Arizona Airport Pavement Management System Update
2010 Executive Summary

applied pavement
TECHNOLOGY

providing engineering solutions to improve pavement performance

Acknowledgement

This document was prepared under the auspices of:

ARIZONA DEPARTMENT OF TRANSPORTATION
John S. Halikowski, Director

MULTIMODAL PLANNING DIVISION
Jennifer Toth, P.E., Assistant Director

AERONAUTICS GROUP
ARIZONA STATEWIDE PAVEMENT MANAGEMENT PROGRAM
Holly Hawkins, P.E., State Airport Engineer

FEDERAL AVIATION ADMINISTRATION (FAA)
Mark McClardy, Division Manager
Western Pacific Region, Airports Division

Prepared By:
Applied Pavement Technology, Inc.
115 West Main Street, Suite 400
Urbana, Illinois 61801
217-398-3977
www.appliedpavement.com

In Association With:

Z&H Engineering, Inc.
9200 E. Pima Center Parkway
Suite 240
Scottsdale, Arizona 85258
602-997-7536

Gutierrez Civil Solutions, LLC
4309 W. Saint Kateri Drive
Laveen, Arizona 85339
602-441-4567

BACKGROUND

Pavements represent one of the largest capital investments in Arizona's aviation system. Timely airport pavement maintenance and rehabilitation are crucial because repairs are much more costly once the condition deteriorates below a certain level. Additionally, airport pavement weaknesses, such as cracks and loose debris, pose a significant safety risk to aircraft.

Recognizing a need to protect this critical investment, the Arizona Department of Transportation (ADOT) – Multimodal Planning Division (MPD) established a statewide airport pavement management system (APMS) in 2000 to monitor the condition of the Arizona airport infrastructure and to proactively plan for its preservation. The ultimate goal of this project was to provide the airports, ADOT, and the Federal Aviation Administration (FAA) with the pavement information and analytical tools that could help them identify pavement-related needs, optimize the selection of projects and treatments over a multi-year period, and evaluate the long-term impacts of their project priorities. This project also provides the airports with an excellent basis for satisfying the requirements of Public Law 103-305.

Applied Pavement Technology, Inc. (APTech), with assistance from Z&H Engineering, Inc. (Z&H) and Gutierrez Civil Solutions, LLC, conducted an update to the APMS in 2010. This report describes the findings and recommendations of the APMS update.

BENEFITS OF THE AIRPORT PAVEMENT MANAGEMENT SYSTEM

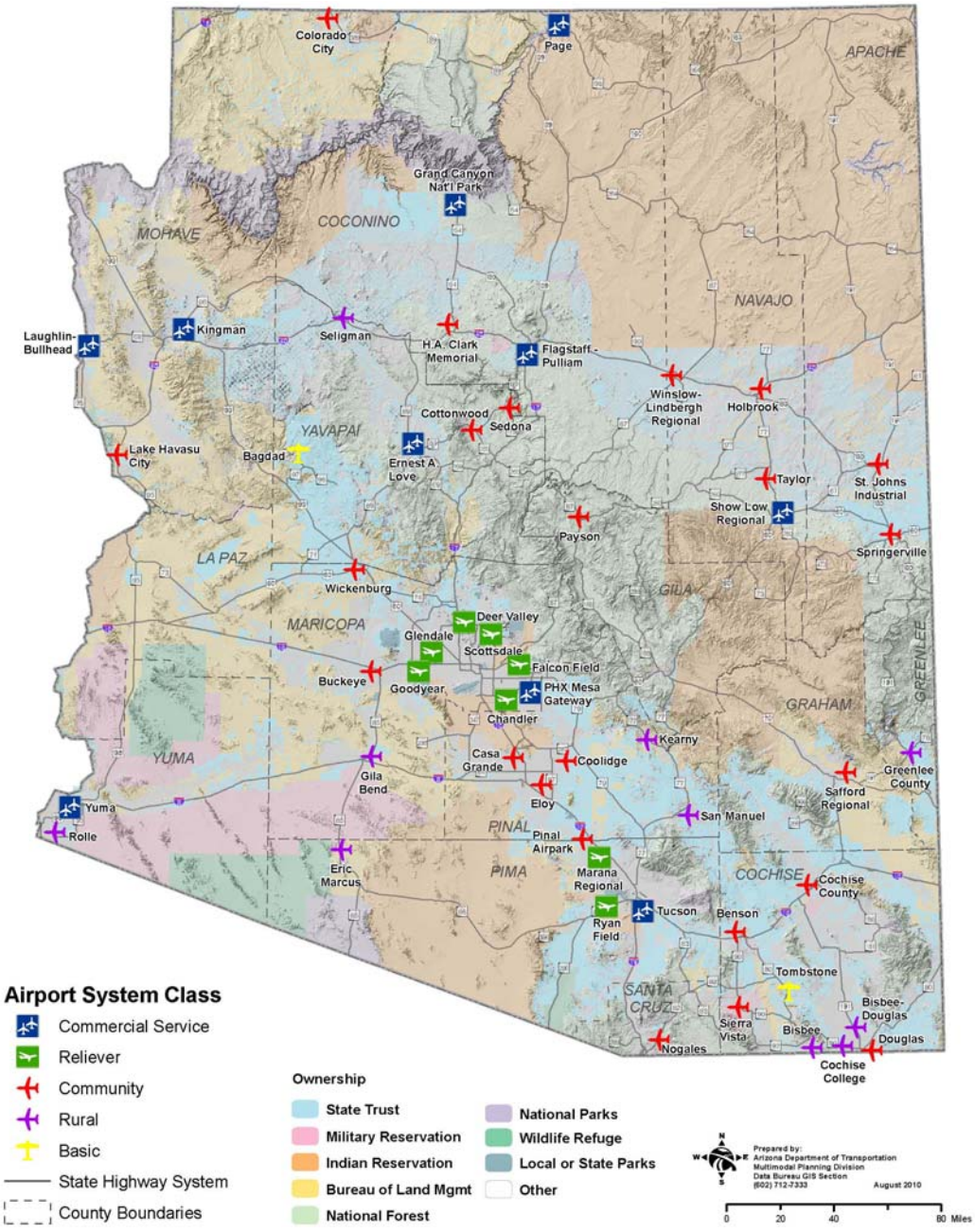
ADOT's APMS yields many benefits. It provides ADOT, the individual airports, and the FAA with the information needed to monitor the condition of the pavements. The APMS is also a tool that can be used to make cost-effective decisions about the maintenance and rehabilitation of the pavement infrastructure while understanding the long-term impacts of the decisions being made. Further, the APMS provides the data needed to identify and prioritize projects for inclusion in ADOT's Airport Pavement Preservation Program (APPP).

The APMS also identifies when different pavement strategies would be most appropriate. The timing of work is important because routine maintenance and pavement preservation actions, such as surface treatments, can extend the life of a pavement in a very cost-effective manner. Once pavement preservation is no longer the appropriate repair, it is critical to step in with major rehabilitation, such as an overlay, as soon as possible. At some point, the pavement structure will become so degraded that the only viable alternative is very costly reconstruction. The financial impact of delaying repairs beyond this point can be severe, as reconstruction can cost many times the cost of an overlay.

Project Airports

In 2010, the pavement conditions at fifty-three airports were assessed and the Arizona APMS database was updated with the information. APTech evaluated forty-nine of these airports as part of the project, and pavement condition data collected as part of independent projects for the remaining four airports (Tucson International Airport, Pinal Airpark, Phoenix Deer Valley Airport, and Phoenix Goodyear Airport) were incorporated into the state APMS database. Data for Phoenix Sky Harbor International Airport were not available upon completion of this project and therefore not incorporated into this study.

These airports represent 140.3 million square feet of pavement—the equivalent of a two-lane highway stretching from Phoenix to Seattle, Washington. This can be further broken down into 44.3 million square feet of runway pavement, 44.5 million square feet of taxiway and T-Hangar pavement, and 51.5 million square feet of apron/helipad pavement. The following figure identifies the airports included in the 2010 APMS update.



Pavement Condition Assessment

The pavements were evaluated using the pavement condition index (PCI) procedure, documented in FAA Advisory Circular (AC) 150/5380-6B, *Guidelines and Procedures for Maintenance of Airport Pavements*, and ASTM Standard D5340, *Standard Test Method for Airport Pavement Condition Index Surveys*. During a PCI survey, the types, severities, and amounts of distress present in a pavement surface 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 number is a measure of overall condition and is indicative of the level of work that will be required to maintain or repair a pavement. Further, the distress information provides insight into what is causing the pavement to deteriorate, which is the first step in selecting the appropriate repair action.

Programmed into an APMS, PCI data are used to determine current pavement condition, predict future pavement condition, determine when pavement preservation actions are advisable, identify the most cost-effective time to perform major rehabilitation, and develop the Arizona APPP. The relationship between a pavement's PCI value and the typical type of repair recommended for the pavement is shown in the figure below. Routine maintenance refers to activities such as patching or periodic crack sealing and joint resealing; pavement preservation includes thin overlays or surface treatments with crack sealing; major rehabilitation consists of thick overlays or reconstructions.

	PCI
ROUTINE MAINTENANCE	86 - 100
PAVEMENT PRESERVATION	56-85
MAJOR REHABILITATION	0 - 55

PCI	REPRESENTATIVE PAVEMENT SURFACE	REPAIR ALTERNATIVE
90		Pavements with PCIs above 85 will benefit from routine maintenance actions, such as periodic crack sealing, periodic joint resealing, or patching.
65		Pavements with a PCI of 56 (65 for PCC pavements) to 85 may require pavement preservation, such as a surface treatment, thin overlay, or PCC joint resealing.
25		Pavement allowed to deteriorate below a PCI of 55 (65 for PCC) will require costly reconstruction to restore it to operational condition.

TYPICAL DISTRESS TYPES AT ARIZONA AIRPORTS

Following is a description of the most commonly observed pavement distresses at Arizona airports. With the exception of spalling, these distresses occur in asphalt surfaced pavements which constitute a majority of the pavements in Arizona's airport infrastructure.

LONGITUDINAL AND TRANSVERSE CRACKING

The predominant distress type found on asphalt pavements at Arizona 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 existing cracking in overlaid pavements.

BLOCK CRACKING

Block cracking generally appears over relatively large areas as a series of L&T cracks arranged in a pattern of square or rectangular blocks. It is caused by shrinkage of the asphalt pavement over time and the repeated deformation caused by daily temperature cycles. It is not a load-related distress, and its occurrence usually indicates that the pavement has significantly hardened (oxidized).

RAVELING AND WEATHERING

As asphalt pavement ages and hardens, the asphalt binder and aggregate can begin to wear away. This process is called weathering and raveling. The wearing away of asphalt cement, or binder, is called weathering. Raveling occurs as the aggregate begins to dislodge and produce loose pieces of material, posing a safety hazard as it may be ingested by aircraft engines.

ALLIGATOR (FATIGUE) CRACKING

Alligator (fatigue) cracking is a load-related distress. Alligator cracking is 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.

DEPRESSION

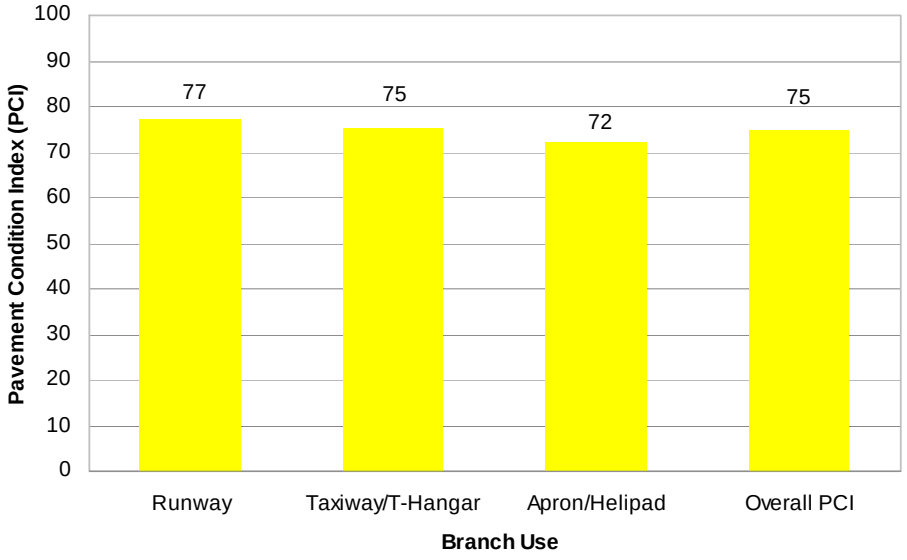
Depressions are pavement surface areas having elevations slightly lower than those of the surrounding pavement. Depressions can be caused by settlement of the underlying base layers or soils. Depressions are often found in areas where insufficient drainage capacity exists and soils are weakened due to water penetration, or where underlying layers were not compacted enough during construction. Additionally, depressions can be built in during construction.

SPALLING

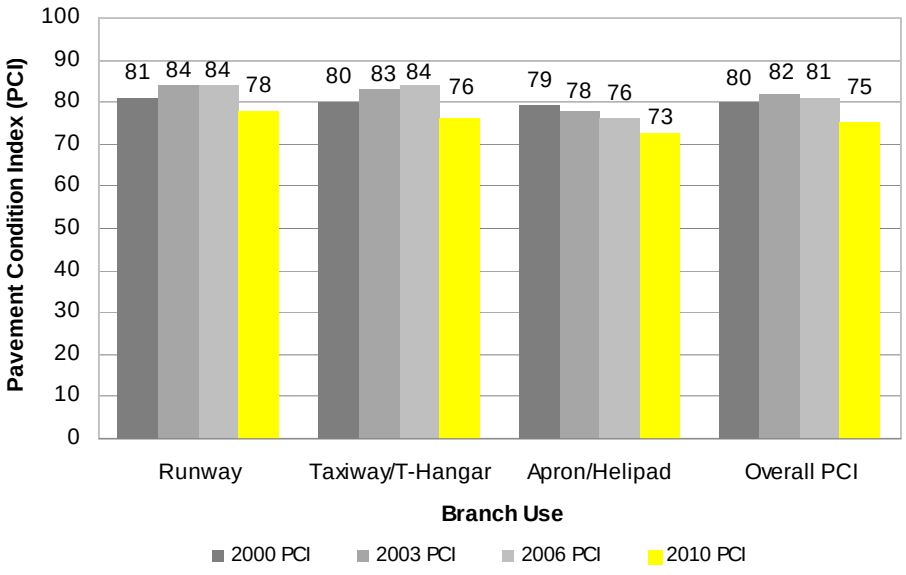
Spalling, in portland cement concrete (PCC) pavement, is the breakdown of the slab edges in close proximity to the slab joint. Spalling is identified as occurring in the corner or along the joint of a PCC slab. Spalling is typically caused by the introduction of incompressible material in the joint, weaker pavement at the joint caused by overworking of the pavement during construction, traffic loading, or a combination of these.

OVERALL PAVEMENT CONDITION

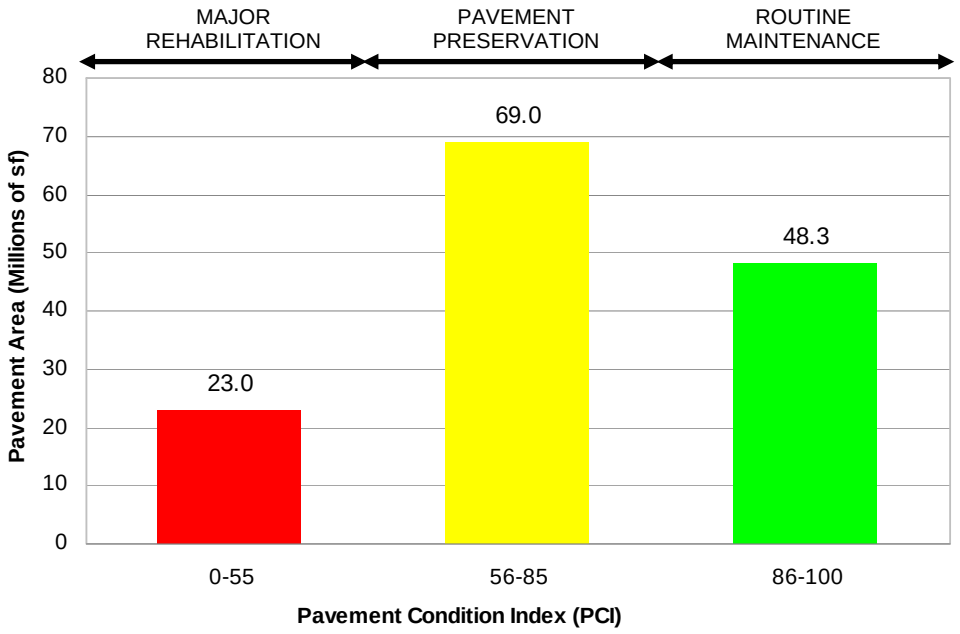
The overall 2010 area-weighted condition of the fifty-three airports included in the Arizona APMS is a PCI of 75. The figure below shows the 2010 condition of the pavement broken out by pavement use (runway, taxiway/T-Hangar, and apron/helipad).

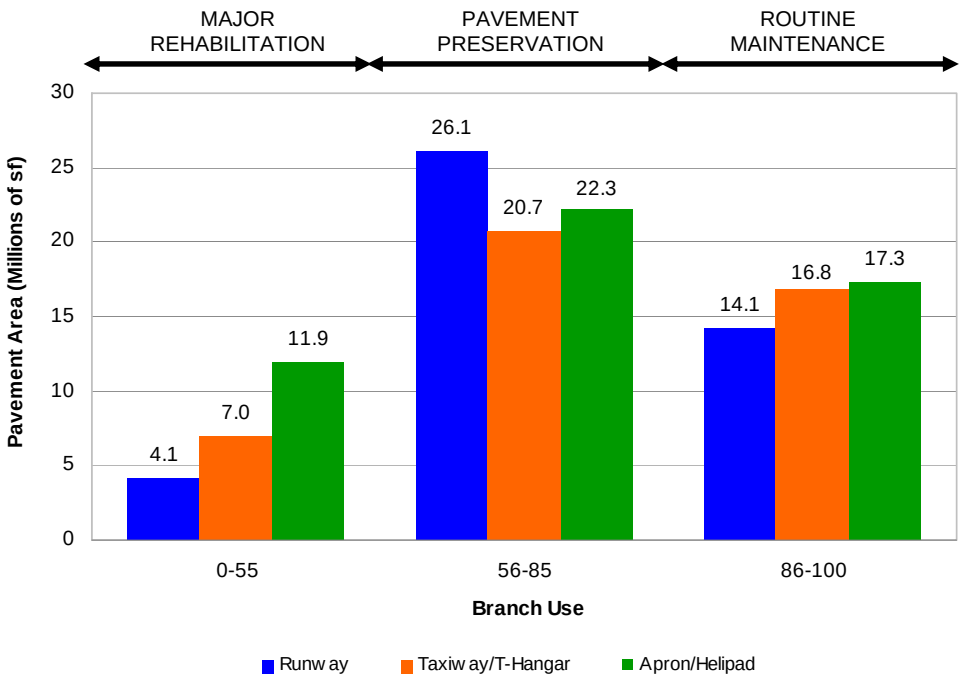


The past conditions (excluding Tucson International Airport which was not incorporated into the database during the 2006 study) are shown in the figure below. It is important to note when reviewing this graph that the 2000 PCI value represents the condition of the pavements prior to the implementation of the APPP. The 2003 and 2006 values represent conditions when the APPP was funded and very active. The 2010 PCI value shows the impact of no funding for the APPP during the past 3 years. This figure dramatically illustrates the importance of the APPP and its significant impact on the condition of the airport pavements in Arizona.



The following figures show, in general, what types of work should be performed on the Arizona airport pavements depending on their condition. A further breakdown of this information reveals that approximately 34.4 percent of the pavement area would benefit from routine maintenance, approximately 49.2 percent would benefit from pavement preservation activities, and approximately 16.4 percent has deteriorated to the point where major rehabilitation is needed.





The APMS is used to identify projects for inclusion in the APPP, subject to budgetary and operational constraints. The APPP was prepared for 8 years (2011-2018) with an inflation rate of 4 percent applied to identify the future cost of work. Tucson International Airport and Phoenix Sky Harbor International Airport were not included in the APPP since they fund their own pavement maintenance management programs.

PAVEMENT PRESERVATION GUIDELINES

For each year of the analysis, the future conditions of the pavements were estimated, and the pavement sections that would benefit from pavement preservation work were identified. Five treatment options were identified by ADOT for consideration in its APPP: 1) crack seal and rubberized asphalt emulsion seal coat, 2) crack seal and slurry seal, 3) thin rubberized asphalt overlay or porous friction course (PFC), 4) mill and replace PFC, and 5) PCC joint resealing and spall repairs.

PAVEMENT PRESERVATION NEEDS

If all projects identified as eligible for the APPP were funded, approximately $141.5 million would be needed over the next 8 years. The APPP budget needs through 2018 for each airport (under an unlimited funding scenario) are summarized in the table presented on the following two pages.

Since state aviation fund dollars are limited, it is not possible for ADOT to fund all the projects identified as being eligible for the APPP; therefore, annual budget values of $3.8 million in 2011, $4.6 million in 2012, $5.5 million in 2013 and 2014, and $5.6 million annually for years 2015 through 2018 were used to run a constrained budget analysis. Projects were prioritized using ADOT's Pavement Priority Rating Number (PPRN) system which is based on pavement use and condition. Additional limitations were placed on the prioritized pavements and the resulting constrained budget APPP is presented in the statewide report.

Pavements with a PCI value falling below 55 for asphalt-surfaced pavements and 65 for PCC pavements were not eligible for the APPP and instead have been identified as requiring major rehabilitation. These pavements are listed in the table presented on pages 11 through 14. Pavements at Tucson International Airport and Phoenix Sky Harbor International Airport were excluded from this list.

In addition to pavement maintenance and rehabilitation projects, it is estimated that 177 pavement sections need paint remarking which is estimated to cost approximately $6.5 million. No paint remarking recommendations were made for Tucson International, Phoenix Deer Valley, or Phoenix Goodyear Airports since data for these airports were obtained from independent pavement management projects that did not include the evaluation of paint conditions.

APPP Under Unlimited Funding Through 2018

Airport Name	Associated City	Airport Classification	APPP under unlimited annual budget (2011-2018)
Bagdad Airport	Bagdad	GA Basic	$373,259
Benson Municipal Airport	Benson	GA Community	$1,136,695
Bisbee Douglas International Airport	Douglas/Bisbee	GA Rural	$1,396,568
Bisbee Municipal Airport	Bisbee	GA Rural	$663,454
Buckeye Municipal Airport	Buckeye	GA Community	$2,149,882
Casa Grande Municipal Airport	Casa Grande	GA Community	$3,732,286
Chandler Municipal Airport	Chandler	Reliever	$6,814,482
Cochise College Airport	Douglas	GA Rural	$0
Cochise County Airport	Willcox	GA Community	$1,233,820
Colorado City Municipal Airport	Colorado City	GA Community	$1,844,842
Coolidge Municipal Airport	Coolidge	GA Community	$2,427,049
Cottonwood Airport	Cottonwood	GA Community	$1,443,656
Douglas Municipal Airport	Douglas	GA Community	$1,354,315
Eloy Municipal Airport	Eloy	GA Community	$1,324,003
Eric Marcus Municipal Airport	Ajo	GA Rural	$493,845
Ernest A. Love Field Airport	Prescott	Commercial Service	$9,565,401
Falcon Field Airport	Mesa	Reliever	$7,780,984
Flagstaff Pulliam Airport	Flagstaff	Commercial Service	$3,091,616
Gila Bend Municipal Airport	Gila Bend	GA Rural	$1,548,126
Glendale Municipal Airport	Glendale	Reliever	$3,394,710
Grand Canyon National Park Airport	Grand Canyon	Commercial Service	$4,527,987
Greenlee County Airport	Clifton/Morenci	GA Rural	$1,048,279
H.A. Clark Memorial Field Airport	Williams	GA Community	$1,752,571
Holbrook Municipal Airport	Holbrook	GA Community	$1,820,736
Kearny Airport	Kearny	GA Rural	$95,038
Kingman Airport	Kingman	Commercial Service	$4,820,368
Lake Havasu City Airport	Lake Havasu City	GA Community	$6,121,386

APPP Under Unlimited Funding Through 2018

Airport Name	Associated City	Airport Classification	APPP under unlimited annual budget (2011-2018)
Laughlin/Bullhead International Airport	Bullhead City	Commercial Service	$4,327,561
Marana Regional Airport	Tucson	Reliever	$6,580,140
Nogales International Airport	Nogales	GA Community	$1,631,841
Page Municipal Airport	Page	Commercial Service	$3,264,334
Payson Airport	Payson	GA Community	$2,225,612
Phoenix-Mesa Gateway Airport	Phoenix	Commercial Service	$3,292,012
Phoenix Deer Valley Airport*	Phoenix*	Reliever	$10,606,822
Phoenix Goodyear Airport*	Goodyear*	Reliever	$4,736,457
Pinal Airpark*	Marana*	GA Community	$671,556
Rolle Airfield	San Luis	GA Rural	$474
Ryan Field Airport	Tucson	Reliever	$3,637,730
Safford Regional Airport	Safford	GA Community	$3,310,035
San Manuel Airport	San Manuel	GA Rural	$652,848
Scottsdale Airport	Scottsdale	Reliever	$6,769,939
Sedona Airport	Sedona	GA Community	$2,265,994
Seligman Airport	Seligman	GA Rural	$1,120,141
Show Low Regional Airport	Show Low	Commercial Service	$2,768,957
Sierra Vista Municipal Airport – Libby AAF	Sierra Vista	GA Community	$699,592
Springerville Municipal Airport	Springerville	GA Community	$2,072,003
St Johns Industrial Air Park	St Johns	GA Community	$1,108,630
Taylor Airport	Taylor	GA Community	$1,229,594
Tombstone Municipal Airport	Tombstone	GA Basic	$353,456
Wickenburg Municipal Airport	Wickenburg	GA Community	$1,607,121
Winslow – Lindbergh Regional Airport	Winslow	GA Community	$2,985,309
Yuma MCAS/Yuma International Airport	Yuma	Commercial Service	$1,650,388

*Pinal Airpark, Phoenix Deer Valley, and Phoenix Goodyear Airports information was obtained from existing APMS databases.

Sections Requiring Major Rehabilitation

Year	Project Airport	Branch	Section(s)	Area (sf)
2011	Bagdad Airport	A02BG	10	8,964
	Bisbee Douglas International Airport	A01BD	10	317,361
			20	379,677
		TH01BD	10	22,715
		TWA1BD	10	218,201
	Bisbee Municipal Airport	TWABM	10	206,091
	Buckeye Municipal Airport	A02BK	10	117,882
		TWHBK	10	272,982
	Casa Grande Municipal Airport	TWBCG	10	99,819
	Cochise College Airport	A01CC	10	171,762
			20	115,132
		RW523CC	10	416,992
		TWACC	10	131,725
	Colorado City Municipal Airport	TH01CL	10	46,420
	Coolidge Municipal Airport	A01CM	10	440,229
		TWBCM	10	112,726
	Douglas Municipal Airport	RW321DM	10	452,980
	Eloy Municipal Airport	TH01EM	10	49,379
	Eric Marcus Municipal Airport	A01AJ	10	741,473
	Ernest A. Love Field Airport	ATANKERPR	10	91,696
	Falcon Field Airport	TH01MF	10	1,797,772
	Flagstaff Pulliam Airport	A03FG	10	76,679
		TH01FG	10	337,343
	Glendale Municipal Airport	A01GL	20	1,416,239
		HP01GL	10	4,356
	Grand Canyon National Park Airport	HP01GC	10	2,000
	Greenlee County Airport	A01GR	10	67,407
	H.A. Clark Memorial Field Airport	A01WI	20	84,396
	Kearny Airport	RW826KE	10	242,242
	Kingman Airport	A01KG	40	447,282
			50	229,414
			60	693,556
		TWCKG	02	2,329
			10	229,020
		TWDKG	10	695,631

Sections Requiring Major Rehabilitation

Year	Project Airport	Branch	Section(s)	Area (sf)
2011	Laughlin/Bullhead International Airport	ATERMLB	10	103,861
	Marana Regional Airport	A01AV	10	530,880
	Nogales International Airport	A01NG	20	20,000
	Page Municipal Airport	A01PM	20	404,013
	Phoenix - Mesa Gateway Airport	AHOLD30CWG	10	87,754
		AMIDWG	10	177,940
		ANORTHWG	30	51,937
			40	26,000
			50	388,522
			60	11,887
		ASOUTHWG	10	52,732
		RW12C30CWG	40	150,001
		RW12R30LWG	10	150,000
			60	149,982
		TWAWG	70	80,625
		TWGWG	110	49,584
			130	52,046
			140	35,187
			150	122,083
		TWKWG	40	20,244
			60	20,255
			70	37,860
			100	34,332
		TWPWG	20	154,492
		TWVWG	20	4,687
			40	4,687
			50	41,485
			80	34,640
	Phoenix Deer Valley Airport*	ASR	04-05, 07-09, 11, 19	863,927
		ATB03HOLD	01	13,849
		R07L	02-03, 05	90,000
		TA	02, 04-08	194,861
		TA03	01	15,790
		TA04	01	7,648
		TA05	01-04	6,360

Sections Requiring Major Rehabilitation

Year	Project Airport	Branch	Section(s)	Area (sf)
2011	Phoenix Deer Valley Airport*	TA09	03-04	7,678
		TA10	02-04	9,378
		TA11	01-03	10,558
		TA12	01	29,106
		TANW1	01	3,278
		TB	01-03, 05	207,173
		TB03	01-02	32,480
		TB05	02-04	20,200
		TB09	01-03	27,171
		TB11	01-03	25,047
	Phoenix Goodyear Airport*	ATERM	01-02, 05, 07-09, 14-16, 18-27	1,387,205
		R03	07b, 08b, 09b, 10b	124,217
		TA2	03	25,625
		TA5	02	14,451
		TA6	02	14,542
		TTHGRS	01	16,209
	Pinal Airpark*	A01PA	10	1,511,819
		RW1230PA	10	1,026,629
		TWAPA	20	150,685
	Rolle Airfield	RW1735RL	10	190,673
	Ryan Field Airport	AWINGRY	10	89,217
		TWDRY	30	49,197
	Safford Regional Airport	HP01SF	10	5,293
	Sedona Airport	TH01SD	20	39,978
	Show Low Regional Airport	TH01SL	10	3,653
		TWBSL	10	58,645
	St. Johns Industrial Air Park	A01SJ	10	140,699
		TWASJ	10	246,548
	Winslow - Lindbergh Regional Airport	A01WN	10	146,954
		RW1129WN	10	1,155,000
		TWBWN	10	343,693
		TWDWN	10	36,035
			20	19,104
	Yuma MCAS/Yuma International Airport	A02YM	10	669,825

Sections Requiring Major Rehabilitation

Year	Project Airport	Branch	Section(s)	Area (sf)
2011	Yuma MCAS/Yuma International Airport	ADCCYM	20	335,892
		ATERMYM	10	229,462
		TH01YM	20	8,127
		TWZYM	10	311,222
2012	Phoenix - Mesa Gateway Airport	ANORTHWG	10	206,440
2013	Kingman Airport	A01KG	30	305,904
	Phoenix - Mesa Gateway Airport	TWHWG	30	34,570
2015	Cochise County Airport	A01CO	10	19,738
2017	Nogales International Airport	A02NG	10	49,796
2018	Casa Grande Municipal Airport	HP02CG	10	4,800
	Phoenix Goodyear Airport*	TA	01	27,940
	Yuma MCAS/Yuma International Airport	ADCCYM	30	7,800

*Pinal Airpark, Phoenix Deer Valley, and Phoenix Goodyear Airports information was obtained from existing APMS databases.

IN SUMMARY

- Fifty-three airports are included in the Arizona APMS; forty-nine airports were evaluated in 2010 as part of this project, and four airports were evaluated as part of independent projects and the data incorporated into the state APMS database.
- The condition of the airport system has dropped significantly since 2006. At that time the area-weighted PCI of the system was 81. The pavement system now has an area-weighted PCI of 75 (excluding Tucson International Airport and Phoenix Sky Harbor International Airport for comparison purposes). This drop in condition can be largely attributed to the lack of funding for the APPP during the past 3 years.
- To fund all the projects eligible for the ADOT APPP program for 2011—2018, $141.5 million would be needed. This does NOT include funding needed for major rehabilitation projects. Additionally, Tucson International Airport and Phoenix Sky Harbor International Airport were not included in the APPP since they fund their own pavement maintenance management programs.
- An estimated 177 pavement sections require paint remarking at an estimated cost of $6.5 million.

Prepared For:

Arizona Department of Transportation
Multimodal Planning Division
Aeronautics Group
206 South 17th Avenue
Phoenix, Arizona 85007