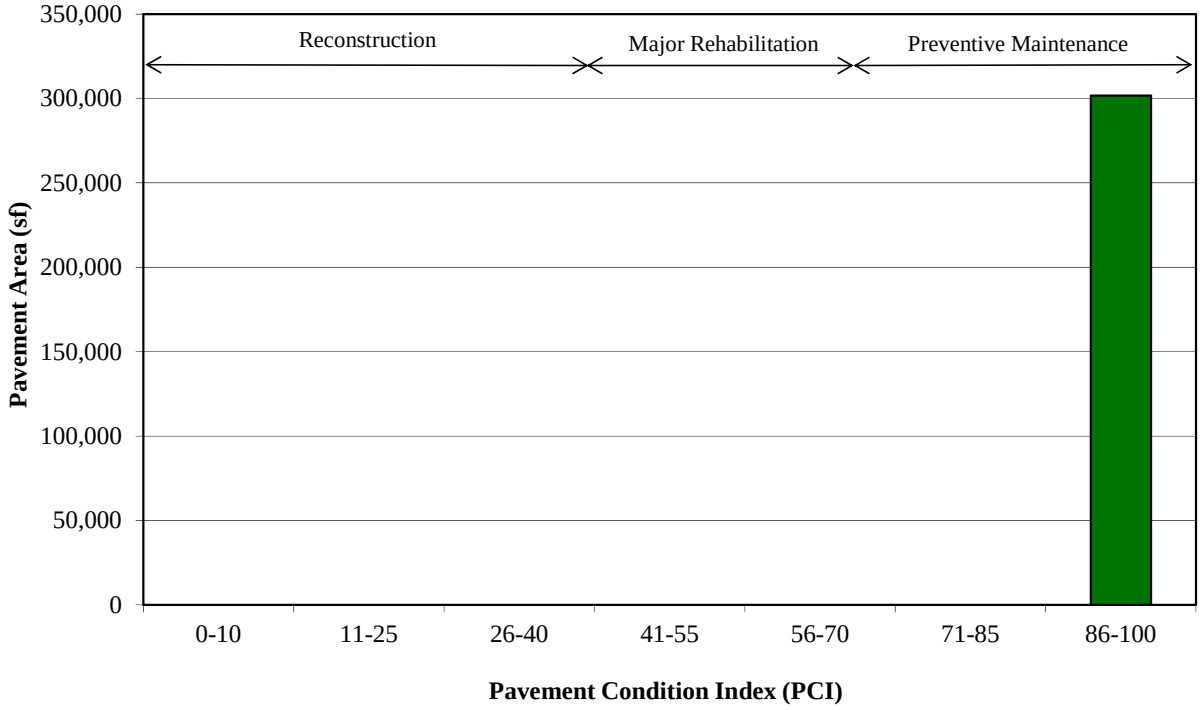


Figure 7. Condition by branch use at Emmetsburg Municipal Airport.

(Values on chart are area-weighted)

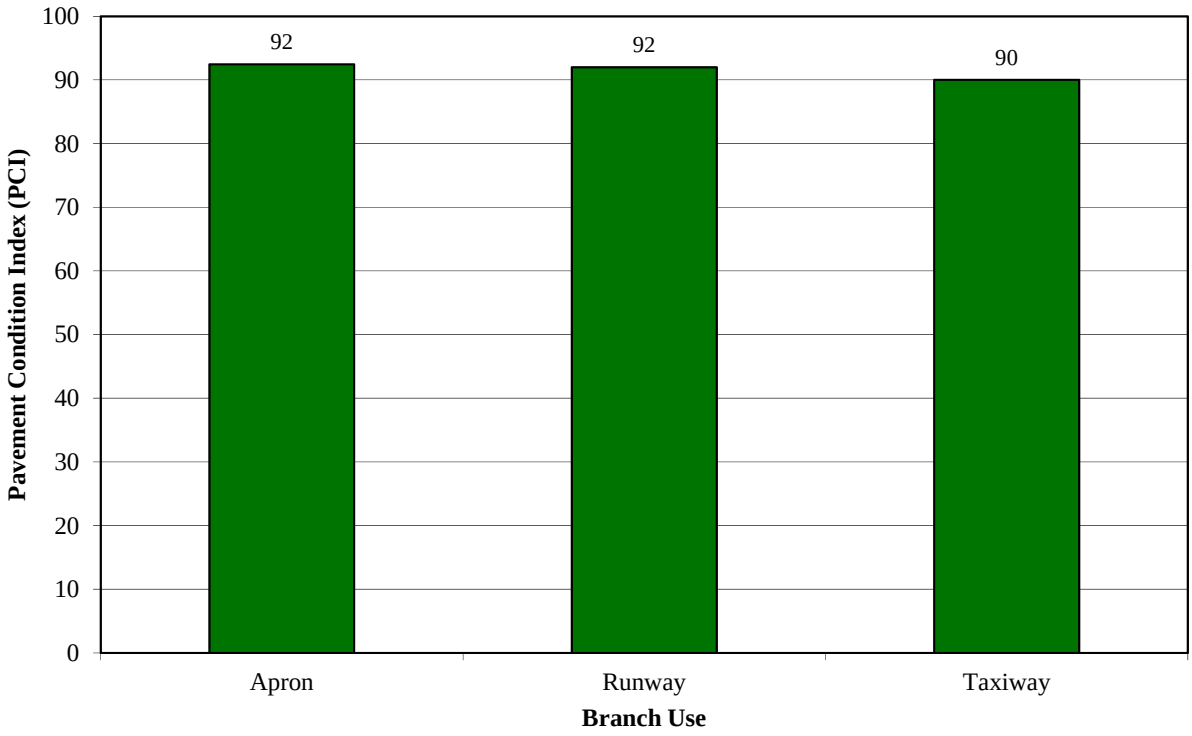
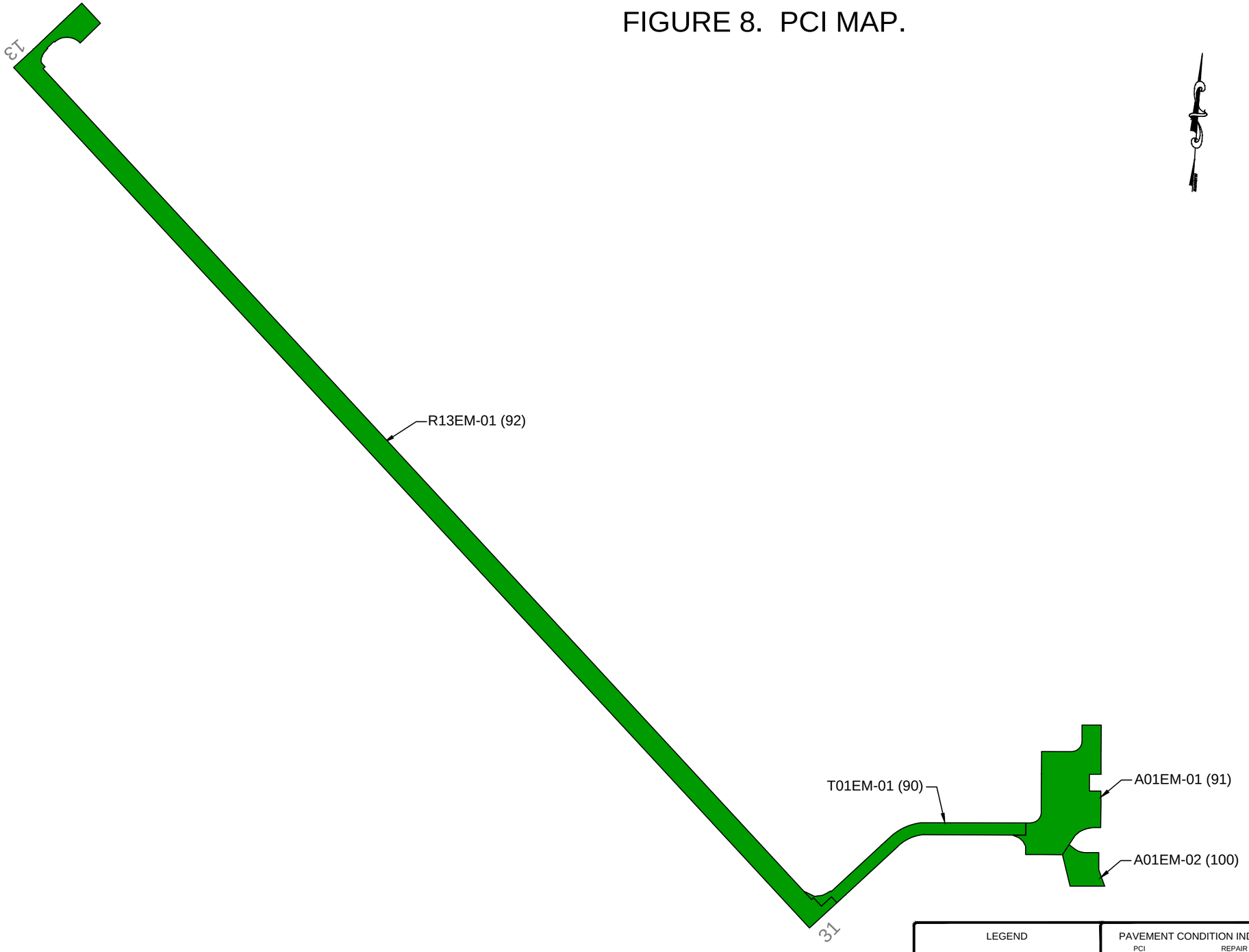


FIGURE 8. PCI MAP.



LEGEND

BRANCH IDENTIFIER
SECTION IDENTIFIER
PCI VALUE
R13EM-01 (100)
SECTION BREAK LINE

PAVEMENT CONDITION INDEX

PCI	REPAIR
100	
85	PREVENTIVE MAINTENANCE
70	
55	MAJOR REHABILITATION
40	
25	
10	RECONSTRUCTION
0	

applied pavement TECHNOLOGY
115 W. Main Street, Suite 400
Urbana, IL 61801
Tel: (217) 398-3977
Fax: (217) 398-4027

Robinson Engineering Company
Consulting Engineers
322 First Street East
Independence, Iowa 50644
319-334-7211

AGENCY: Iowa Department of Transportation Office of Aviation			
LOCATION: Emmetsburg Municipal Airport, Emmetsburg, Iowa			
PAGE TITLE: 2015 Pavement Condition Index Map			
PROJECT DATE: OCT. 2015	CREATION DATE: OCT. 2015	PROJECT MANAGER: LJR	JOB NUMBER: 2012-001-AM04
DRAWING SCALE: 1"=300'	LAST MODIFIED DATE: DEC. 2015	REVISED BY: KEW	DRAWN BY: KEW
FILENAME: Emmetsburg.dwg		LAYOUT NAME/NUMBER: PCI	PAGE NUMBER: 8

Table 1. Pavement evaluation results.

Emmetsburg Municipal Airport								
						% Distress Due to:		
Branch[1]	Section[1]	Surface Type[2]	Section Area (sf)	LCD[3]	2015 PCI	Load[4]	Climate or Durability[5]	Distress Types[6]
A01EM	01	PCC	52,486	6/2/2006	91	0	74	Corner Spalling, Joint Seal Damage, Joint Spalling
	02	PCC	10,143	5/3/2014	100	0	0	No Distress
R13EM	01	PCC	215,834	10/1/2005	92	32	50	Corner Break, Corner Spalling, Joint Seal Damage, Joint Spalling, LTD Cracking
T01EM	01	PCC	23,304	6/2/2006	90	42	58	Joint Seal Damage, LTD Cracking

[1]See Figure 3 for the location of the branch and section.

[2]AC = asphalt cement concrete; AAC = asphalt overlay on AC; PCC = portland cement concrete; APC = asphalt overlay on PCC.

[3]LCD = last construction date.

[4]Distress due to load includes those distresses attributed to a structural deficiency in the pavement, such as alligator cracking or rutting on asphalt-surfaced pavements or shattered slabs on PCC pavements.

[5]Distress due to climate or durability includes those distresses attributed to either the aging of the pavement and the effects of the environment (such as weathering, raveling, or block cracking in asphalt-surfaced pavements) or to a materials-related problem (such as durability cracking or alkali-silica reaction [ASR] in a PCC pavement). If materials-related distresses were recorded during the inspection, further laboratory testing is required to definitively determine the type present.

[6]L&T Cracking = Longitudinal and Transverse Cracking; LTD Cracking = Longitudinal, Transverse, and Diagonal Cracking; ASR = Alkali-Silica Reaction.

Inspection Comments

Emmetsburg Municipal Airport was inspected on November 7, 2015. There were four pavement sections defined during the inspection.

Runway

Runway 13-31 was defined by one section with medium-severity joint seal damage recorded throughout. In addition, small amounts of low-severity corner breaks and low- and medium-severity joint spalling and corner spalling were identified. Isolated areas of low- and medium-severity longitudinal, transverse, and diagonal (LTD) cracking were observed and recorded as additional sample units in accordance with the ASTM procedure.

Taxiway

Taxiway 01 consisted of one section with low- and medium-severity joint seal damage identified throughout along with smaller quantities of low-severity LTD cracking.

Apron

The apron area was defined by two sections. Section 01, the majority of the apron area, had low- and medium-severity joint seal damage identified throughout. Isolated quantities of medium-severity joint spalling and corner spalling were also noted. Section 02, the southern portion of the apron area, was recently constructed and had no distresses observed at the time of inspection.

PAVEMENT MAINTENANCE AND REHABILITATION PROGRAM

Using the information collected during the pavement inspection, a 5-year M&R program was developed for Emmetsburg Municipal Airport. In addition, a 1-year plan for localized preventive maintenance (such as crack sealing and patching) was prepared. The PAVER™ pavement management software was used to perform this analysis.

Analysis Parameters

Localized Preventive Maintenance Policies and Unit Costs

Localized preventive maintenance policies were developed for asphalt-surfaced and PCC pavements. These policies, shown in Appendix E, identify the localized preventive maintenance actions that the Iowa DOT considered appropriate to correct different distress types and severities. The Iowa DOT provided unit costs for each of the localized preventive maintenance actions included in these policies, and these costs are detailed in Appendix E. Please note that this information is of a general nature for the entire state. The maintenance policies and unit costs may require adjustment to reflect specific conditions at Emmetsburg Municipal Airport.

Major Rehabilitation Unit Costs

PAVER™ estimates the cost of major rehabilitation based on the predicted PCI of the pavement section. The Iowa DOT provided these costs, and they are presented in Appendix E. If major rehabilitation is recommended in the 5-year program, further engineering investigation will be needed to identify the most appropriate rehabilitation action and to more accurately estimate the cost of such work.

Budget and Inflation Rate

An unlimited budget with a start date of July 1, 2016 and an inflation rate of 2.5 percent was used during the analysis.

Analysis Approach

The 5-year M&R program was prepared with the goal of maintaining the pavements above established critical PCIs. The Iowa DOT set the critical PCI at 65 for runways, 60 for taxiways, and 55 for aprons. During this analysis, major rehabilitation was recommended for pavements in the year they dropped below their critical PCI.

For the first year (2016) of the analysis only, a localized preventive maintenance plan was developed for those pavement sections that were above their critical PCI. If major rehabilitation was triggered for a section in 2017 or 2018, then localized maintenance was not recommended for 2016. While localized preventive maintenance should be an annual undertaking at Emmetsburg Municipal Airport, it is not possible to accurately predict the propagation of cracking and other distress types. Therefore, the airport should budget for maintenance every year and can use the 2016 localized preventive maintenance plan as a baseline for that work. As the pavements age, it can be assumed that the amount of localized maintenance required will increase.

Analysis Results

A summary of the M&R program for Emmetsburg Municipal Airport is presented in Table 2. Detailed information on the recommended localized preventive maintenance plan for 2016 is contained in Appendix F.

Table 2. 5-year M&R program under an unlimited funding analysis scenario.

Year	Branch[1]	Section[1]	Surface Type[2]	Type of Repair[3]	Estimated Cost[4]
2016	A01EM	01	PCC	Localized Maintenance	$18,186
	R13EM	01	PCC	Localized Maintenance	$106,212
	T01EM	01	PCC	Localized Maintenance	$4,464
				Total:	**$128,862**

[1]See Figure 3 for the location of the branch and section.

[2]AC = asphalt cement concrete; AAC = asphalt overlay on AC; PCC = portland cement concrete; APC = asphalt overlay on PCC.

[3]Major Rehabilitation: such as pavement reconstruction or an overlay. Localized Maintenance: such as crack sealing or patching.

[4]Cost estimates are based on broad statewide numbers and should be adjusted to reflect local costs.

The recommendations made in this report are based on a broad network level analysis and are meant to provide Emmetsburg Municipal Airport with an indication of the type of pavement-related work required during the next 5 years. Further engineering investigation may be necessary to identify which repair action is most appropriate. In addition, the cost estimates provided are based on overall unit costs for the entire state, and Emmetsburg Municipal Airport should adjust the plan to reflect local costs.

Because an unlimited budget was used in the analysis, the pavement repair program may need to be adjusted to take into account economic and/or operational constraints. Identifying a project need does not necessarily mean that state or federal funding will be available in the year it is indicated. It is important to remember that, regardless of the recommendations presented within this report, Emmetsburg Municipal Airport is responsible for repairing pavements where existing conditions pose a hazard to safe operations.

General Maintenance Recommendations

In addition to the specific maintenance actions presented in Appendix F, it is recommended that the following strategies are considered for prolonging pavement life:

1. Regularly inspect all safety areas of the airport, and document all inspection activity. A sample form that can be used to perform these inspections is provided in Table 3 of this report.
2. Provide a method of tracking all maintenance activities that occur as a result of inspections. These need to be reported to the FAA and Iowa DOT. This is important because this information is used to update the APMS records and is required to remain in compliance with Public Law 103-305 (see the next section of this report for further information on this law).

3. Conduct an aggressive campaign against weed growth through timely herbicide applications and/or mowing programs for the safety areas. Vegetation growth in pavement cracks is very destructive and significantly increases the rate of pavement deterioration.
4. Implement a periodic crack and joint sealing program. Keeping water and debris out of the pavement system by sealing cracks and joints is a proven and cost-effective method of extending the life of the pavement system.
5. Ensure that dirt does not build up along the edges of the pavements. This can create a "bathtub" effect, reducing the ability of water to drain away from the pavement system.
6. Closely monitor the movement of heavy equipment (particularly farming, construction, and fueling equipment) to make sure it is only operating on pavements that are designed to accommodate heavy loads. Failure to restrict heavy equipment to appropriate areas may result in the premature failure of airport pavements.

FAA Requirements (Public Law 103-305)

Since Emmetsburg Municipal Airport is in the National Plan of Integrated Airport Systems (NPIAS), the airport sponsor is required to keep the airport in a viable operating condition. This includes maintaining airport pavements in accordance with Public Law 103-305. Public Law 103-305 states that after January 1, 1995, NPIAS airport sponsors must provide assurances or certifications that an airport has implemented an effective airport pavement maintenance management system (PMMS) before the airport will be considered for federal funding of pavement replacement or reconstruction projects. To be in full compliance with the federal law, the PMMS must include the following components, at minimum: pavement inventory, pavement inspections, record keeping, information retrieval, and program funding.

This report serves as a complete pavement inventory and detailed inspection. To remain in compliance with the law, the airport will also need to undertake monthly drive-by inspections of pavement conditions and track pavement-related maintenance activities.

FAA AC 150/5380-6C and FAA AC 150/5380-7B provide detailed guidance pertaining to the requirements for an acceptable pavement management program. Appendix A of FAA AC 150/5380-7B outlines what needs to be included in a pavement management program (PMP) to remain in compliance with this law and Grant Assurance #11. Following is a copy of this Appendix, along with instructions for supplementing this report so that all requirements are met. **Note that the italicized words are direct quotations from the FAA AC.**

FAA AC 150/5830-7B, Appendix A. Pavement Management Program (PMP)

A-1.0 *An effective PMP specifies the procedures to follow to assure that proper preventative and remedial pavement maintenance is performed. The program should identify funding or anticipated funding and other resources available to provide remedial and preventive maintenance activities. An airport sponsor may use any format deemed appropriate, but the program needs to, as a minimum, include the following:*

A-1.1. Pavement Inventory. *The following must be depicted:*

a. *Identification of all runways, taxiways, and aprons with pavement broken down into sections each having similar properties.*

The network definition map provided in Figure 3 of this report shows the location of all runways, taxiways, and aprons at Emmetsburg Municipal Airport. If any new pavements are constructed or any pavement areas are permanently closed, this map must be updated. Maps can be updated by submitting the project plans to the Iowa DOT after project completion.

b. *Dimensions of pavement sections.*

The dimensions of all runways, taxiways, and aprons are stored in the PAVER™ database. Appendix C provides information on length, width, and area. In addition, the network definition map (Figure 3) is drawn to scale. Any changes to pavement dimensions must be recorded.

c. *Type of pavement surface.*

The type of pavement for each section at the airport is listed in Table 1 of this report and is also stored in the PAVER™ database. Any changes to pavement type (through an overlay or reconstruction) must be recorded.

d. *Year of construction and/or most recent major rehabilitation.*

Dates for pavement construction, rehabilitation, or reconstruction must be recorded.

e. *Whether AIP [Airport Improvement Program] or PFC [Passenger Facility Charge] funds were used to construct, reconstruct, or repair the pavement.*

Funding sources for all pavement projects should be recorded.

A-1.2. PMP Pavement Inspection Schedule. *Airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a pavement condition index (PCI) survey is performed, as set forth in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspection by PCI surveys may be extended to three years. Less comprehensive routine daily, weekly, and monthly maintenance inspections required for operations should be addressed.*

This report consists of a detailed inspection that will extend the inspection period to 3 years. It is the airport sponsor's responsibility to perform a monthly drive-by inspection. A sample pavement inspection report form is provided in Table 3 of this report.

A-1.3. Record Keeping. *The airport must record and keep on file complete information about all detailed inspections and maintenance performed until the pavement system is replaced. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information recorded includes:*

a. Inspection date

b. Location

c. Distress types

d. Maintenance scheduled or performed

Items a through c are satisfied by this inspection report. Item d is the responsibility of the airport, as is record keeping of the monthly drive-by inspections.

A-1.4. Information Retrieval. *An airport sponsor may use any form of record keeping it deems appropriate so long as the information and records from the pavement survey can generate required reports, as necessary.*

Keep this report, monthly drive-by inspection reports, construction updates, and all records of maintenance activities in a readily accessible location so that they can be easily retrieved as requested by the FAA.

Table 3. Pavement inspection report.

Inspected By: _____
Date Inspected: _____

Inspection Record			Maintenance Action			
Location[1]		Distress Description/Dimensions/Severity/ Recommended Action	Description of Repair	Date Performed	Cost	Funding Source
Branch	Section					
A01EM	01					
	02					
R13EM	01					
T01EM	01					

[1]See Figure 3 for the location of the branch and section.

SUMMARY

This report documents the results of the pavement evaluation conducted at Emmetsburg Municipal Airport. During a visual inspection of the pavements in 2015, it was found that the overall condition of the pavement network is a PCI of 92. A 5-year pavement repair program, shown in Table 2, was generated for Emmetsburg Municipal Airport, which revealed that approximately $129,000 needs to be expended on M&R. Emmetsburg Municipal Airport should utilize these study results to assist in planning for future maintenance needs as part of the airport CIP planning process.

APPENDIX A

CAUSE OF DISTRESS TABLES

Table A-1. Cause of pavement distress, asphalt-surfaced pavements.

Distress Type	Probable Cause of Distress
Alligator Cracking	Fatigue failure of the asphalt concrete surface under repeated traffic loading.
Bleeding	Excessive amounts of asphalt cement or tars in the mix and/or low air void content.
Block Cracking	Shrinkage of the asphalt concrete and daily temperature cycling; it is not load associated.
Corrugation	Traffic action combined with an unstable pavement layer.
Depression	Settlement of the foundation soil or can be "built up" during construction.
Jet Blast Erosion	Bituminous binder has been burned or carbonized.
Joint Reflection Cracking	Movement of the concrete slab beneath the asphalt concrete surface due to thermal and moisture changes.
L&T Cracking	Cracks may be caused by 1) a poorly constructed paving lane joint, 2) shrinkage of the asphalt surface due to low temperatures or hardening of the asphalt, or 3) reflective cracking caused by cracks in an underlying PCC slab.
Oil Spill Damage	Deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.
Patching	N/A
Polished Aggregate	Repeated traffic applications.
Raveling	Asphalt binder may have hardened significantly, causing coarse aggregate pieces to dislodge.
Rutting	Usually caused by consolidation or lateral movement of the materials due to traffic loads.
Shoving	Where PCC pavements adjoin flexible pavements, PCC "growth" may shove the asphalt pavement.
Slippage Cracking	Low strength surface mix or poor bond between the surface and the next layer of the pavement structure.
Swelling	Usually caused by frost action or by swelling soil.
Weathering	Asphalt binder and/or fine aggregate may wear away as the pavement ages and hardens.

Table A-2. Cause of pavement distress, PCC pavements.

Distress Type	Probable Cause of Distress
ASR	Chemical reaction of alkalis in the portland cement with certain reactive silica minerals. ASR may be accelerated by the use of chemical pavement deicers.
Blow-Up	Incompressible materials in the joints.
Corner Break	Load repetition combined with loss of support and curling stresses.
Durability Cracking	Concrete's inability to withstand environmental factors such as freeze-thaw cycles.
Joint Seal Damage	Stripping of joint sealant, extrusion of joint sealant, weed growth, hardening of the filler (oxidation), loss of bond to the slab edges, or absence of sealant in the joint.
LTD Cracking	Combination of load repetition, curling stresses, and shrinkage stresses.
Patching (Small and Large)	N/A
Popouts	Freeze-thaw action in combination with expansive aggregates.
Pumping	Poor drainage, poor joint sealant.
Scaling	Over finishing of concrete, deicing salts, improper construction, freeze-thaw cycles, and poor aggregate.
Settlement	Upheaval or consolidation.
Shattered Slab	Load repetition.
Shrinkage Cracking	Setting and curing of the concrete.
Spalling (Joint and Corner)	Excessive stresses at the joint caused by infiltration of incompressible materials or traffic loads; weak concrete at the joint combined with traffic loads.

APPENDIX B

INSPECTION PHOTOGRAPHS

A01EM-01. Overview.

A01EM-01. Corner Spalling (Sample Unit No. 16).

A01EM-02. Overview.

R13EM-01. Overview

R13EM-01. LTD Cracking (Additional Sample Unit No. 03).

T01EM-01. Overview.

T01EM-01. LTD Cracking (Sample Unit No. 02).

APPENDIX C

INSPECTION REPORT

Re-inspection Report

IA2015
Report Generated Date: March 31, 2016

Network: EGQ Name: EMMETSBURG MUNICIPAL AIRPORT

Branch: A01EM Name: APRON AT EMMETSBURG Use: APRON Area: 62,629.00SqFt

Section: 01 of 2 From: HANGERS To: TAXIWAY 01 Last Const.: 06/02/2006
Surface: PCC Family: IowaPCCAPNC Zone: Category: Rank: P
Area: 52,486.00SqFt Length: 300.00Ft Width: 170.00Ft
Slabs: 379 Slab Width: 11.21Ft Slab Length: 12.34Ft Joint Length: 8,212.41Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0

Section Comments:

Last Insp. Date: 11/07/2015 Total Samples: 22 Surveyed: 4
Conditions: PCI : 91
Inspection Comments:

Sample Number: 07 Type: R Area: 16.00Slabs PCI = 88
Sample Comments:

75 CORNER SPALLING	M	1.00 Slabs	Comments:
65 JOINT SEAL DAMAGE	M	16.00 Slabs	Comments:

Sample Number: 08 Type: R Area: 20.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	20.00 Slabs	Comments:

Sample Number: 16 Type: R Area: 20.00Slabs PCI = 85
Sample Comments:

65 JOINT SEAL DAMAGE	M	20.00 Slabs	Comments:
75 CORNER SPALLING	M	1.00 Slabs	Comments:
74 JOINT SPALLING	M	1.00 Slabs	Comments:

Sample Number: 21 Type: R Area: 22.00Slabs PCI = 98
Sample Comments:

65 JOINT SEAL DAMAGE	L	22.00 Slabs	Comments:

Re-inspection Report

IA2015
Report Generated Date: March 31, 2016

Network: EGQ Name: EMMETSBURG MUNICIPAL AIRPORT

Branch: A01EM Name: APRON AT EMMETSBURG Use: APRON Area: 62,629.00SqFt

Section: 02 of 2 From: SEE MAP To: SEE MAP Last Const.: 05/03/2014
Surface: PCC Family: IowaPCCAPNC Zone: Category: Rank: P
Area: 10,143.00SqFt Length: 100.00Ft Width: 100.00Ft
Slabs: 111 Slab Width: 10.00Ft Slab Length: 10.00Ft Joint Length: 1,800.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0

Section Comments:

Last Insp. Date: 11/07/2015 Total Samples: 6 Surveyed: 2
Conditions: PCI : 100
Inspection Comments:

Sample Number: 02 Type: R Area: 20.00Slabs PCI = 100
Sample Comments:
<NO DISTRESSES>

Sample Number: 03 Type: R Area: 20.00Slabs PCI = 100
Sample Comments:
<NO DISTRESSES>

Re-inspection Report

IA2015
Report Generated Date: March 31, 2016

Network: EGQ Name: EMMETSBURG MUNICIPAL AIRPORT

Branch: R13EM Name: RUNWAY 13/31 EMMETSBURG Use: RUNWAY Area: 215,834.00SqFt

Section: 01 of 1 From: RUNWAY END 13 To: RUNWAY SECT 02 Last Const.: 10/01/2005
Surface: PCC Family: IowaPCCRWNC Zone: Category: Rank: P
Area: 215,834.00SqFt Length: 3,401.00Ft Width: 60.00Ft
Slabs: 2,158 Slab Width: 10.00Ft Slab Length: 10.00Ft Joint Length: 37,351.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0

Section Comments:

Last Insp. Date: 11/07/2015 Total Samples: 91 Surveyed: 10
Conditions: PCI : 92
Inspection Comments:

Sample Number: 03 Type: A Area: 24.00Slabs PCI = 75
Sample Comments:

74 JOINT SPALLING	L	4.00 Slabs	Comments:
75 CORNER SPALLING	L	1.00 Slabs	Comments:
62 CORNER BREAK	L	1.00 Slabs	Comments:
63 LINEAR CRACKING	M	1.00 Slabs	Comments:
65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 12 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 22 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 32 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 42 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 52 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 62 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:

Sample Number: 63 Type: A Area: 24.00Slabs PCI = 88
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:
63 LINEAR CRACKING	L	2.00 Slabs	Comments:

Sample Number: 72 Type: R Area: 24.00Slabs PCI = 86
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:
75 CORNER SPALLING	M	1.00 Slabs	Comments:
74 JOINT SPALLING	M	1.00 Slabs	Comments:

Re-inspection Report

IA2015
Report Generated Date: March 31, 2016

Sample Number: 82 Type: R Area: 24.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	24.00 Slabs	Comments:	

Re-inspection Report

IA2015
Report Generated Date: March 31, 2016

Network: EGQ Name: EMMETSBURG MUNICIPAL AIRPORT

Branch: T01EM Name: TAXIWAY 01 AT EMMETSBURG Use: TAXIWAY Area: 23,304.00SqFt

Section: 01 of 1 From: APRON 01 SECT 01 To: RUNWAY END 31 Last Const.: 06/02/2006
Surface: PCC Family: IowaPCCTWNC Zone: Category: Rank: P
Area: 23,304.00SqFt Length: 547.00Ft Width: 35.00Ft
Slabs: 228 Slab Width: 8.75Ft Slab Length: 11.67Ft Joint Length: 3,246.53Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0

Section Comments:

Last Insp. Date: 11/07/2015 Total Samples: 8 Surveyed: 2
Conditions: PCI : 90
Inspection Comments:

Sample Number: 02 Type: R Area: 28.00Slabs PCI = 87
Sample Comments:

63 LINEAR CRACKING	L	4.00 Slabs	Comments:
65 JOINT SEAL DAMAGE	L	28.00 Slabs	Comments:

Sample Number: 06 Type: R Area: 28.00Slabs PCI = 93
Sample Comments:

65 JOINT SEAL DAMAGE	M	28.00 Slabs	Comments:

APPENDIX D

WORK HISTORY REPORT

Work History Report

Pavement Database:IA2015

Network: EGQ **Branch**: A01EM (APRON AT EMMETSBURG) **Section:** 01 **Surface:** PCC
L.C.D.: 06/02/2006 **Use:** APRON **Rank** P **Length:** 300.00 Ft **Width:** 170.00 Ft **True Area:** 52,486.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2006	CR-PC	Complete Reconstruction - PC	$0	6.00	True	
06/01/2006	BA-AG	Base Course - Aggregate	$0	13.00	False	PULVERIZED BASE
07/15/1978	NC-AC	New Construction - AC			True	

Network: EGQ **Branch**: A01EM (APRON AT EMMETSBURG) **Section:** 02 **Surface:** PCC
L.C.D.: 05/03/2014 **Use:** APRON **Rank** P **Length:** 100.00 Ft **Width:** 100.00 Ft **True Area:** 10,143.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
05/03/2014	NC-PC	New Construction - PCC	$0	6.00	True	6" PCC
05/02/2014	SB-AG	Subbase - Aggregate	$0	6.00	False	6" MODIFIED GRANULAR SUBBASE
05/01/2014	SG-CO	Subgrade - Compacted	$0	12.00	False	12" COMPACTED SUBGRADE

Network: EGQ **Branch**: R13EM (RUNWAY 13/31 EMMETSBURG) **Section:** 01 **Surface:** PCC
L.C.D.: 10/01/2005 **Use:** RUNWAY **Rank** P **Length:** 3,401.00 Ft **Width:** 60.00 Ft **True Area:** 215,834.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
10/01/2005	CR-PC	Complete Reconstruction - PC			True	
08/01/1984	NC-AC	New Construction - AC			True	

Network: EGQ **Branch**: T01EM (TAXIWAY 01 AT EMMETSBURG) **Section:** 01 **Surface:** PCC
L.C.D.: 06/02/2006 **Use:** TAXIWAY **Rank** P **Length:** 547.00 Ft **Width:** 35.00 Ft **True Area:** 23,304.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2006	CR-PC	Complete Reconstruction - PC	$0	6.00	True	
06/01/2006	BA-AG	Base Course - Aggregate	$0	13.00	False	PULVERIZED BASE
07/15/1978	NC-AC	New Construction - AC			True	

Summary:

Work Description	Section Count	Area Total (SqFt)	Thickness Avg (in)	Thickness STD (in)
Base Course - Aggregate	2	75,790.00	13.00	.00
Complete Reconstruction - PCC	2	75,790.00	6.00	.00
Complete Reconstruction - PCC	1	215,834.00		
New Construction - AC	3	291,624.00		
New Construction - PCC	1	10,143.00	6.00	
Subbase - Aggregate	1	10,143.00	6.00	
Subgrade - Compacted	1	10,143.00	12.00	

APPENDIX E

LOCALIZED PREVENTATIVE MAINTENANCE POLICIES AND UNIT COST TABLES

Table E-1. Localized preventive maintenance policy, asphalt-surfaced pavements.

Distress Type	Severity Level	Maintenance Action
Alligator Cracking	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Bleeding	N/A	Monitor
Block Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Corrugation	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Depression	Low	Monitor
	Medium	Monitor
	High	AC Patch
Jet Blast Erosion	N/A	AC Patch
Joint Reflection Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
L&T Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Oil Spill Damage	N/A	AC Patch
Patching	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Polished Aggregate	N/A	Monitor
Raveling	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Rutting	Low	Monitor
	Medium	Monitor
	High	AC Patch
Shoving	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Slippage Cracking	N/A	AC Patch
Swelling	Low	Monitor
	Medium	Monitor
	High	AC Patch
Weathering	Low	Monitor
	Medium	Monitor
	High	AC Patch

Table E-2. Localized preventive maintenance policy, PCC pavements.

Distress Type	Severity Level	Maintenance Action
ASR	Low	Monitor
	Medium	Slab Replacement
	High	Slab Replacement
Blow-Up	Low	Slab Replacement
	Medium	Slab Replacement
	High	Slab Replacement
Corner Break	Low	Crack Seal
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Durability Cracking	Low	Monitor
	Medium	Full Depth Patch
	High	Slab Replacement
Joint Seal Damage	Low	Monitor
	Medium	Joint Seal
	High	Joint Seal
LTD Cracking	Low	Monitor
	Medium	Crack Seal
	High	Slab Replacement
Patching (Small and Large)	Low	Monitor
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Popouts	N/A	Monitor
Pumping	N/A	Monitor
Scaling	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Slab Replacement
Settlement	Low	Monitor
	Medium	Grinding
	High	Slab Replacement
Shattered Slab	Low	Crack Seal
	Medium	Slab Replacement
	High	Slab Replacement
Shrinkage Cracking	N/A	Monitor
Spalling (Joint and Corner)	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Partial Depth PCC Patch

Table E-3. 2015 unit costs for preventive maintenance actions.

Maintenance Action	Unit Cost
AC Patch – Asphalt-Surfaced Pavement	$13.39/sf
Crack Sealing – Asphalt-Surfaced Pavement	$2.29/lf
Partial Depth PCC Patch – PCC Pavement	$34.28/sf
Full Depth PCC Patch – PCC Pavement	$15.31/sf
Crack Sealing – PCC Pavement	$2.75/lf
Joint Resealing – PCC Pavement	$2.75/lf
Grinding – PCC Pavement	$0.33/sf
Slab Replacement – PCC Pavement	$15.31/sf

Table E-4. 2015 unit costs (per square foot) based on PCI Ranges.

Pavement Type	PCI Range										
	0	10	20	30	40	50	60	70	80	90	100
Asphalt-Surfaced	$9.51	$9.51	$9.51	$9.51	$9.51	$4.50	$4.50	$4.50	$0.00	$0.00	$0.00
PCC	$15.87	$15.87	$15.87	$15.87	$15.87	$7.50	$7.50	$7.50	$0.00	$0.00	$0.00

APPENDIX F

YEAR 2016 LOCALIZED PREVENTIVE MAINTENANCE DETAILS

Table F-1. Year 2016 localized preventive maintenance details.

Branch[1]	Section[1]	Distress Type[2]	Severity	Distress Quantity	Unit	Maintenance Action	Unit Cost	Estimated Cost[3]
A01EM	01	Corner Spalling	Medium	10	Slabs	Patching - PCC Partial Depth	$34.28	$896
		Joint Spalling	Medium	5	Slabs	Patching - PCC Partial Depth	$34.28	$1,076
		Joint Seal Damage	Medium	272	Slabs	Joint Seal	$2.75	$16,214
R13EM	01	Corner Break	Low	1	Slabs	Crack Sealing - PCC	$2.75	$23
		Corner Spalling	Medium	11	Slabs	Patching - PCC Partial Depth	$34.28	$1,014
		Joint Spalling	Medium	11	Slabs	Patching - PCC Partial Depth	$34.28	$2,433
		Joint Seal Damage	Medium	2,158	Slabs	Joint Seal	$2.75	$102,715
		LTD Cracking	Medium	1	Slabs	Crack Sealing - PCC	$2.75	$28
T01EM	01	Joint Seal Damage	Medium	114	Slabs	Joint Seal	$2.75	$4,464

[1]See Figure 3 for the location of the branch and section.

[2]L&T Cracking = Longitudinal and Transverse Cracking; LTD Cracking = Longitudinal, Transverse, and Diagonal Cracking; ASR = Alkali-Silica Reaction.

[3]Cost estimates are shown in 2016 dollar amounts. These estimates are based on broad statewide numbers and should be adjusted to reflect local costs.

Iowa Department of Transportation
Office of Aviation
800 Lincoln Way
Ames, IA 50010
Ph: (515) 239-1691
www.iowadot.gov/aviation

Applied Pavement Technology, Inc.
115 W. Main Street, Suite 400
Urbana, IL 61801
Ph: (217) 398-3977
Fax: (217) 398-4027
www.appliedpavement.com

Robinson Engineering Company
322 1st Street East
Independence, IA 50644
Ph: (319) 334-7211
www.robinsoneng-ia.com