Lehigh Valley International Airport (ABE)

Airside Pavement Management Plan

Final Working Report – February, 2018

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Introduction

Lehigh–Northampton Airport Authority (the Authority), as owner and operator of the Lehigh Valley International Airport (ABE), maintains and manages the entire pavement network of the airport. The airside pavement network comprising runways, taxiways, terminal apron areas and cargo areas represent a significant investment for the Authority. Maintenance and Management of this pavement network ensures good ride quality and safe operation of aircraft. As a result of the growth in airport activity and aging of the airside pavements, the deterioration of pavement conditions has accelerated in recent years. To sustain the pavements at an acceptable condition in support of the airport's users, a Programmatic Pavement Management System (PMS) is required to develop the most cost effective and efficient Maintenance and Rehabilitation plans. This will lead to timely funding of critical pavement repairs to ensure that the airport meet its short term and long-term objectives.

ABE, being a federally obligated airport, is required to perform a detailed inspection of airfield pavements and implement a Pavement Management Plan (PMP). A PMP is a set of defined procedures for collecting, analyzing, maintaining and reporting pavement data. In this context, ADCI (as a sub-consultant to C&S Companies) was asked to perform a pavement condition evaluation and analysis of the airside pavement network at the Lehigh Valley International Airport and ultimately develop a PAVER based PMP. It is to be noted that a pavement condition evaluation of the airside pavements was performed by Pennsylvania Department of Transportation's (PennDOT) Bureau of Aviation in 2016 and the results from that study are available as a web based PMP on the PennDOT website. PennDOT indicated that they are not in possession of the source database files from the 2016 study in PAVER format. ADCI's scope for this task involved verifying the data from the 2016 PennDOT study and creating a new PMP database in PAVER for the Authority's use in maintaining and developing a PMS.

Accordingly, the scope of the project included the sub-tasks as indicated below:

- Develop a comprehensive PMP database inventory in PAVER using data from PennDOT website. This includes updating all pavement network inventory information along with work history and available pavement condition data.
- Verify and confirm the accuracy of PennDOT provided data on the field by conducting a site visit and performing pavement condition surveys in accordance with ASTM standard D-5340: *Standard Test Method for Airport Pavement Condition Index Surveys.*
- Develop a final PMP and a working paper for the Authority's review.

The deliverables for the project include a newly created PAVER database (version 7.0.5) along with a working paper and briefing summary to the Authority. ADCI has developed a comprehensive pavement database in PAVER and will submit it to the authority in the ***E70*** format which is the standard PAVER Database format. This report summarizes the key elements in the PMP database which include pavement inventory, work history, pavement condition and future maintenance and rehabilitation plans for the airport.

ABE Airside Inventory

The total area of airfield pavement at ABE airport is approximately 6.5 million square feet or approximately 148 acres. The airfield system at ABE consists of two intersecting air carrier runways and associated taxiways, hold pads and terminal aprons. The two primary air carrier runways are designated as 6-24 and 13-31. Runway 6-24 is asphalt surfaced and has a length of 7,599' and width of 150'. Runway 13-31 is also asphalt surfaced and has a length of 5,800' and width of 150'. The critical aircraft for Runway 6-24 is the Boeing 767-300 ER with a Maximum Takeoff Weight(MTOW) of 412,000 lbs. while the critical aircraft for Runway 13-31 is the Airbus A-320-100 with a MTOW of 172,000 lbs.

Pavement Network and Branches

A key element in a pavement management system is defining the pavement network, which is the process of dividing an installation's pavements into a hierarchical order that facilitates inspection and maintenance planning. The ABE airside network has been divided into branches, which are a readily identifiable part of the pavement system and have distinct functions. For airports, branches typically consist of individual runways, taxiways and aprons. The branches are then divided into sections based on the construction history. A pavement section is the smallest management unit used when considering the application and selection of maintenance and rehabilitation treatments.

At ABE, the airside network has been divided into 21 branches that include 63 sections for a total area of 6.5 million square feet. 49 of the 63 sections are asphalt surfaced which includes Asphalt Overlay over Concrete (AAC) or Asphalt surfaced (AC) and the remaining 14 sections are Portland Cement Concrete (PCC) surfaced. Roughly 84% of the airside pavement at ABE is asphalt surfaced while 16% is PCC. A summary of the pavement area distribution by surface type is shown in *Figure 1* while *Figure 2* shows the distribution of airfield pavement type by usage. A listing of all branches is shown in *Table 1* while a summary by age of pavement is shown in *Table 2.*

Figure 1: ABE Airside Pavement Area by Surface Type

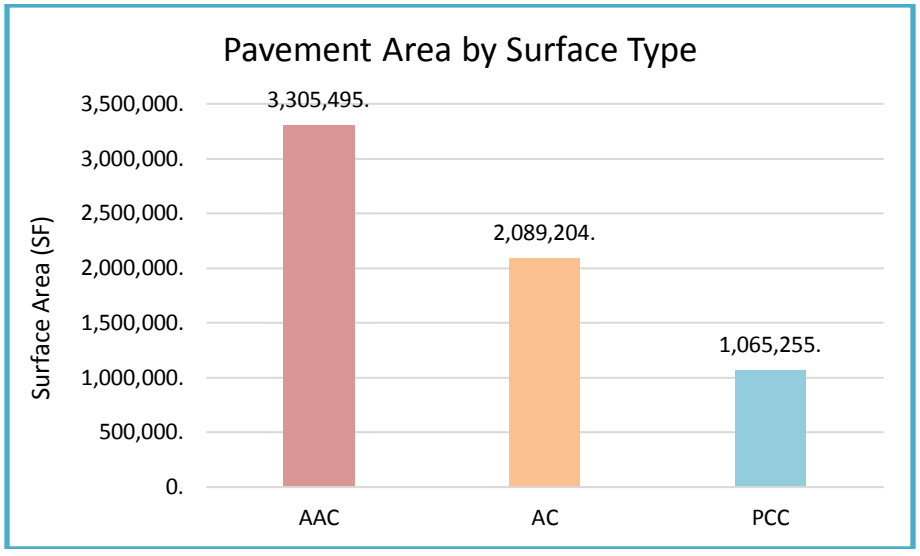


Figure 2: ABE Airside Pavement Area by Branch Use

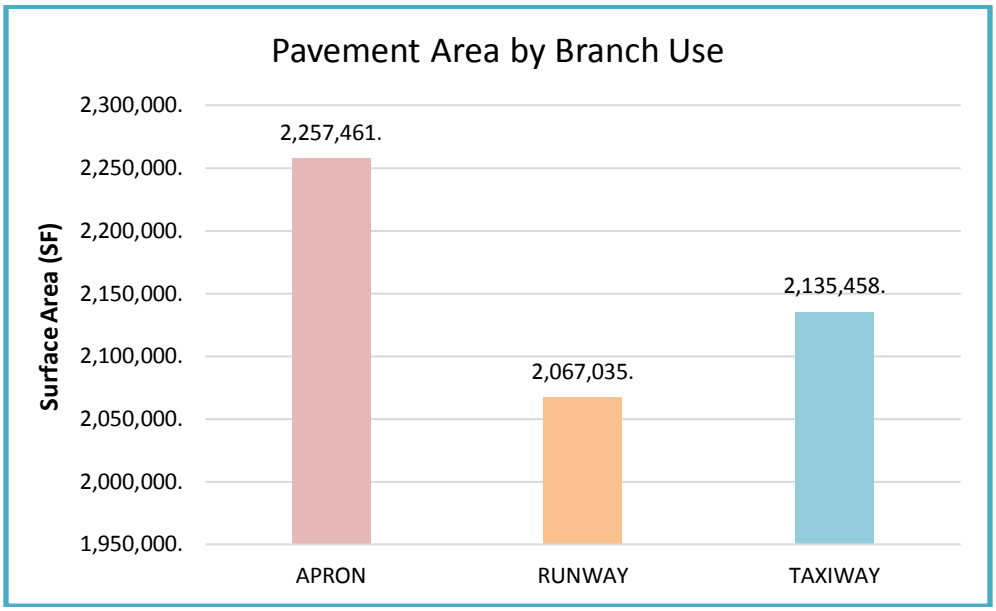
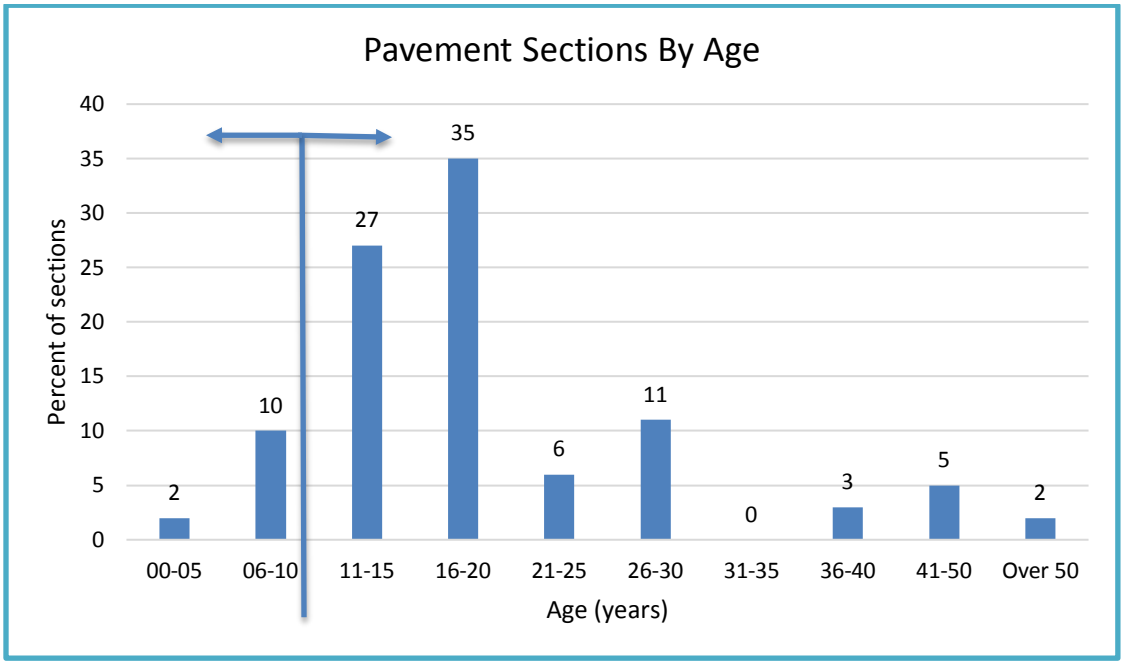


Figure 3: ABE Airside Pavement Sections by Age



From *Figure 3*, it may be noted that only **12%** of the pavement sections or 7 out of 63 sections are less than 10 years old.

Table 1: Branch Listing at ABE Airport

Branch ID	Name	Use	Number of Sections	Area (SqFt)
A01LV	APRON 01	APRON	4	217,502.00
A02LV	APRON 02	APRON	2	150,746.00
A03LV	APRON 03	APRON	2	149,608.00
ACARGOLV	CARGO APRON	APRON	1	400,823.00
AHPRW31LV	RUNWAY 31 HOLD PAD APRON	APRON	1	70,996.00
ANSGALV	NORTHSIDE GENERAL AVIATION APRON	APRON	1	174,616.00
ATERMLV	TERMINAL APRON	APRON	11	1,093,170.00
RW0624LV	RUNWAY 06-24	RUNWAY	6	1,136,543.00
RW1331LV	RUNWAY 13-31	RUNWAY	9	930,492.00
TWA2LV	TAXIWAY A2	TAXIWAY	1	29,813.00
TWA3LV	TAXIWAY A3	TAXIWAY	2	51,199.00
TWALV	TAXIWAY A	TAXIWAY	5	866,324.00
TWB1LV	TAXIWAY B1	TAXIWAY	1	26,855.00
TWB3LV	TAXIWAY B3	TAXIWAY	2	114,057.00
TWB4LV	TAXIWAY B4	TAXIWAY	1	26,728.00
TWB5LV	TAXIWAY B5	TAXIWAY	1	30,729.00
TWB6LV	NEW	TAXIWAY	1	30,417.00
TWBLV	TAXIWAY B	TAXIWAY	3	476,154.00
TWCLV	TAXIWAY C	TAXIWAY	4	212,987.00
TWELV	TAXIWAY E	TAXIWAY	3	117,935.00
TWJLV	TAXIWAY J	TAXIWAY	2	152,260.00

Table 2: Pavement Inventory by Age

Age (years)	Number of Sections	Pavement Area	Percent of Area
0-5	1	57,070	1%
06-10	6	269,688	4%
11-15	17	1,523,647	24%
16-20	22	2,922,596	45%
21-25	4	259,261	4%
26-30	7	541,772	8%
36-40	2	149,608	2%
41-50	3	677,654	10%
Over 50	1	58,658	1%

Pavement Construction Work History

Pavement construction work history is also a key component of a Pavement Management System. In addition to the information available from the PennDOT study, ADCI reviewed the construction history from available record drawings provided by the Authority. All the relevant information from the Penn DOT website and record drawings has been used to update the PMP database in PAVER. The following record drawings were available and have been used for updating the current pavement construction history.

- Taxiway A Rehabilitation – August 2001
- Itinerant Aircraft Parking Apron – February 2002.
- Taxiway B Reconstruction Phase 1 – March 2004
- Taxiway B Reconstruction Phase 2 – September 2004
- Terminal Apron Reconstruction Phase 1 – June 2006
- Construction of Taxiway J – April 2009.
- Terminal Apron Reconstruction Phase 3 – June 2009

It is to be noted that apart from the information taken from the record drawings, very limited information is currently available on pavement section data for rest of the airside pavements. As a result, the construction work history section has not been discussed in detail. However, in the future with the pavement coring data becoming available, more detailed analysis can be performed and included in the database as the PMP will be a 'living' document.

Pavement Condition Inspection and Data Analysis

The Pavement Condition Index (PCI) is a measure of the pavement's functional surface condition. It provides insight into the causes of distress, and whether the distress is related to a load or climatic condition. The PCI is a numerical rating (on a scale of 0 to 100) based on the type, severity, and quantity of each distress found in an inspected sample unit. The results are displayed using seven categories and ratings in accordance with ASTM D-5340, but can also be presented using a simplified 3-category rating system for use in comparing with other distress related indices as shown in *Table 3* below.

Table 3: Pavement Condition Index Rating Scale

	Simplified PCI Color Legend	ASTM PCI Color Legend	PCI Range	PCI Ratings and Definition
GOOD			86-100	GOOD: Pavement has minor or no distresses and should require only routine maintenance.
			71-85	SATISFACTORY: Pavement has scattered low severity distresses that should require only routine maintenance.
FAIR			56-70	FAIR: Pavement has a combination of generally low and medium-severity distresses. Near-term maintenance and repair needs may range from routine to major.
POOR			41-55	POOR: Pavement has low, medium-, and high-severity distresses that probably cause some operational problems. Near-term M&R needs range from routine to major.
			26-40	VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance & operational problems. Near-term M&R needs will be major.
			11-25	SERIOUS: Pavement has mainly high-severity distresses that cause operational restrictions; immediate repairs are needed.
			0-10	FAILED: Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible; complete reconstruction is required.

ADCI personnel conducted a visual Pavement Condition Index survey of the airside pavements at ABE in June 2017. The survey was performed in accordance with methods described in ASTM D-5340: *Standard Test Method for Airport Pavement Condition Index Surveys* and FAA AC 150/5380-7B: *Airports Pavement Management Program (PMP)*. The purpose of this survey was to assess the condition of existing AC and PCC pavements and confirm that the PCI values were in line with the PennDOT study report. By verifying the accuracy of the PennDOT data, the results of this inspection will be used to develop an airside Pavement Management Plan (PMP) that includes recommendations for immediate repair as well as a long-term rehabilitation program. An Overall map of the airside network showing the PCI values for all the branches is included in **Appendix A.**

Inspection of the airside pavements consisted of identifying distresses and documenting the observations with notes and photos. The inspection documented the type of pavement use (apron, runway, taxiway, etc.) as well as the pavement conditions and distress types with severity levels within the various areas of pavement.

The following major distresses were identified and fall into one of the cause categories as listed below with some distresses having more than one cause. The severity levels for each of the distresses were categorized into three levels as high, medium and low.

- Load related: Asphalt concrete distresses include alligator cracking, corrugation, depression, polished aggregate, rutting and slippage cracking;
- Climate and Durability Related: Asphalt concrete distresses include bleeding, block cracking, joint reflection cracking, longitudinal and transverse (L&T) cracking and weathering.
- Moisture & Drainage related: Asphalt distresses include alligator cracking, depressions, potholes and swelling; A condition that can be related to poor surface drainage or subgrade drainage as well.

The branch and section wise summary and results of the PCI survey inspection and PennDOT data for the entire airside network of the airport have been summarized and presented in **Appendix B.**

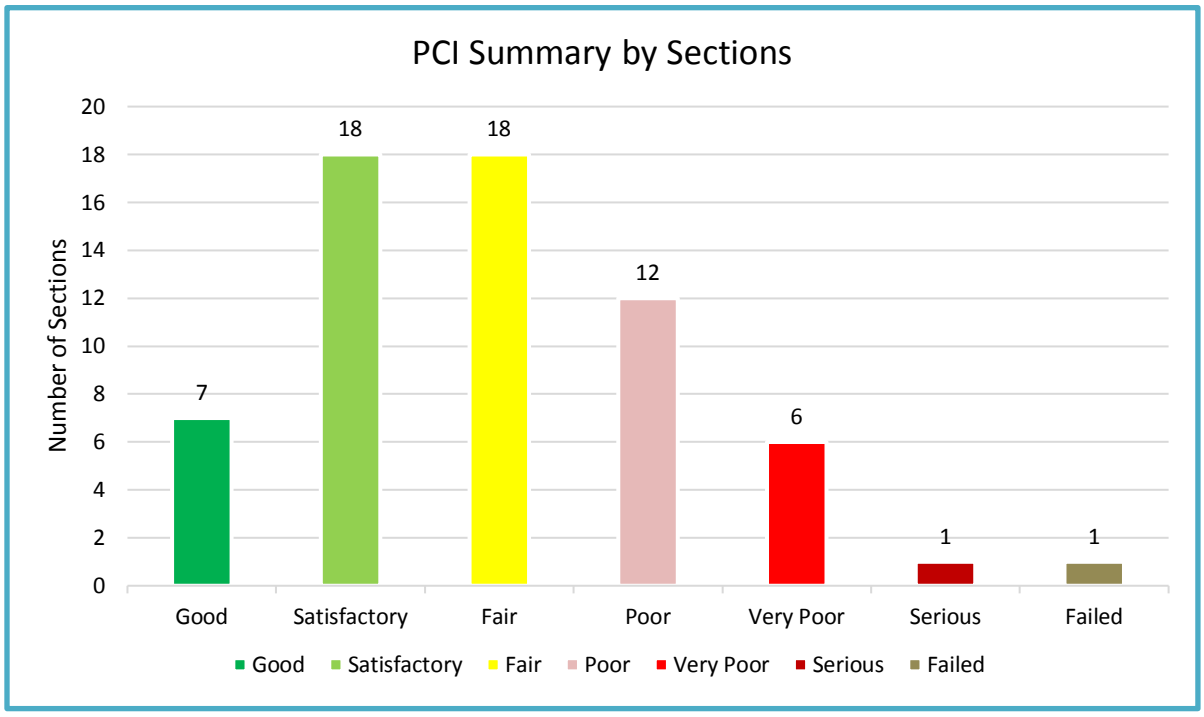
All the various types of flexible and rigid pavement distresses mentioned above are described in detail in **Appendix D** while select photographs of pavement distresses are included in **Appendix E**.

The Distress data thus recorded during the field inspection was entered into PAVER Software program to determine the PCI values for each of the sections. The PCI values generated from PAVER closely matched the data from the 2016 Penn DOT study in almost all the instances. In a few instances, the PCI was found to be marginally less than the 2016 values. It was concluded that the 2016 PennDOT data was accurate and reliable enough to be used for conducting pavement analysis and formulating cost-effective Maintenance and Rehabilitation (M&R) plans for the airport.

PCI Condition Summary

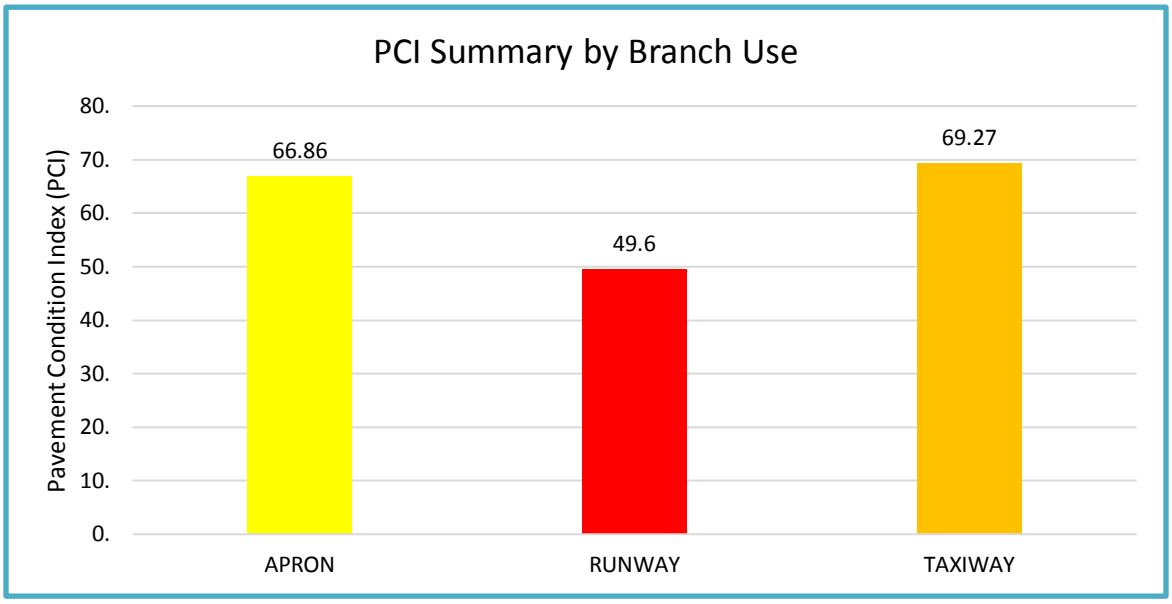
In Summary, 43 sections out of total 63 sections were found to be in condition ranging from fair to good with PCI values ranging from 56 to 94 while 20 sections were found to be in poor to failed condition with PCI values ranging from 9 to 55. The PCI summary by sections is shown graphically in *Figure 4.* It may be noted from *Figure 4* that the sections in good condition (7) are the ones which are less than 10 years old.

Figure 4: ABE Airside PCI Summary by Sections



Based on Branch Use, the runway pavements were found to be in poor condition with an average PCI of 50 while the apron and taxiway pavements were found to be in fair condition with average PCIs being 67 and 69 respectively. The PCI summary by branch use is depicted graphically in *Figure 5*.

Figure 5: ABE Airside PCI Summary by Branch Use

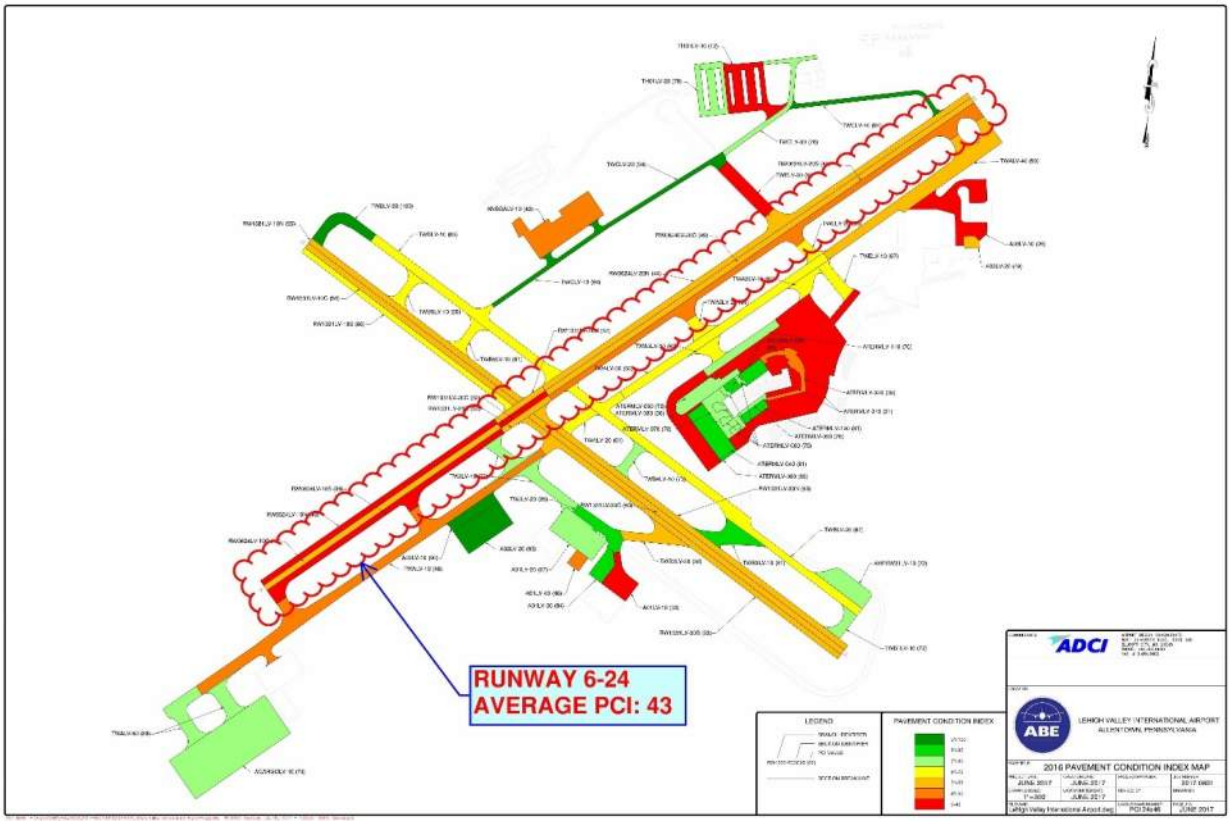


Based on observations from the pavement condition survey, a brief summary of condition for each branch is discussed below. An Overall map of the airside network showing the PCI values for all the branches is included in **Appendix A.**

Runway 6-24:

Runway 6-24 contained six sections. All of the sections had low severity block cracking and medium-severity weathering. Medium severity weathering was recorded where missing fine material and asphalt binder were observed. Sections 10N, 10S, 20C, 20N, and 10S had low and medium-severity alligator cracking observed. Low severity alligator cracking was also observed in Section 10C. Low and medium-severity longitudinal and transverse (L&T) cracking was observed in all sections, except Section 10S. Medium severity block cracking was recorded in Sections 10N, 10S, 20N, and 20S where crack widths exceed ¼ inch or where the sealant was in unsatisfactory condition. High severity raveling was observed in Sections 10C, 10S, 20N, and 20S where coarse aggregate was missing from the surface of the pavement. High severity raveling was identified in Sections 10C and 20C. Low severity patching was observed in Sections 10N and 20S. An area of atypical condition in Section 10N was inspected as an additional sample according to PCI procedure. This area had a large high-severity depression observed during the inspection.

Runway 6-24 PCI

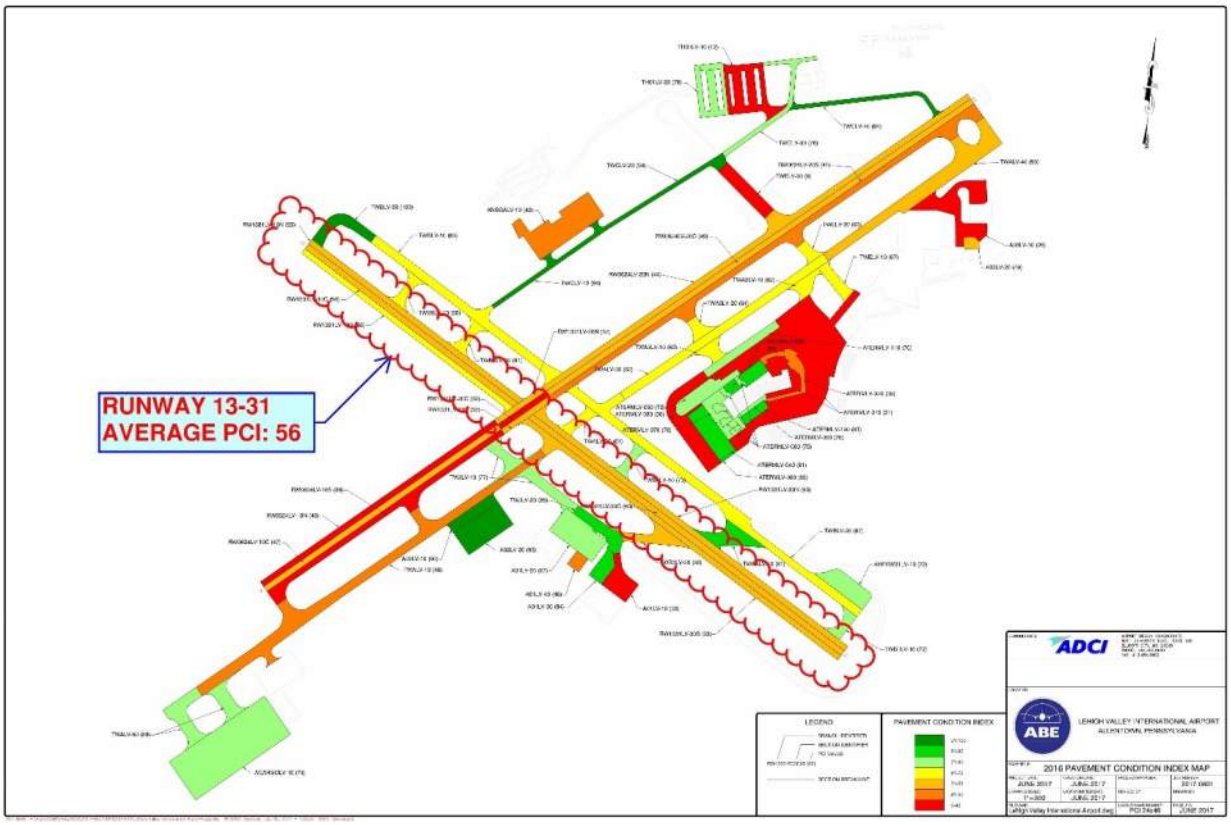


Runway 13-31:

Nine sections comprised Runway 13-31. All sections had low and medium severity L&T cracking identified. Low severity L&T cracking was observed in both the unsealed and sealed conditions. Medium-severity L&T cracking was recorded where crack sealant was no longer performing satisfactorily, unsealed crack widths exceed ¼ inch, or secondary cracking had developed. Low severity weathering was also observed in all sections. Sections 10C, 10N, 20C, 20N, 20S, 30C, 30N, and 30S had low severity alligator cracking.

Sections 10C, 30N, and 30S also had medium severity alligator cracking and raveling. Medium severity weathering was recorded in Sections 10C, 10N, and 10S. Low severity block cracking was observed in Sections 20N and 20S. Isolated amounts of high severity raveling were recorded in Sections 10N and 20C. Small amounts of low severity swelling were observed in Section 10C. Additionally, low severity patching was identified in Section 20C and in an atypical area in Section 30S. The atypical area was inspected as an additional sample according to PCI procedure.

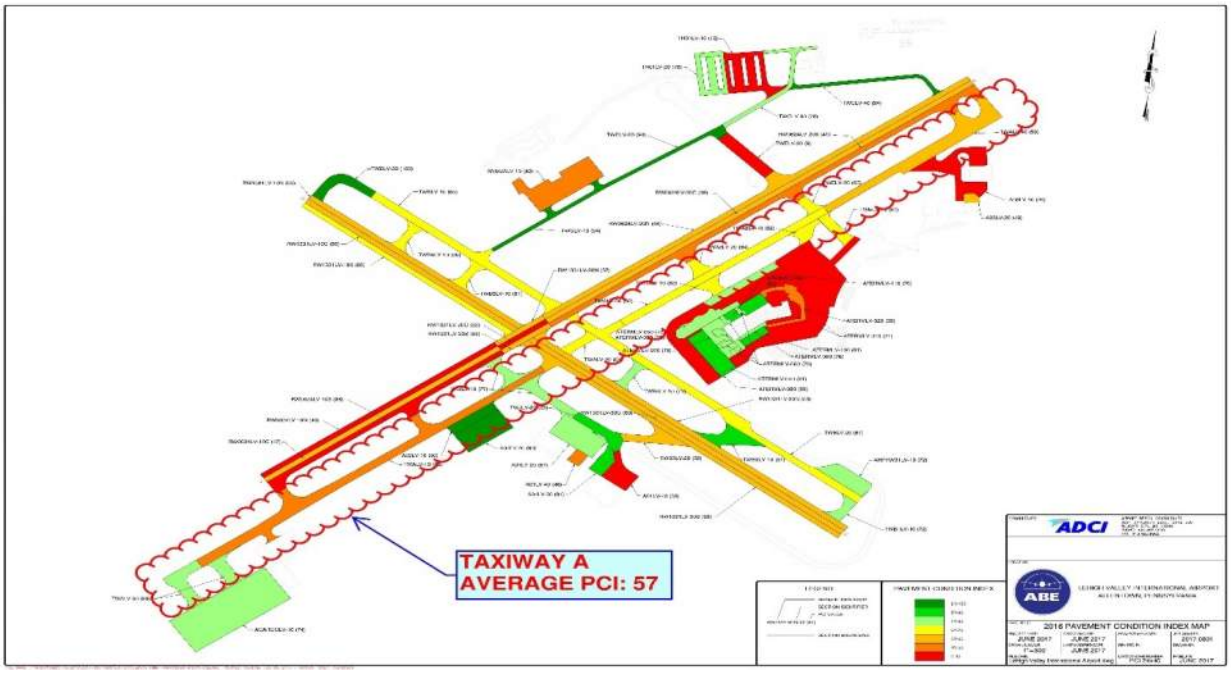
Runway 13-31 PCI



Taxiway A:

Taxiway A was comprised of five sections. Low severity L&T cracking and alligator cracking were observed in Sections 10, 20, and 40. Low and medium severity L&T cracking was identified in Sections 10, 20, 30, and 50. Low severity L&T cracking was observed in both the unsealed and sealed conditions, while the medium-severity L&T cracking was recorded where crack sealant was no longer performing satisfactorily, unsealed crack widths exceed ¼ inch, or secondary cracking associated with primary cracking was observed. Sections 10, 30, and 40 had low severity rutting recorded. Low severity weathering was observed in all sections, and medium severity weathering was recorded in all but Section 30. Low severity raveling was identified in Sections 10 and 20, while medium-severity was observed in Sections 10 and 50. Low severity, unsealed block cracking was identified in moderate quantities in Section 40. Bleeding was recorded in Section 30. Low severity patching was observed in Section 20. Isolated quantities of high severity raveling and moderate quantities of medium severity alligator cracking were identified in Section 10.

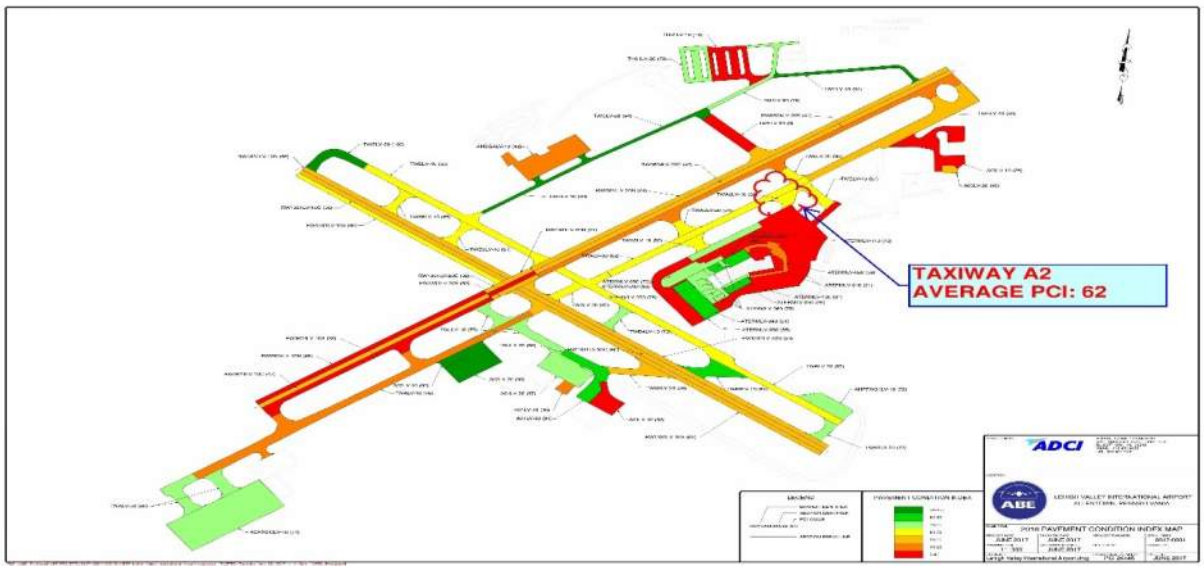
Taxiway A PCI



Taxiway A2:

Taxiway A2 consisted of one section that served as a connector for the northern area of the Terminal Apron to Taxiway A. Small amounts of medium severity alligator cracking were observed. Low severity L&T cracking was observed in the unsealed condition, while the medium severity L&T cracking was recorded where crack sealant was in unsatisfactory condition or where unsealed crack widths exceeded ¼ inch. Additionally, low severity depression, weathering, and bleeding were identified.

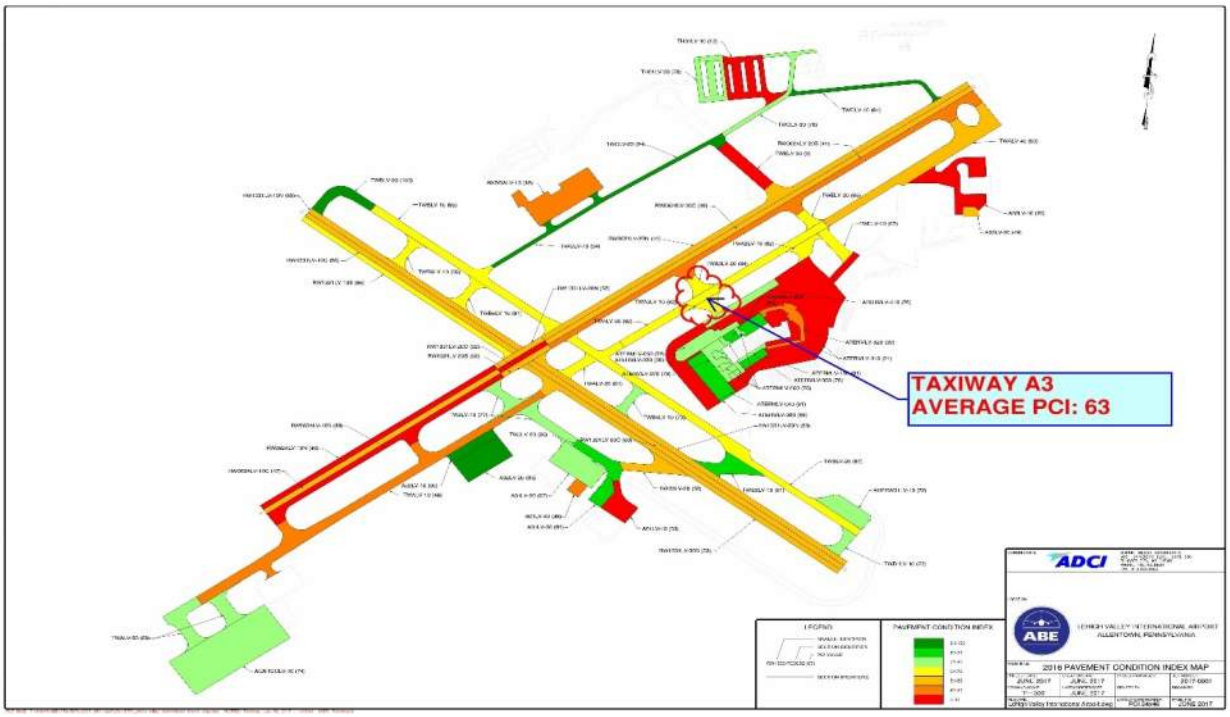
Taxiway A2 PCI



Taxiway A3:

Taxiway A3 was defined by two sections. Sections 10 and 20 were in comparable condition with similar distresses observed during the inspection. Moderate amounts of bleeding were identified. Low and medium severity L&T cracking were also observed. Additionally, low severity weathering was identified where asphalt binder appeared to be missing, leaving aggregate exposed. Section 10 had a large area of medium severity patching identified.

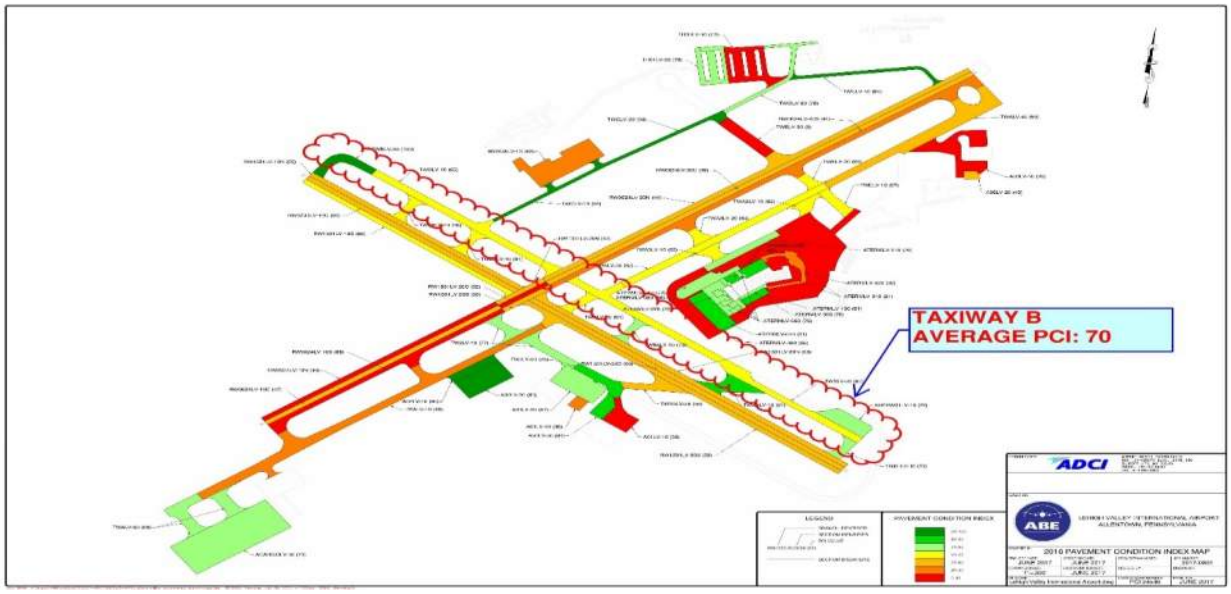
Taxiway A3 PCI



Taxiway B:

Taxiway B contained three sections. Sections 10 and 20 were in comparable condition with similar distresses observed during the inspection. Low and medium severity L&T cracking, low severity raveling, and low and medium severity weathering were identified in both sections. Section 10 also had low severity patching, medium severity raveling, and isolated amounts of bleeding. Section 30 defined the connector at the approach end of Runway 13 and was in excellent condition with no distresses recorded.

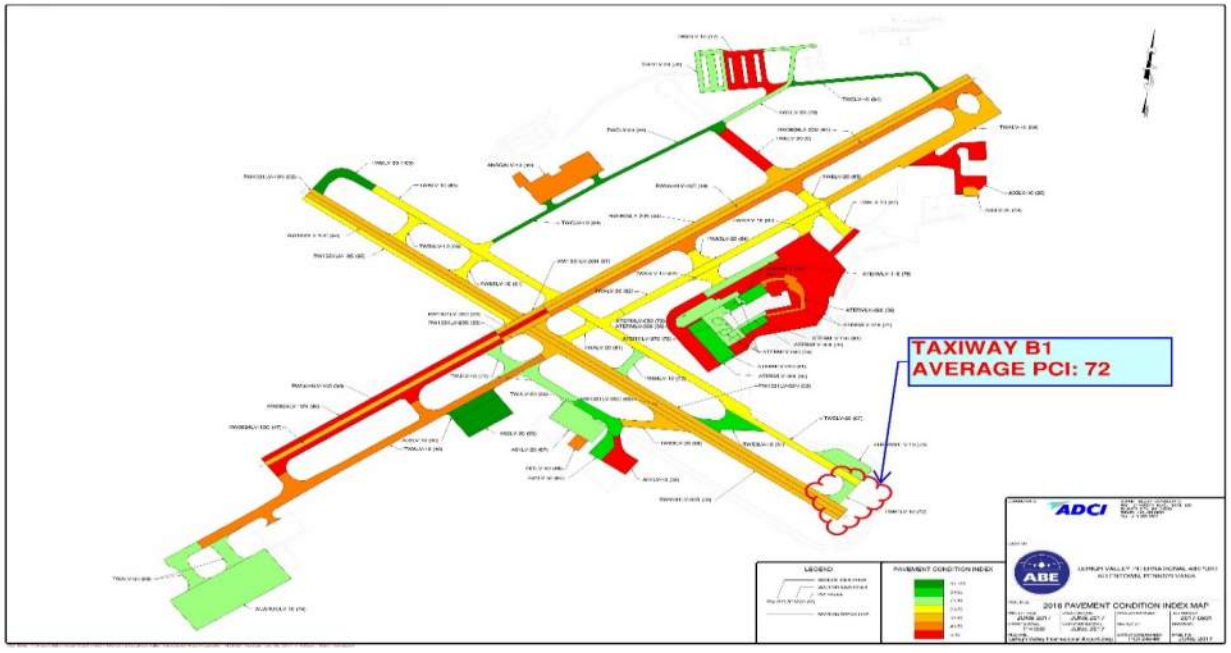
Taxiway B PCI



Taxiway B1:

Taxiway B1 consisted of one section. Isolated quantities of medium severity raveling and bleeding were identified. Low severity L&T cracking was observed in the unsealed condition. Additionally, low and medium severity weathering was recorded throughout the majority of the section where an oxidized pavement surface and missing fine material were observed.

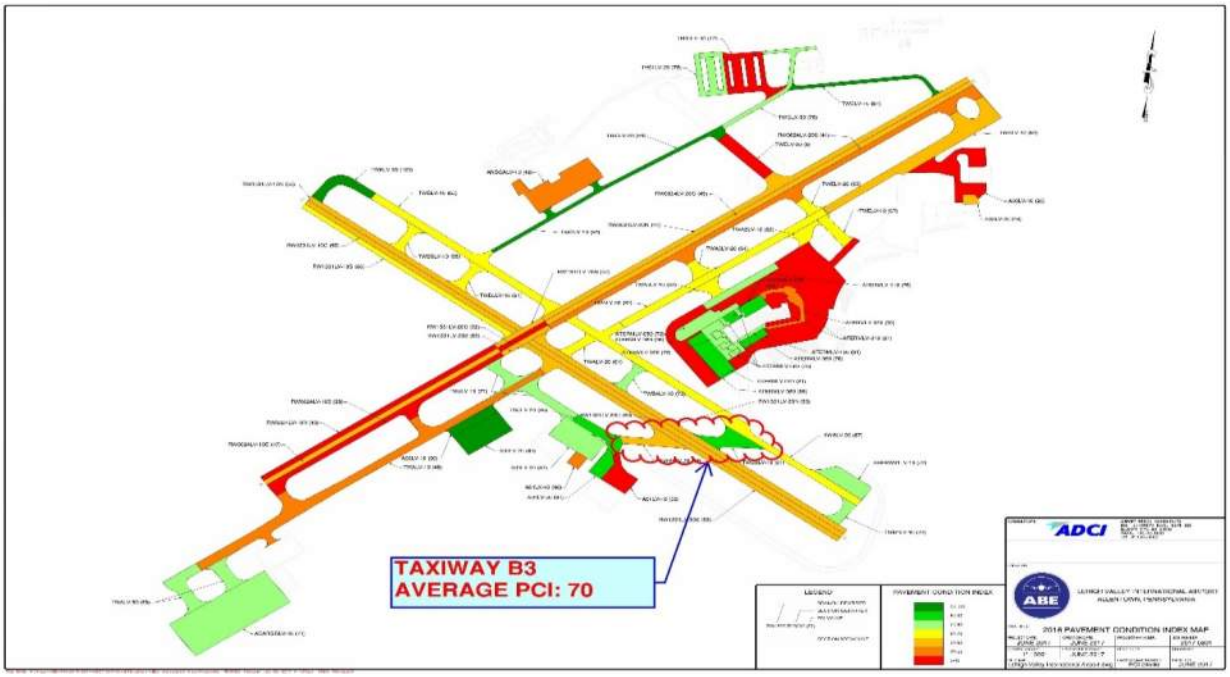
Taxiway B1 PCI



Taxiway B3:

Taxiway B3 contained two sections. Section 10 defined the connector east of Runway 13-31. Low severity, unsealed L&T cracking along with low and medium severity weathering were the only distresses observed at the time of the inspection. Section 20 defined the connector west of Runway 13-31. Low and medium severity L&T cracking and weathering were identified. Low severity patching and alligator cracking were also observed. In addition, areas of medium severity depression were observed.

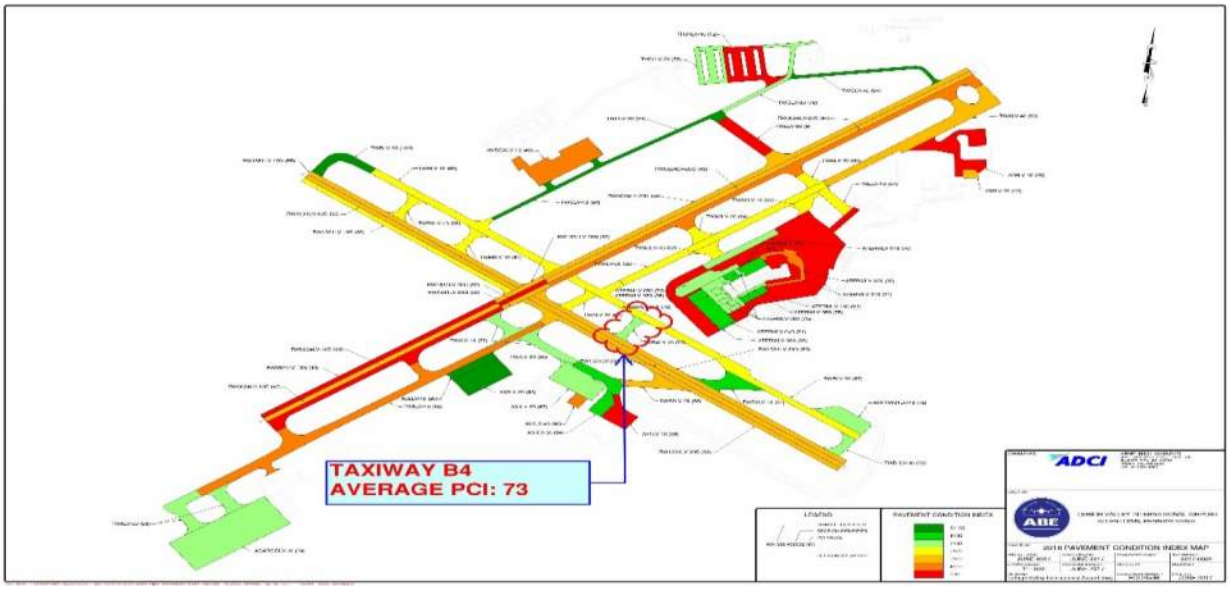
Taxiway B3 PCI



Taxiway B4:

Taxiway B4 consisted of one section. Low severity L&T cracking was identified in the unsealed condition. Isolated amounts of low severity raveling were also observed. All severities of weathering were identified, but only minor amounts of high-severity were recorded.

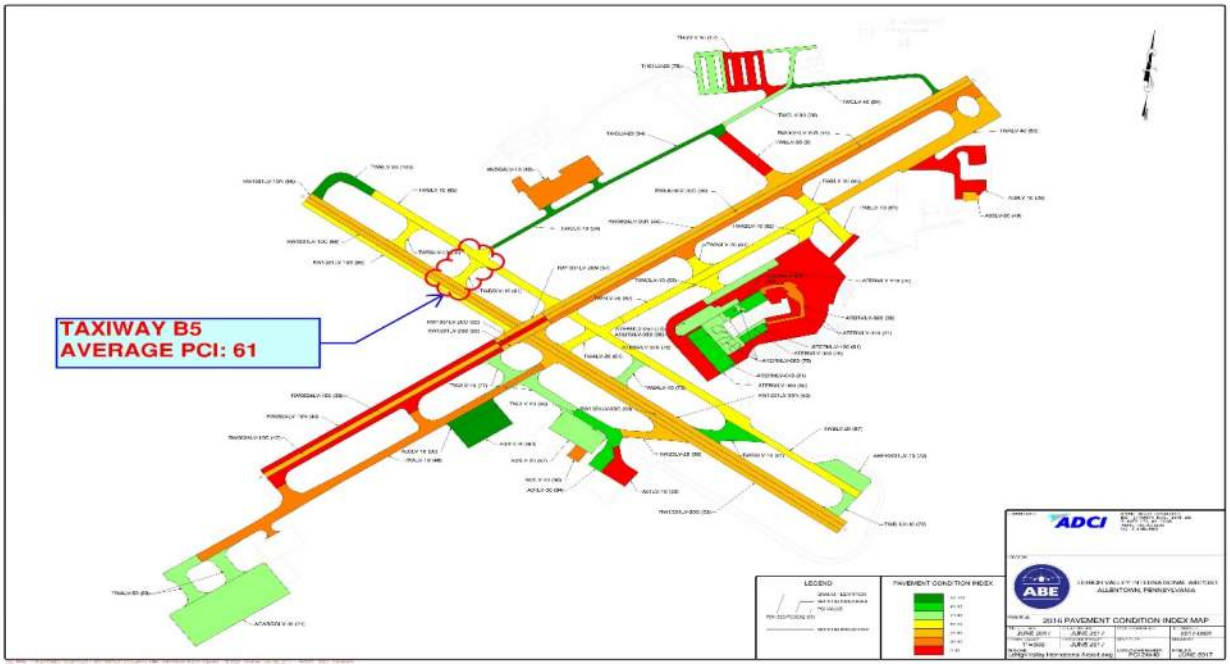
Taxiway B4 PCI



Taxiway B5:

Taxiway B5 was defined by one section. Low and medium severity weathering and L&T cracking were observed. Small amounts of low severity alligator cracking and patching were also identified. Additionally, isolated quantities of raveling were observed.

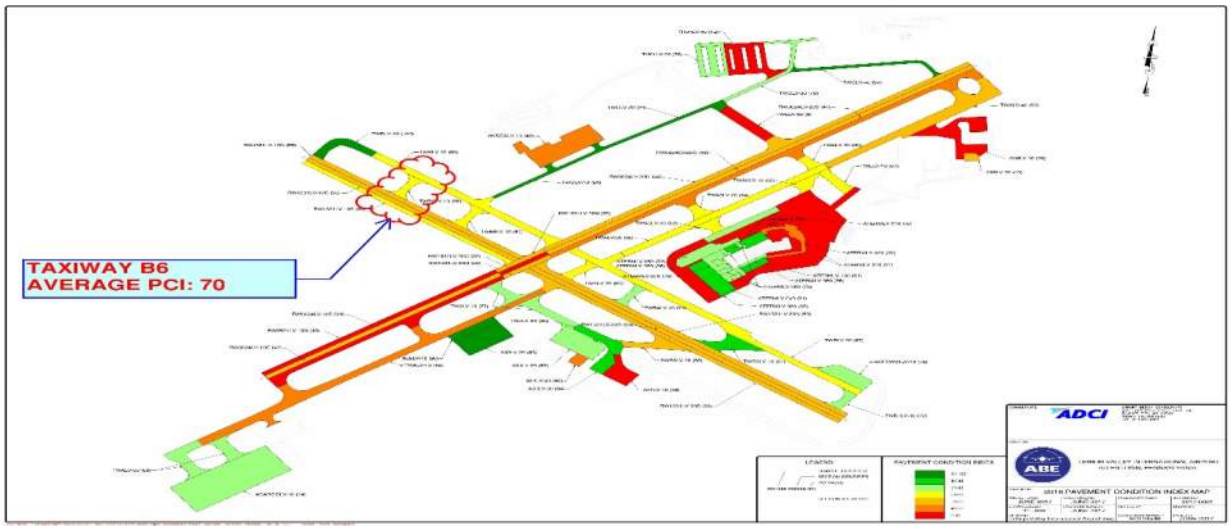
Taxiway B5 PCI



Taxiway B6:

Taxiway B6 was also defined by one section. Low and medium severity weathering and L&T cracking were observed. Small quantities of low severity alligator cracking were also identified. In addition, all severities of weathering were identified but only minor amounts of high severity were recorded.

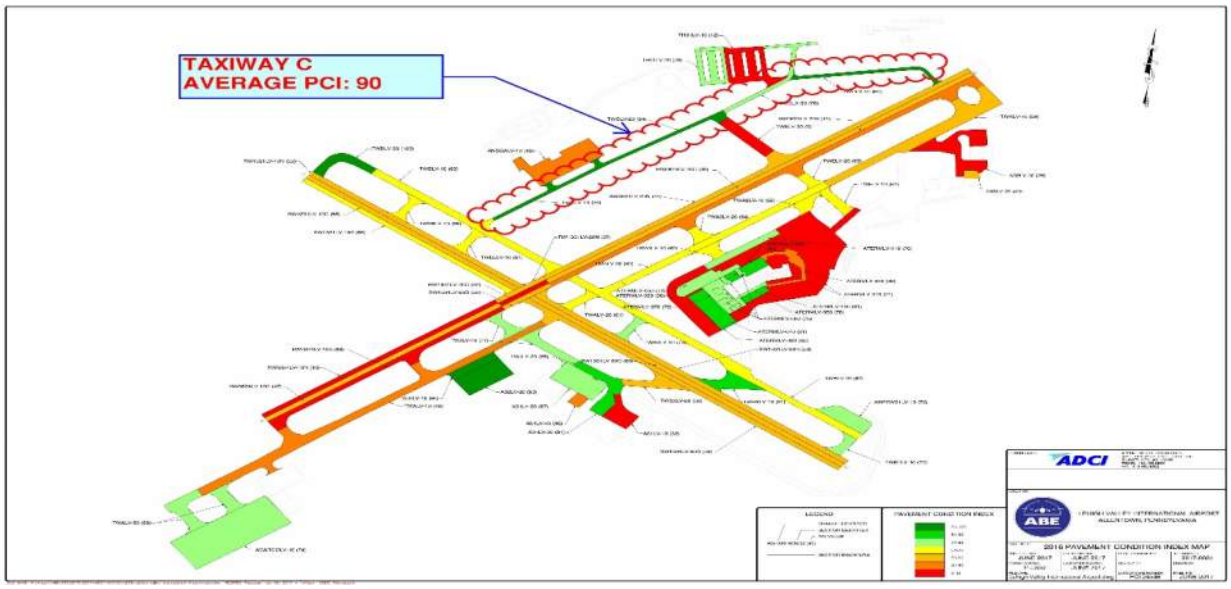
Taxiway B6 PCI



Taxiway C:

Taxiway C consisted of four sections. Sections 10, 20, and 40 were in comparable condition with only low severity weathering identified in each section. Section 30 had low severity L&T cracking observed in the unsealed condition, while the medium severity L&T cracking was recorded where unsealed crack widths exceeded ¼ inch. Low severity weathering was also observed in Section 30.

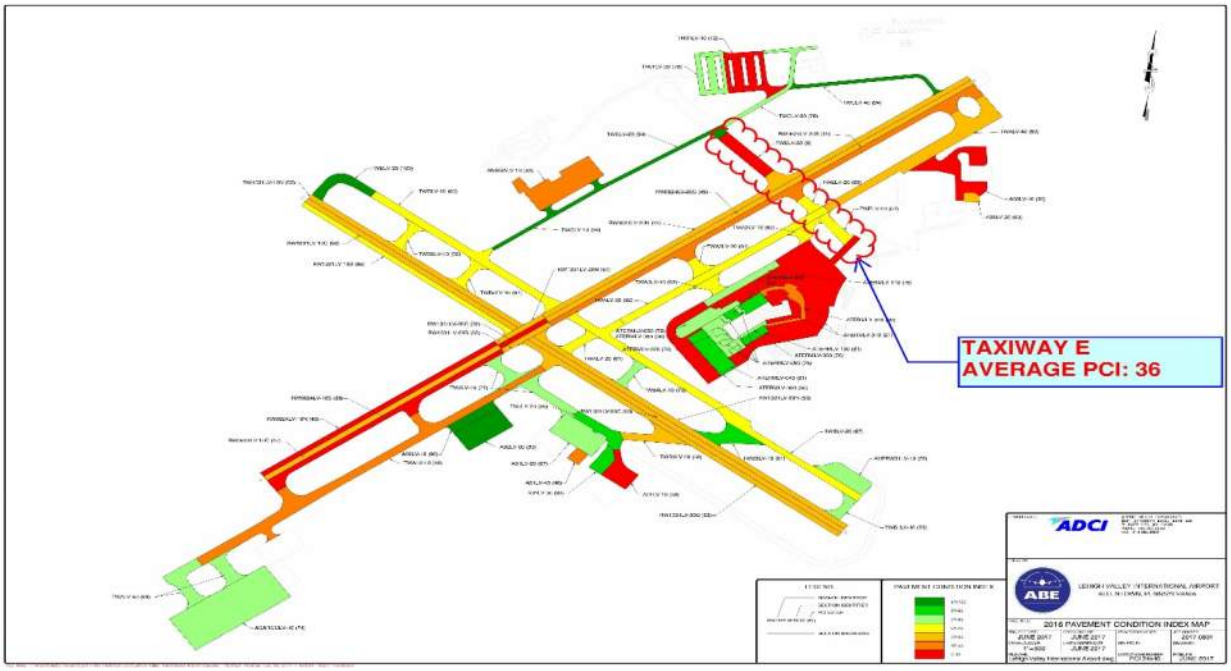
Taxiway C PCI



Taxiway E:

Taxiway E was defined by three sections. Sections 10 and 20 were in comparable condition with similar distresses observed during the inspection. Low and medium severity L&T cracking, low severity weathering, and bleeding were identified in both sections. Additionally, low severity raveling was observed in Section 10. Section 30 was in poor condition with extensive amounts of alligator cracking and block cracking recorded. Significant quantities of depression, patching, high severity alligator cracking, rutting, and high severity raveling and weathering were also observed throughout the pavement section.

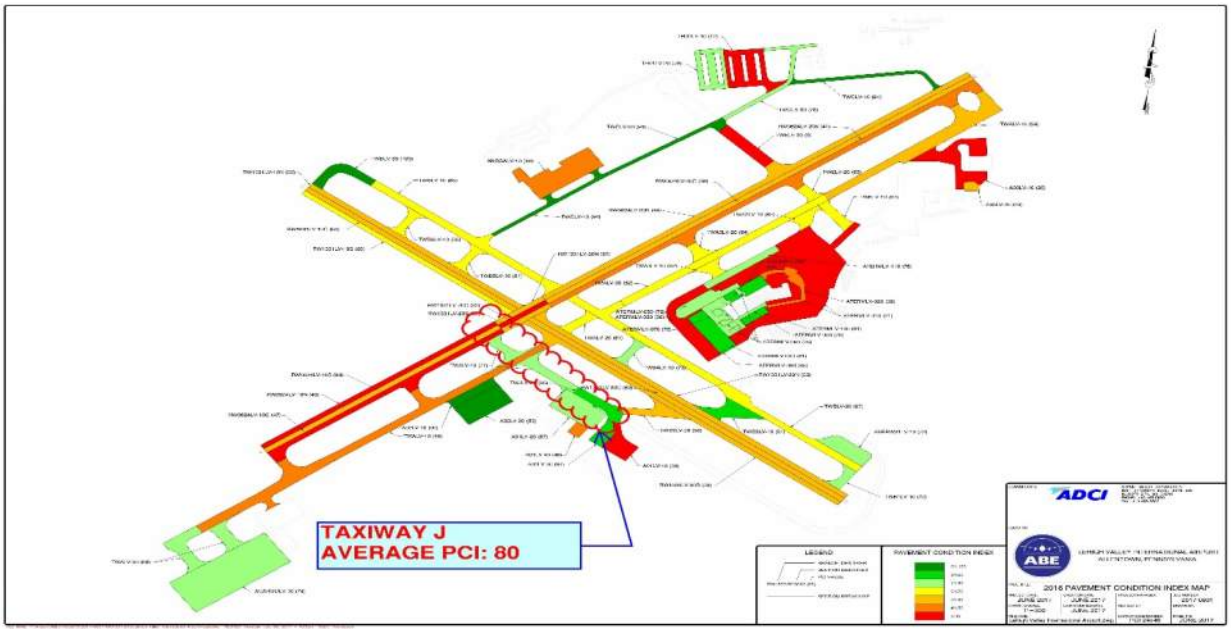
Taxiway E PCI



Taxiway J:

Taxiway J consisted of two sections. Low severity L&T cracking was observed in both the unsealed and sealed conditions in Section 10. Low severity weathering and alligator cracking were also observed. Low severity, unsealed L&T cracking and weathering were the only distresses observed during the inspection of Section 20.

Taxiway J PCI

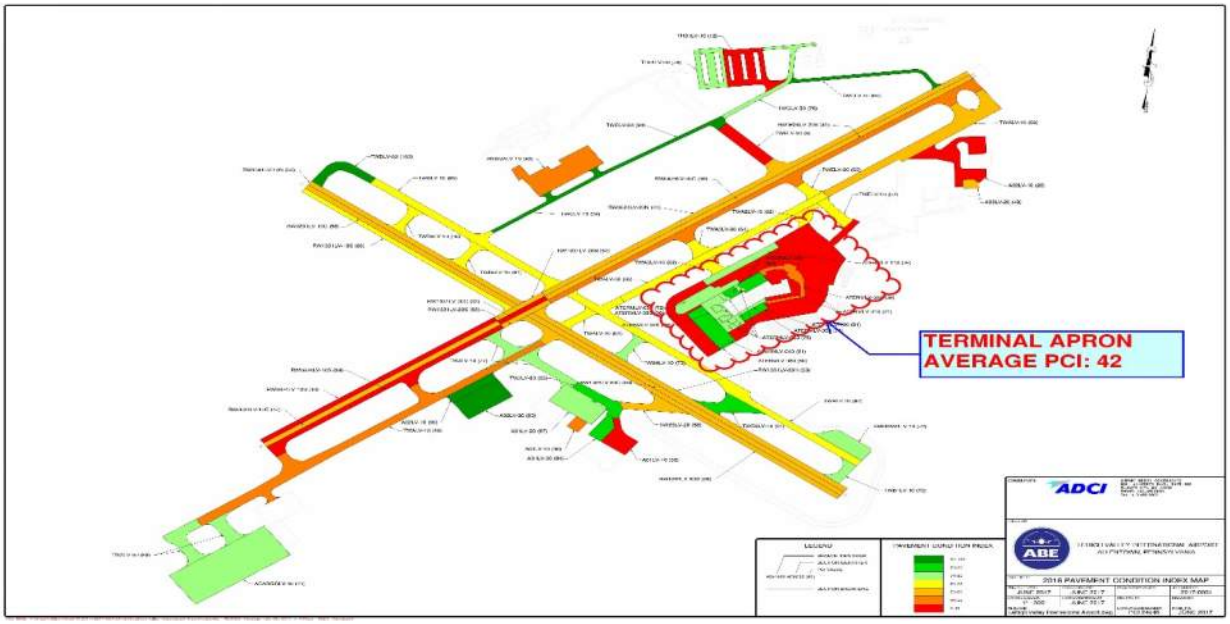


Terminal Apron:

The terminal apron comprised of eleven sections. Sections 50 and 110 were in comparable condition with similar distresses observed during the inspection. Both sections had low and medium severity L&T cracking and low severity weathering observed. Section 50 also had small amounts of medium severity alligator cracking and low severity depression identified. Sections 10 and 30 were in poor condition. Each section had significant amounts of low and medium severity alligator cracking, L&T cracking, block cracking, and weathering identified. High severity raveling was also observed in both sections. Medium-severity raveling and high severity L&T cracking were also observed in Section 30. Low and medium-severity depression, low and high severity patching, and low and medium severity rutting were also identified in Section 110. Sections 40, 60, 70, 80, 90, and 100 consisted of PCC pavement. High-severity joint seal damage was observed in Sections 40 and 80, while medium severity was identified in Sections 90 and 100. Shrinkage cracking was observed in each of the sections. High severity corner spalling was observed in Sections 40, 60, 70 and 100. Medium severity joint spalling was observed in Sections 40, 60, 70, 90, and 100. Low severity longitudinal, transverse, and diagonal (LTD) cracking was observed in Sections 60 and 100, while medium severity LTD cracking was recorded in Section 60, 70, and 90. Low severity joint spalling was recorded in Sections 90 and 100. Low severity corner breaks and ASR were also observed in Section 40. Low severity corner spalling was identified in Sections 70 and 90, while medium-severity corner spalling was observed in Section 40, 60, and 90. Small amounts of low severity ASR were also observed in Section 40.

In addition, low severity patching was identified in Sections 70 and 90. Small amounts of high severity joint spalling were observed in Section 70. Section 20 was in poor condition with significant amounts of LTD cracking, joint seal damage, shrinkage cracking, and scaling identified. Additionally, small amounts of shattered slabs, spalling, patching, durability cracking, and corner breaks were recorded.

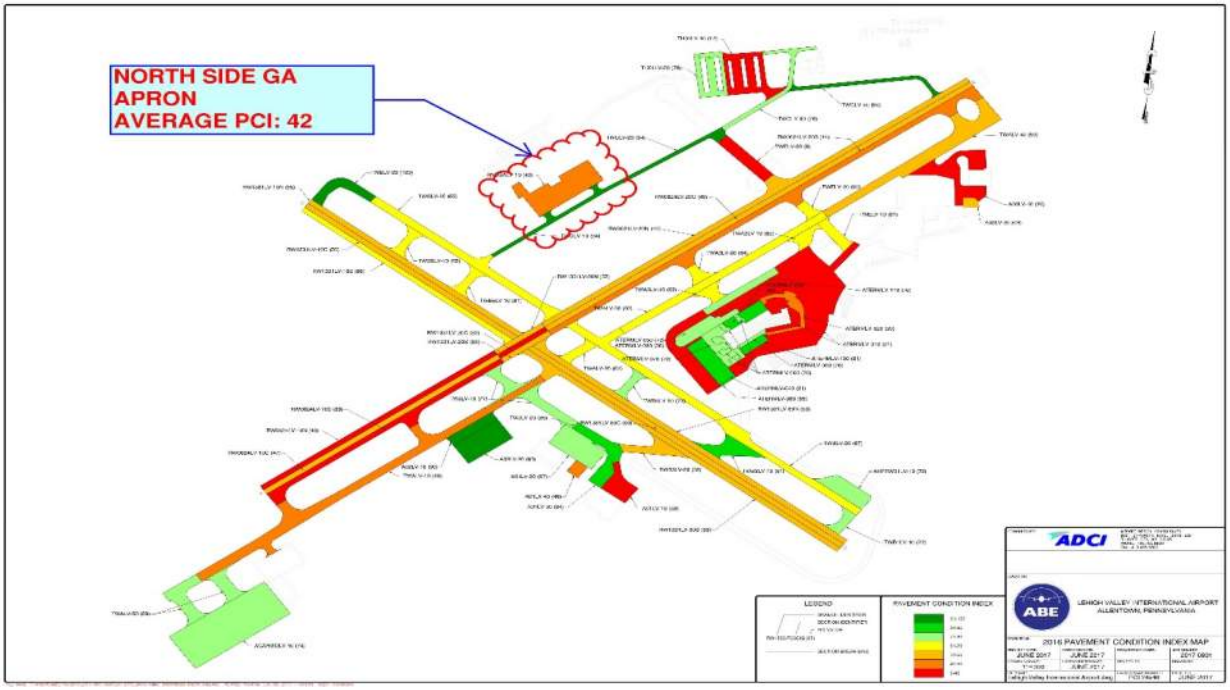
Terminal Apron PCI



North Side General Aviation Apron:

The North Side General Aviation Apron consists of one section with substantial amounts of low and medium severity block and L&T cracking observed. Smaller areas of medium-severity alligator cracking and high severity L&T cracking were recorded. Additionally, low severity weathering and raveling were identified.

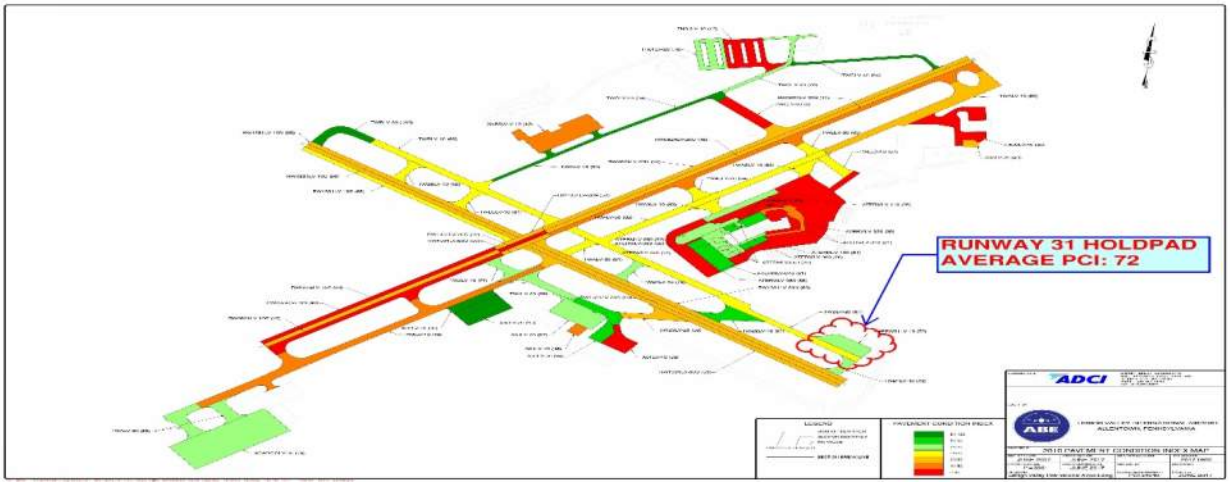
Northside GA Apron PCI



Runway 31 Hold Pad:

The hold pad for Runway 31 consists of one section. Low severity corner breaks, LTD cracking, durability cracking, patching, and spalling were identified. Medium severity spalling and joint seal damage were also observed. Additionally, shrinkage cracking and high severity joint seal damage were observed during the inspection. High severity joint seal damage was recorded where joint sealant had deteriorated or visible gaps between the sealant and slab edge were observed. This condition allows for the penetration of water into the underlying pavement layers and can contribute to future deterioration.

Runway 31 Hold pad PCI



Cargo Apron:

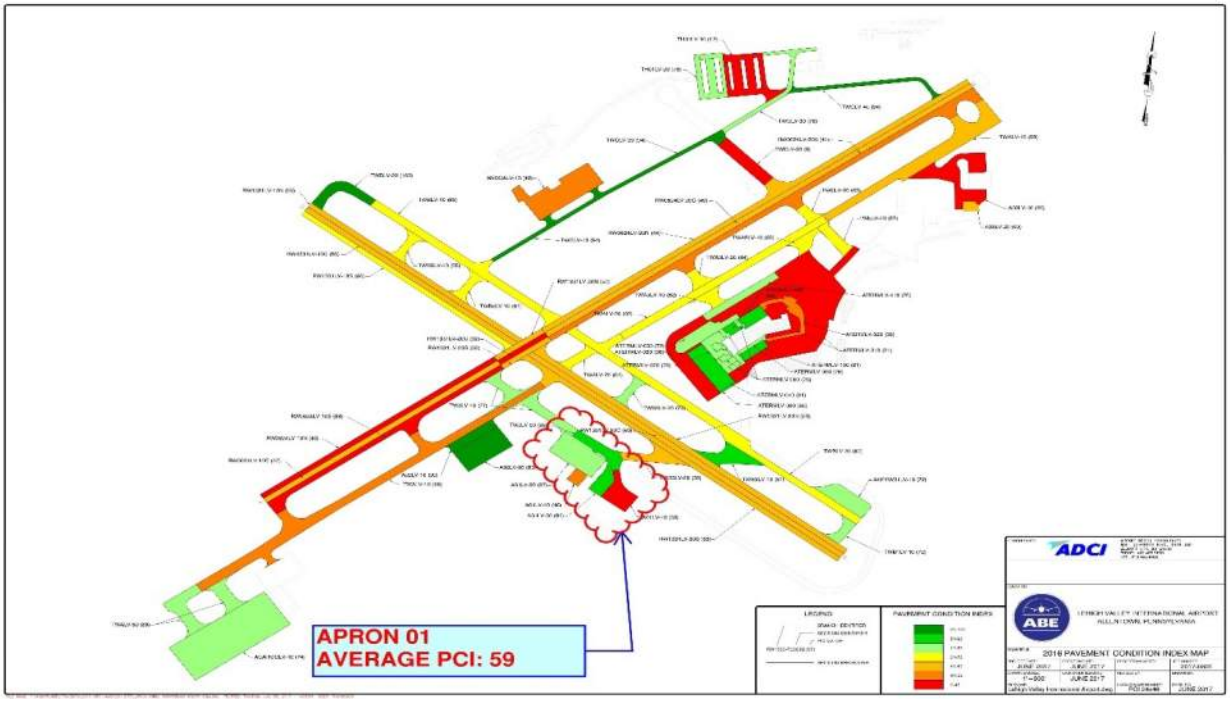
The Cargo Apron was defined by one section. Low, medium, and high severity corner spalling, joint spalling, and small patching were observed. In addition, medium and high severity joint seal damage and shrinkage cracking were identified.

Cargo Apron PCI

Apron 01:

Apron 01 was defined by four sections. Section 10 was in poor condition with substantial amounts of corner breaks, LTD cracking, shattered slabs, spalling, and Alkali Silica Reactivity (ASR) identified in varying severities. Additionally, shrinkage cracking, low severity faulting, low severity large patching, and high severity joint seal damage was observed. Low severity LTD cracking was observed in the Sections 20, 30, and 40, while medium severity was identified in Sections 20 and 40. Medium severity corner breaks were recorded in Sections 20 and 30, while only low severity corner breaks were identified in Section 40. High severity joint seal damage and shrinkage cracking was observed in each of the three sections. High severity corner spalling was observed in Section 30 producing foreign object debris (FOD) potential. Significant amounts of low and medium severity shattered slabs were observed in Section 40. Additional distress identified in Section 20 included low and medium severity small patching, large patching, ASR, corner spalling, and joint spalling.

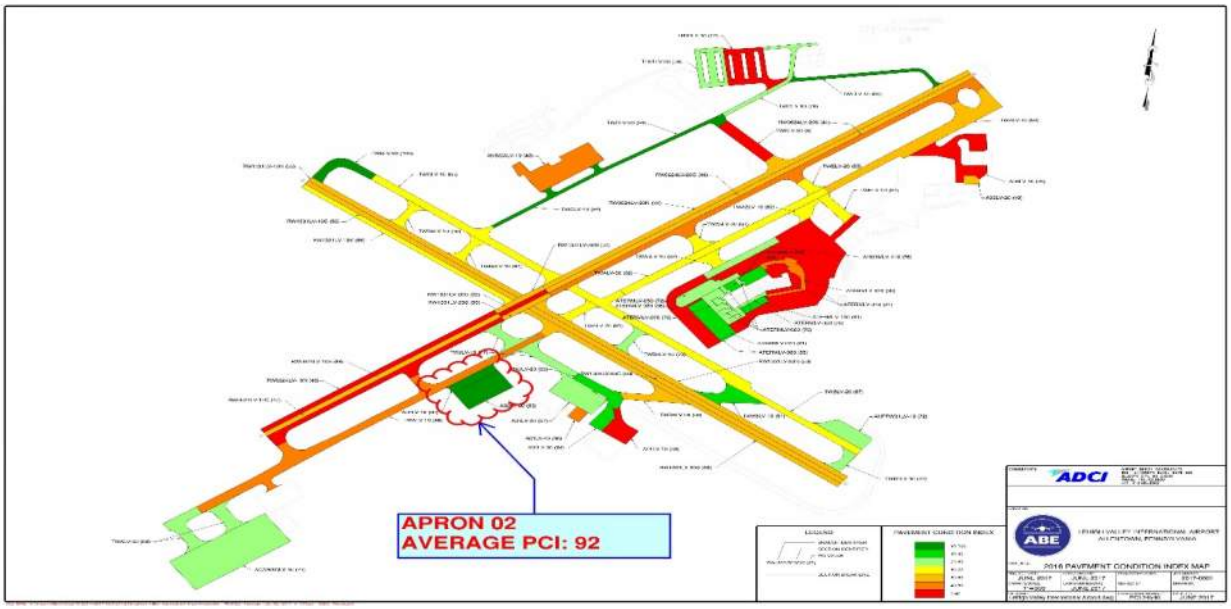
Apron 01 PCI



Apron 02:

Apron 02 consisted of two sections. Low severity L&T cracking and weathering were the only distresses observed in Section 10 during the inspection. Section 20 consisted of the PCC portion of Apron 02 and had only medium- and high-severity joint seal damage.

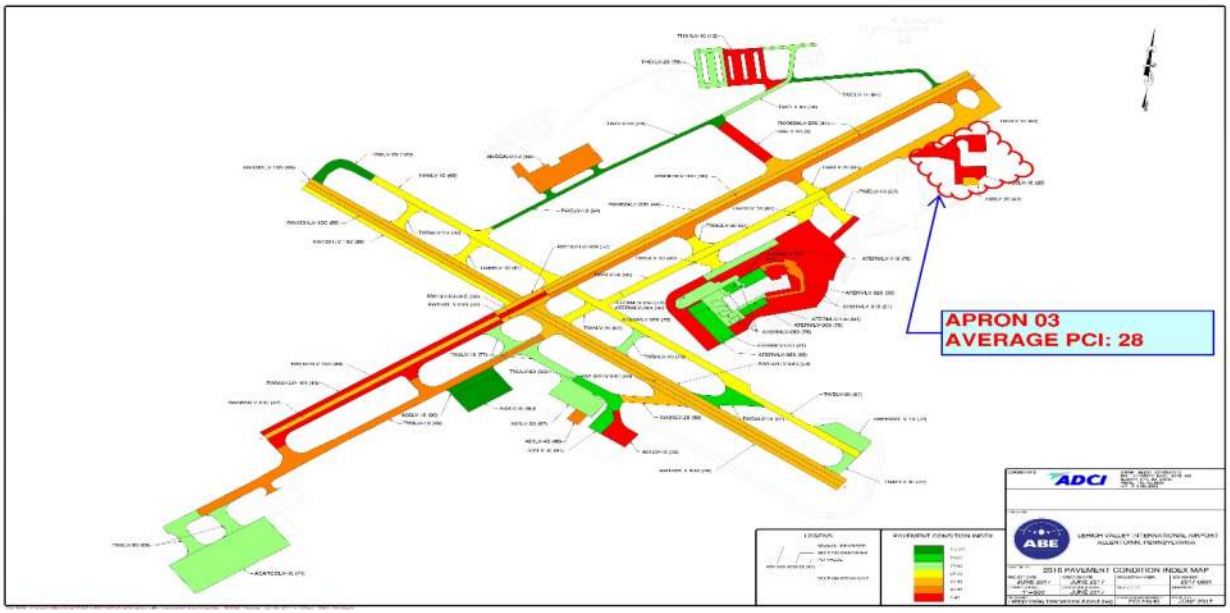
Apron 02 PCI



Apron 03:

Apron 03 was comprised of two sections. Section 10 was in poor condition with significant amounts of low and medium severity alligator cracking, block cracking, L&T cracking, patching, and weathering observed. Additional distresses identified included low severity raveling and bleeding. Section 20 had medium severity L&T cracking and joint reflection cracking observed, along with low severity weathering during the time of the inspection.

Apron 03 PCI



Maintenance and Rehabilitation Planning

The PCI data collected and analyzed for ABE can be utilized as a tool in developing a Maintenance and Rehabilitation (M&R) plan for the airport's pavement network. 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. 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. *Table 4* below illustrates how the appropriate repair types typically vary with the PCI of a pavement section.

Table 4: PCI and Repair Types

PCI		REPAIR TYPE
91-100		PREVENTIVE MAINTENANCE
81-90		
71-80		
61-70		MAJOR REHABILITATION
51-60		
41-50		
0-40		RECONSTRUCTION

Pavement Condition Prediction:

Figure 7 illustrates how pavement usually deteriorates and the relative cost of rehabilitation at various times throughout its life. Pavement generally performs well for the majority of its life, after which it reaches a "critical condition" and begins to deteriorate rapidly. Maintaining and preserving a pavement in good condition versus rehabilitating a pavement in fair to poor condition is four to five times less expensive and increases pavement useful life. Critical PCI value is defined as the PCI value at which the rate of PCI loss increases with time, or the cost of applying localized preventive maintenance increases significantly. This definition is incorporated into PAVER in defining and measuring the critical PCI values. The Critical PCI values are assigned based on the branch use which then trigger the M&R planning and analysis.

Table 5 gives a listing of PCI deterioration values over the next five years for all the branches at ABE while Figure 6 illustrates the predicted pavement condition over the next five years at ABE based on the branch use.

Table 5: PCI Values- 5-year Projected Changes

	Years				
Branch ID	2017	2018	2019	2020	2021
A01LV	57	56	55	53	52
A02LV	91	91	90	89	89
A03LV	25	23	21	19	17
ACARGOLV	71	69	67	65	63
AHPRW31LV	70	68	67	65	63
ANSGALV	39	37	35	33	31
ATERMLV	39	37	35	33	31
RW0624LV	39	35	32	29	25
RW1331LV	52	50	48	45	43
TWA2LV	60	58	57	55	54
TWA3LV	61	59	58	56	55
TWALV	53	51	48	45	42
TWB1LV	68	65	62	59	56
TWB3LV	67	65	62	60	57
TWB4LV	69	66	64	61	58
TWB5LV	56	52	49	45	41
TWB6LV	60	57	54	51	47
TWBLV	66	62	59	56	52
TWCLV	89	88	87	86	86
TWELV	33	31	29	27	27
TWJLV	75	71	67	64	60

Figure 6: PCI Prediction by Branch Use

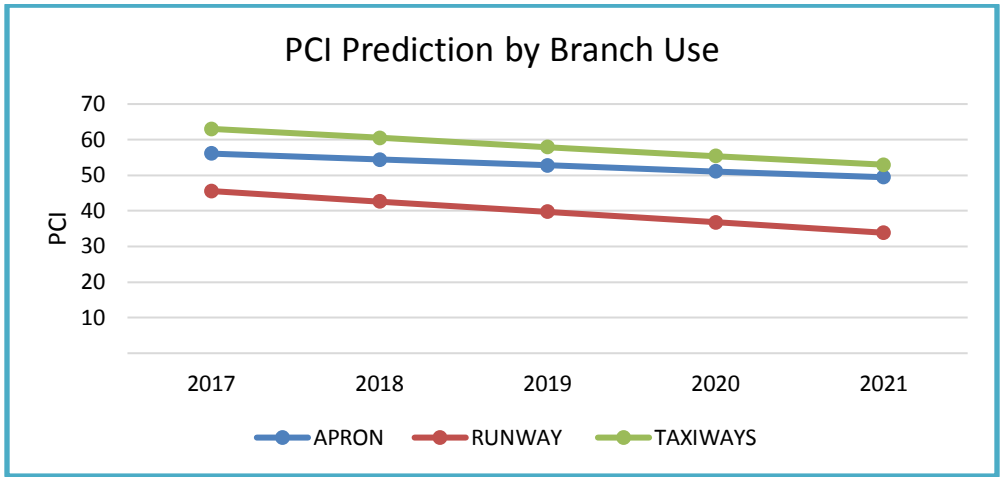
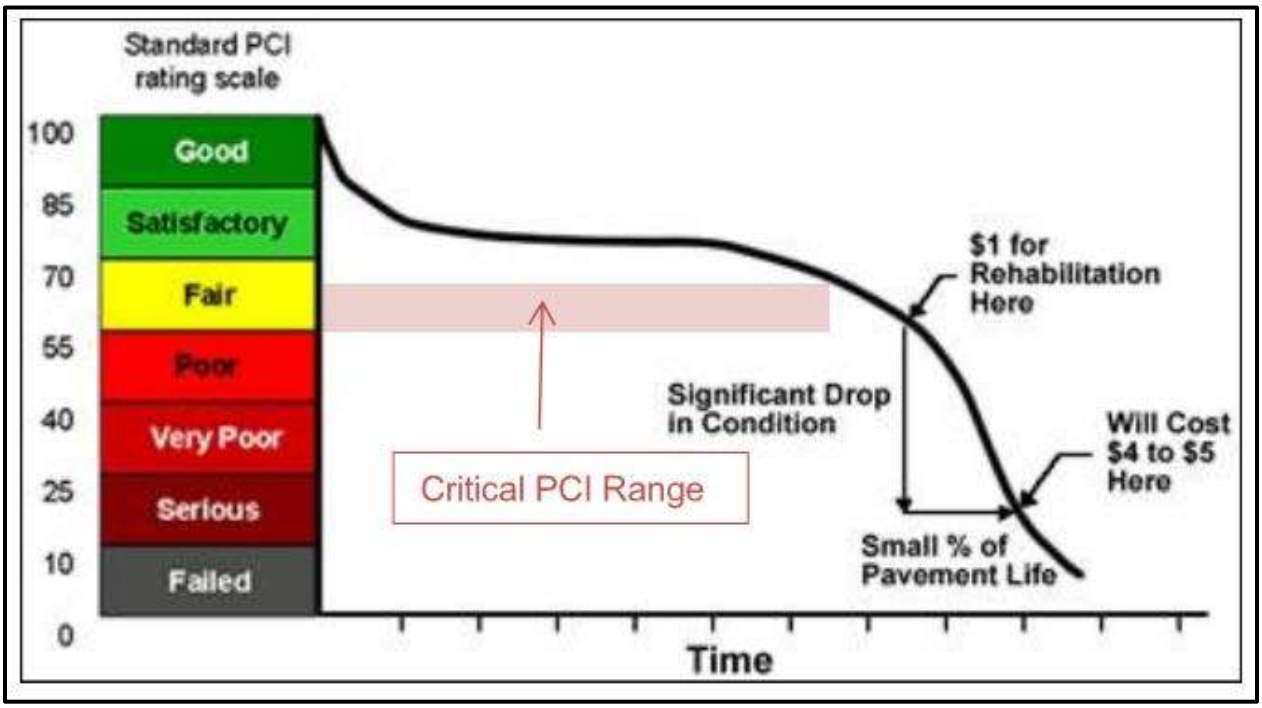


Figure 7: Pavement Deterioration Curve - Critical PCI



For ABE, the following critical PCI are recommended to be used:

- 70 for runway sections.
- 65 for taxiway and apron sections.

Based on the above critical PCI values, further analysis can be performed in PAVER using various Maintenance and Rehabilitation policies. However, further Analysis in PAVER requires input from the Authority about their capital Budget and funding source availability. The funding availability information is critical in the analysis process and enables in providing a thorough and cost-effective plan for rehabilitation of the pavements. As this information is currently unavailable, capital funding will be evaluated later in the master planning process and that will shape the priorities for the pavement projects over the next five years.

The analysis information from the PennDOT study is presented here. In the PennDOT study, PAVER was used to develop an M&R Plan under an unlimited budget scenario and an airport needs assessment was performed to identify localized preventative maintenance, global maintenance, and major M&R needs for the next five years. Order of magnitude costs were developed for the recommended repairs in each of the areas that were inspected. Monitoring and surface treatments were recommended for sections of pavement that were experiencing low to medium severity creating weathering, raveling, oil spill damage, and other surface distresses. Localized maintenance, including crack sealing, patching, and joint resealing was recommended based on the severity and quantity of distresses observed in each area. Major M&R,

including mill and overlay, full depth patches, and complete pavement reconstruction was recommended for the areas with the most significant distresses. The unit costs used to develop the overall order of magnitude costs for the repairs were based on averages for the state of Pennsylvania and are not specific to ABE or the Lehigh Valley area. These costs are intended to be used for planning purposes and only include the pavement repairs themselves. Other costs associated with engineering, construction, and project management have not been considered in this analysis. Soft costs such as design fee, Construction Management Fee and hard construction costs such as mobilization, security, temporary construction items, marking, drainage etc. have not been included.

Based on the assumptions stated in the earlier paragraph, a brief summary of the M&R plans for each of the branches along with costs generated thru PAVER are listed in the following section.

Taxiway A:

Global preventative maintenance is recommended. The last major rehabilitation occurred in 2001 for the section south of Runway 13-31, 2006 for the section between Runway 13-31 and Taxiway B, 2001 for the section between Taxiway B and Taxiway E, and 1991 for the section north of Taxiway E. Recommendation is to apply new crack sealant to repair the longitudinal cracking. Patching should also be performed to repair deterioration due to weathering, block cracking, and rutting.

- Total estimated cost of repairs = $2,167,791 (*PAVER generated value from PennDOT Study)*

Taxiway A2 and Taxiway A3:

A combination of preventive maintenance and Major M&R is recommended as the last major rehabilitation occurred in 1991. Recommendation is to apply new crack sealant to repair longitudinal cracking. Full Depth Patching should also be performed to repair alligator cracking.

- Total estimated cost of repairs = $235,262(*PAVER generated value from PennDOT Study)*

Taxiway B:

Major M&R is recommended in the distressed portions of Taxiway B aside from the westernmost section. The last major rehabilitation of the eastern portions occurred in 2005 and 2006. Recommendation is to apply new crack sealant to repair the longitudinal cracking. Partial depth patching should also be done to repair the weathering and raveling. The westernmost portion of Taxiway B was rehabilitated in 2014 and is not in need of any repairs at this time, however the pavement should be regularly monitored and preventive maintenance be performed to ensure that its condition is maintained.

- Total estimated cost of repairs = $1,325,097(*PAVER generated value from PennDOT Study)*

Taxiway B1 – Taxiway B6

Substantial M&R is needed for Taxiway B3 as the last rehabilitation was completed in 2001 and its condition is deteriorating. Recommendation is to perform partial-depth patching and AC crack sealing. Localized preventative maintenance should be performed on Taxiway B4 as the last major rehabilitation occurred in 2006. Recommendation is to perform patching to prevent further deterioration from weathering. Major M&R should be performed on Taxiway B5 and Taxiway B6 as the last major rehabilitation occurred in 2005. Recommendation is to apply new crack sealant to repair the longitudinal cracking and patching to repair the weathering. For Taxiway B5 only, patching should be done to repair raveling. Leveling patchwork should be performed on Taxiway B1. The last major rehabilitation for this section occurred in 2006.

- Total estimated cost of repairs = $344,711(*PAVER generated value from PennDOT Study)*

Taxiway C

The last major rehabilitation occurred in 1999 for the section between Taxiway E and the T Hangars and in 2004 for the other sections. Global maintenance should be conducted on the section between Taxiway E and the T Hangars. Minor localized preventative maintenance should be performed on the other sections. Recommendation is to perform crack sealing to repair the longitudinal cracking on the section between Taxiway E and the T Hangars. Monitoring the weathering in the other sections is the only thing that should be done at this time.

- Total estimated cost of repairs = $9,860(*PAVER generated value from PennDOT Study)*

Taxiway E

Major M&R is needed. The last rehabilitation was completed in 1975 for the northernmost portion, 1991 for the middle portion, and 1999 for the southernmost portion of Taxiway E. Recommendation is to perform full-depth reconstruction of the northern AC pavement section and apply new crack sealant to repair the longitudinal cracking and to closely monitor the weathering and raveling in the area south of Runway 6-24.

- Total estimated cost of repairs = $599,345(*PAVER generated value from PennDOT Study)*

Taxiway J

Localized preventative maintenance should be performed to repair the distresses observed on Taxiway J, however it is not a priority at this time as the pavement is in relatively good condition, compared to adjacent pavements. The last major rehabilitation was completed in 2010. Recommendation is to closely monitor the observed distresses.

Total estimated cost of repairs = $0(*PAVER generated value from PennDOT Study)*

Runway 6-24

Major M&R is required on Runway 6-24 as the last major rehabilitation occurred in 1999. Recommendation is to perform mill and overlay for the entire runway to remediate the existing distresses and prevent future distresses from occurring. An ongoing pavement rehabilitation project for this Runway has been funded by FAA and is currently in construction phase.

- Total estimated cost of repairs = $4,140,684(*PAVER generated value from PennDOT Study)*

Runway 13-31

Major M&R should be conducted on Runway 13-31 as the last rehabilitation was completed in 1998. Recommendation is to perform mill and overlay for the entire runway to remediate the existing distresses and prevent future distresses from occurring.

- Total estimated cost of repairs = $2,755,647(*PAVER generated value from PennDOT Study)*

Apron-01

Major M&R is required as well as localized preventative maintenance in the less-distressed sections. The last major rehabilitation occurred in 1955 for the southernmost section, 1990 in the northern section,

1993 in the southwestern section, and 1995 for the southeastern section directly adjacent to the southernmost section. Recommendation is to perform full depth slab replacement for the areas that are most significantly distressed, to apply joint sealant, patching and crack sealing in the other areas.

- Total estimated cost of repairs = $2,285,350(*PAVER generated value from PennDOT Study)*

Apron-02

Localized preventative maintenance should be performed within Apron 2 as the last major rehabilitation occurred in 2003. Recommendation is to apply new joint sealant to repair the distressed PCC and to closely monitor the AC distresses.

- Total estimated cost of repairs = $88,976(*PAVER generated value from PennDOT Study)*

Apron-03

Major M&R is required for Apron 3 as the last rehabilitation was performed in 1980. Recommendation is to perform full-depth reconstruction of both sections of the apron.

- Total estimated cost of repairs = $993,244(*PAVER generated value from PennDOT Study)*

Terminal Apron

The Terminal Apron is in need of several repairs and rehabilitation strategies, ranging from localized preventative maintenance to major M&R. Some areas of the apron near the terminal have been serviced as recently as 2011, however sections of the outer apron have not been rehabilitated since 1969. Recommendation for the Terminal Apron is to perform mill and overlay on the most distressed portions of AC pavement on the apron and to perform crack sealing and patching on the sections of AC that were less deteriorated. PCC sections should be treated with localized preventative maintenance such as patching, application of joint sealant, and crack sealing.

- Total estimated cost of AC Repairs = $4,907,187(*PAVER generated value from PennDOT Study)*

- Total estimated cost of PCC Repairs = $1,285,097(*PAVER generated value from PennDOT Study)*

Cargo Apron

Localized preventative maintenance should be conducted in the Cargo Apron as the last major rehabilitation occurred in 2003. Recommendation is to perform localized crack sealing and patching to remediate the distresses in the AC pavement in the connecting taxiways and to apply new joint sealants and PCC patches to the distressed areas within the PCC apron.

- Total estimated cost of AC repairs = $5,328 (*PAVER generated value from PennDOT Study)*

- Total estimated cost of PCC repairs = $398,950(*PAVER generated value from PennDOT Study)*

North Side General Aviation Apron

Major M&R is required in the North Side General Aviation Apron as the last rehabilitation was conducted in 1988. Recommendation is to perform mill and overlay to remediate the weathering, raveling, longitudinal and alligator cracking and to perform full-depth reconstruction of the portions of the apron

where the block cracking has developed into large gaps and pavement lips.

- Total estimated cost of repairs = $591,860(*PAVER generated value from PennDOT Study)*

Runway 31 Hold Pad

Localized joint seal maintenance and partial depth patching should be performed. The last major rehabilitation occurred in 1998.

- Total estimated cost of repairs = $53,796(*PAVER generated value from PennDOT Study)*

A summary of this work plan in tabular format has been included in **Appendix C.** The work plan has been developed for a period of 10 years starting from 2019 and ending in 2028. It has been developed in coordination with the Airport planning group and in line with the Capital Improvement Plan for the airport. It may be noted here that due to a high level of need in the capital programming requirements, a detailed study may be needed to prioritize pavement projects.

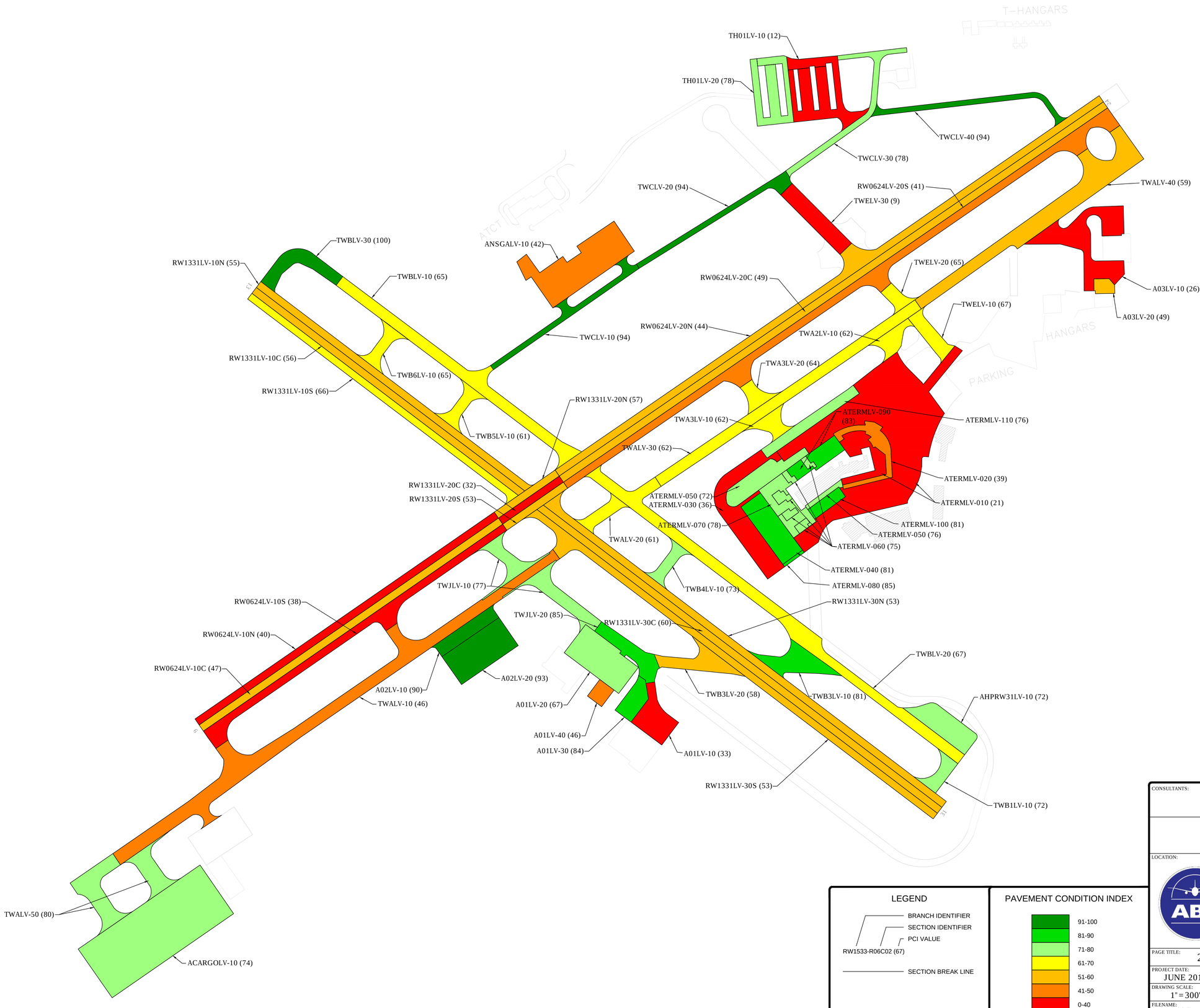
Conclusion

The primary objective of this task was to develop a comprehensive pavement management database in PAVER which will help the Authority in development of future pavement maintenance strategies.
With the PMP database in place, it is critical for the Authority to continue with the maintenance of the PAVER database to establish timely M&R programs. As such when new construction work is completed, new coring and boring data becomes available, the database needs to be updated. The continued maintenance of the PMP will ensure that the Authority management has the most current pavement condition data available for any decision-making process.

The M&R plan presented in this report is based on a network level data collection and analysis. For each project that is recommended, a more detailed analysis needs to be performed before designing and construction of new pavement. As discussed in earlier sections, ADCI discussed the funding availability with the Authority in order to come up with this M&R plan and it is in line with the Authority's budget. This will ensure that the Authority undertakes a strategic approach to Pavement Management/Rehabilitation to protect and preserve their valuable assets.

APPENDIX - A

PAVEMENT CONDITION INDEX MAP



LEGEND

- BRANCH IDENTIFIER
- SECTION IDENTIFIER
- PCI VALUE

RW1533-R06C02 (67)

SECTION BREAK LINE

PAVEMENT CONDITION INDEX

91-100
81-90
71-80
61-70
51-60
41-50
0-40

CONSULTANTS:
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LOCATION:

LEHIGH VALLEY INTERNATIONAL AIRPORT
ALLENTOWN, PENNSYLVANIA

PAGE TITLE: 2016 PAVEMENT CONDITION INDEX MAP

PROJECT DATE:	CREATION DATE:	PROJECT MANAGER:	JOB NUMBER:
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FILENAME: Lehigh Valley International Airport.dwg	LAYOUT NAME/NUMBER: PCI 24x46	PAGE_FIG: JUNE 2017	

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APPENDIX - B

BRANCH & SECTION PCI DATA

Branch Condition Report

Pavement Database: ABE-AIRSIDE

Branch ID	Number of Sections	Sum Section Length (Ft)	Avg Section Width (Ft)	True Area (SqFt)	Use	Average PCI	Standard Deviation PCI	Weighted Average PCI
A01LV	4	1,122.00	171.25	217,502.00	APRON	57.50	19.53	58.91
A02LV	2	933.00	161.50	150,746.00	APRON	91.50	1.50	92.13
A03LV	2	731.00	109.00	149,608.00	APRON	37.50	11.50	28.00
ACARGOL	1	1,000.00	400.00	400,823.00	APRON	74.00	0.00	74.00
AHPRW31L	1	525.00	160.00	70,996.00	APRON	72.00	0.00	72.00
ANSGALV	1	675.00	245.00	174,616.00	APRON	42.00	0.00	42.00
ATERMLV	11	5,085.00	127.73	1,093,170.00	APRON	66.18	21.62	41.71
RW0624LV	6	20,775.00	50.00	1,136,543.00	RUNWAY	43.17	3.89	43.35
RW1331LV	9	18,440.00	50.00	930,492.00	RUNWAY	53.89	8.70	55.95
TWA2LV	1	150.00	140.00	29,813.00	TAXIWAY	62.00	0.00	62.00
TWA3LV	2	350.00	125.00	51,199.00	TAXIWAY	63.00	1.00	62.91
TWALV	5	8,586.00	85.00	866,324.00	TAXIWAY	61.60	10.86	57.34
TWB1LV	1	250.00	85.00	26,855.00	TAXIWAY	72.00	0.00	72.00
TWB3LV	2	810.00	127.50	114,057.00	TAXIWAY	69.50	11.50	70.32
TWB4LV	1	290.00	75.00	26,728.00	TAXIWAY	73.00	0.00	73.00
TWB5LV	1	290.00	75.00	30,729.00	TAXIWAY	61.00	0.00	61.00
TWB6LV	1	290.00	75.00	30,417.00	TAXIWAY	65.00	0.00	65.00
TWBLV	3	3,905.00	716.67	476,154.00	TAXIWAY	77.33	16.05	70.27
TWCLV	4	5,290.00	36.25	212,987.00	TAXIWAY	90.00	6.93	89.54
TWELV	3	1,130.00	98.33	117,935.00	TAXIWAY	47.00	26.88	35.83
TWJLV	2	1,350.00	87.50	152,260.00	TAXIWAY	81.00	4.00	79.79

Use Category	Number of Sections	Total Area (SqFt)	Arithmetic Average PCI	Average STD PCI	Weighted Average PCI
APRON	22	2257461.00069005	63.82	22.07	52.53
RUNWAY	15	2067035.00063184	49.60	8.89	49.02
TAXIWAY	26	2135458.00065276	69.27	17.79	65.28
ALL	63	6459954.00197466	62.68	19.46	55.62

Pavement Database: ABE-AIRSIDE *NetworkId: ABE-AIR*

Branch ID	Section ID	Last Const. Date	Surface	Use	Rank	Lanes	True Area (SqFt)	Last Inspection Date	Age At Inspection	PCI
A01LV	10	6/1/1955	PCC	APRON	P	0	58,658.00	2/20/2016	61	33
A01LV	20	6/1/1990	PCC	APRON	P	0	107,491.00	2/19/2016	26	67
A01LV	30	6/1/1995	PCC	APRON	P	0	34,553.00	2/20/2016	21	84
A01LV	40	6/1/1993	PCC	APRON	P	0	16,800.00	2/20/2016	23	46
A02LV	10	6/1/2003	AC	APRON	P	0	43,796.00	2/18/2016	13	90
A02LV	20	6/1/2003	PCC	APRON	P	0	106,950.00	2/19/2016	13	93
A03LV	10	6/1/1980	AC	APRON	P	0	136,593.00	2/18/2016	36	26
A03LV	20	6/1/1980	AAC	APRON	P	0	13,015.00	2/20/2016	36	49
ACARGOLV	10	6/1/2003	PCC	APRON	P	0	400,823.00	2/19/2016	13	74
AHPRW31LV	10	6/1/1998	PCC	APRON	P	0	70,996.00	2/18/2016	18	72
ANSGALV	10	6/3/1988	AC	APRON	P	0	174,616.00	2/18/2016	28	42
ATERMLV	10	6/1/1969	AAC	APRON	P	0	567,354.00	2/18/2016	47	21
ATERMLV	100	3/1/2010	PCC	APRON	P	0	20,740.00	2/18/2016	6	81
ATERMLV	110	6/2/2011	AAC	APRON	P	0	53,224.00	2/20/2016	5	76
ATERMLV	20	6/2/1973	PCC	APRON	P	0	47,605.00	2/18/2016	43	39
ATERMLV	30	6/3/1994	AC	APRON	P	0	129,094.00	2/18/2016	22	36
ATERMLV	40	6/3/1994	PCC	APRON	P	0	78,814.00	2/18/2016	22	81
ATERMLV	50	6/3/1997	AC	APRON	P	0	74,514.00	2/27/2016	19	72
ATERMLV	60	6/1/2006	PCC	APRON	P	0	26,420.00	2/18/2016	10	75
ATERMLV	70	6/1/2006	PCC	APRON	P	0	51,941.00	2/18/2016	10	79
ATERMLV	80	6/1/2007	PCC	APRON	P	0	3,354.00	2/18/2016	9	85
ATERMLV	90	6/1/2008	PCC	APRON	P	0	40,110.00	2/18/2016	8	83
RW0624LV	10C	5/1/1999	AAC	RUNWAY	P	0	123,027.00	2/18/2016	17	47
RW0624LV	10N	5/1/1999	AAC	RUNWAY	P	0	123,000.00	2/18/2016	17	40
RW0624LV	10S	5/1/1999	AAC	RUNWAY	P	0	148,951.00	2/18/2016	17	38
RW0624LV	20C	5/1/1999	AAC	RUNWAY	P	0	223,268.00	2/18/2016	17	49
RW0624LV	20N	5/1/1999	AAC	RUNWAY	P	0	238,521.00	2/19/2016	17	44
RW0624LV	20S	5/1/1999	AAC	RUNWAY	P	0	279,776.00	2/18/2016	17	41
RW1331LV	10C	6/1/1998	AAC	RUNWAY	P	0	113,654.00	2/18/2016	18	56
RW1331LV	10N	6/1/1998	AAC	RUNWAY	P	0	114,113.00	2/18/2016	18	55
RW1331LV	10S	6/1/1998	AAC	RUNWAY	P	0	108,751.00	2/18/2016	18	66
RW1331LV	20C	6/1/1998	AAC	RUNWAY	P	0	24,999.00	2/18/2016	18	32
RW1331LV	20N	6/1/1998	AAC	RUNWAY	P	0	24,892.00	2/18/2016	18	57
RW1331LV	20S	6/1/1998	AAC	RUNWAY	P	0	24,999.00	2/18/2016	18	53
RW1331LV	30C	6/1/1998	AAC	RUNWAY	P	0	169,534.00	2/18/2016	18	60
RW1331LV	30N	6/1/1998	AAC	RUNWAY	P	0	172,989.00	2/27/2016	18	53
RW1331LV	30S	6/1/1998	AAC	RUNWAY	P	0	176,561.00	2/18/2016	18	53
TWA2LV	10	5/30/1991	AC	TAXIWAY	P	0	29,813.00	2/18/2016	25	62
TWA3LV	10	5/30/1991	AAC	TAXIWAY	P	0	27,815.00	2/18/2016	25	62
TWA3LV	20	5/30/1991	AAC	TAXIWAY	P	0	23,384.00	2/18/2016	25	64
TWALV	10	8/30/2001	AAC	TAXIWAY	P	0	341,352.00	2/18/2016	15	46
TWALV	20	6/3/2006	AC	TAXIWAY	P	0	27,993.00	2/18/2016	10	61
TWALV	30	5/30/1991	AAC	TAXIWAY	P	0	159,049.00	2/18/2016	25	62
TWALV	40	8/30/2001	AC	TAXIWAY	P	0	220,680.00	2/18/2016	15	59
TWALV	50	6/1/2003	AC	TAXIWAY	P	0	117,250.00	2/18/2016	13	80
TWB1LV	10	6/3/2006	AC	TAXIWAY	P	0	26,855.00	2/18/2016	10	72
TWB3LV	10	6/3/2006	AC	TAXIWAY	P	0	61,074.00	2/18/2016	10	81
TWB3LV	20	8/30/2001	AC	TAXIWAY	P	0	52,983.00	2/19/2016	15	58

TWB4LV	10	6/3/2006	AC	TAXIWAY	P	0	26,728.00	2/18/2016	10	73
TWB5LV	10	6/3/2005	AC	TAXIWAY	P	0	30,729.00	2/18/2016	11	61
TWB6LV	10	6/3/2005	AC	TAXIWAY	P	0	30,417.00	2/18/2016	11	65
TWBLV	10	6/3/2005	AC	TAXIWAY	P	0	162,631.00	2/18/2016	11	65
TWBLV	20	6/3/2006	AC	TAXIWAY	P	0	256,453.00	2/18/2016	10	67
TWBLV	30	6/3/2014	AC	TAXIWAY	P	0	57,070.00	2/18/2016	2	100
TWCLV	10	4/30/2004	AAC	TAXIWAY	P	0	53,267.00	2/18/2016	12	94
TWCLV	20	5/15/2004	AC	TAXIWAY	P	0	50,457.00	2/18/2016	12	94
TWCLV	30	6/30/1999	AC	TAXIWAY	P	0	59,400.00	2/18/2016	17	78
TWCLV	40	5/15/2004	AC	TAXIWAY	P	0	49,863.00	2/18/2016	12	94
TWELV	10	6/1/1999	AC	TAXIWAY	P	0	35,636.00	2/18/2016	17	67
TWELV	20	6/1/1991	AC	TAXIWAY	P	0	19,604.00	2/18/2016	25	65
TWELV	30	9/1/1975	AC	TAXIWAY	P	0	62,695.00	2/18/2016	41	9
TWJLV	10	8/1/2010	AC	TAXIWAY	P	0	99,195.00	2/18/2016	6	77
TWJLV	20	10/1/2010	AC	TAXIWAY	P	0	53,065.00	2/18/2016	6	85

Section Condition Report (Summary)

Pavement Database: ABE-AIRSIDE

Age Category	Average Age at Inspection	Total Area (SqFt)	Number of Sections	Arithmetic Average PCI	Standard Deviation PCI	Weighted Average PCI
00-02	2	57,070.00	1	100.00	0.00	100.00
03-05	5	53,224.00	1	76.00	0.00	76.00
06-10	9	693,928.00	12	76.58	7.06	73.85
11-15	13	1,661,198.00	13	74.85	16.27	68.37
16-20	18	2,307,581.00	19	54.37	12.28	51.49
21-25	24	518,926.00	9	62.44	14.10	59.57
26-30	27	282,107.00	2	54.50	12.50	51.53
36-40	36	149,608.00	2	37.50	11.50	28.00
41-50	44	677,654.00	3	23.00	12.33	21.15
Over 50	61	58,658.00	1	33.00	0.00	33.00
ALL	18	6,459,954.00	63	62.68	19.46	55.62

APPENDIX - C

10 YEAR M&R WORK PLAN

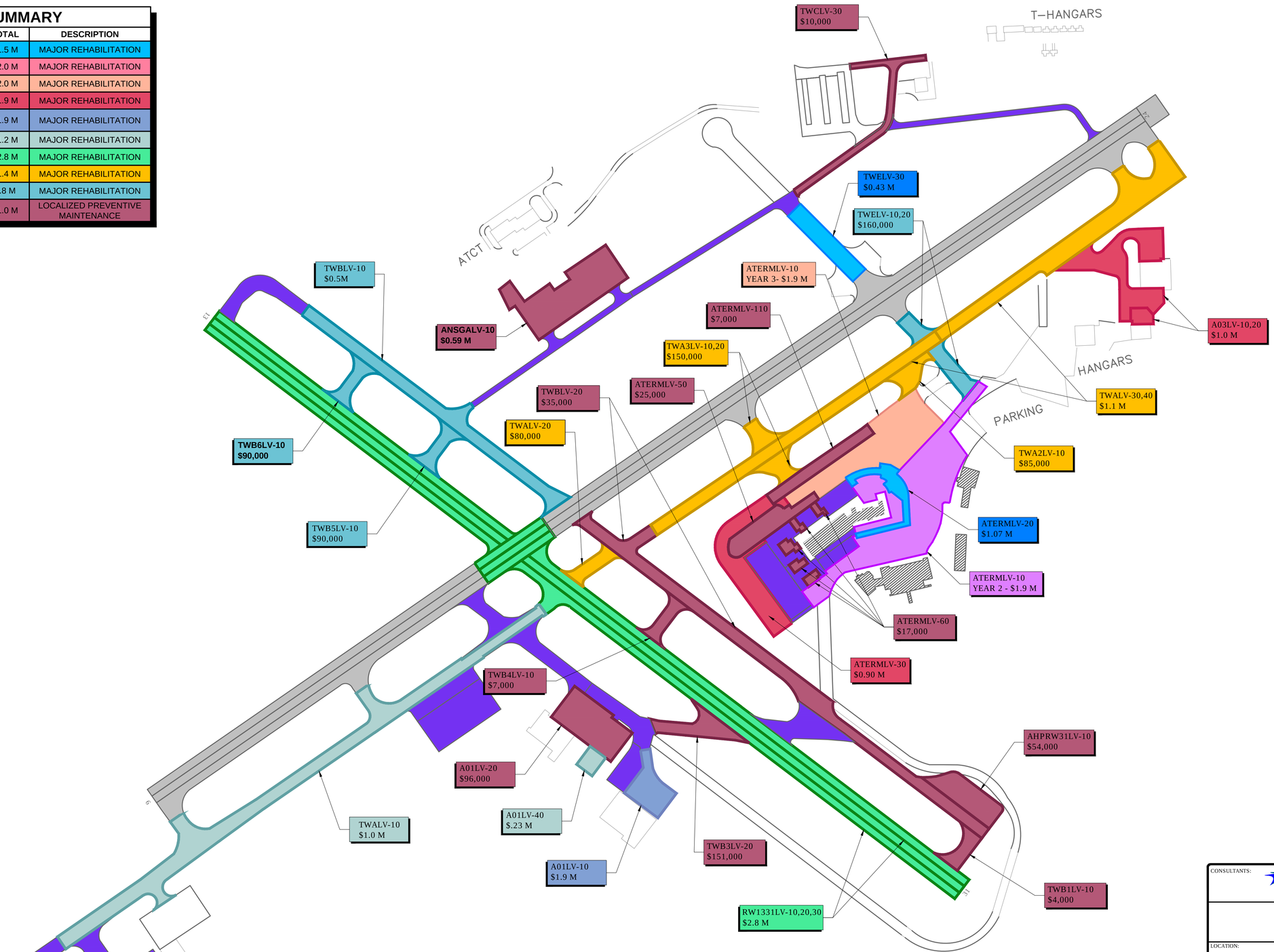
ABE AIRSIDE PMP
M&R WORK PLAN (2019-2028)

Plan Year	Branch	Section	Projected PCI in 2019	Localized Preventive Maintenance	Global Maintenance	Major Rehabilitation	Total Cost	YEAR	COST PER YEAR
2019	TWELV	30	5	$0	$0	$438,865	$438,865	YEAR 1	$ 1.5 M
	ATERMLV	20	37	$0	$0	$1,070,502	$1,070,502		
2020	ATERMLV	10	20	$0	$0	$1,985,740	$1,985,740	YEAR 2	$ 2.0 M
2021	ATERMLV	10	20	$0	$0	$1,985,740	$1,985,740	YEAR 3	$ 2.0 M
2022	ATERMLV	30	34	$0	$0	$903,658	$903,658	YEAR 4	$ 1.9 M
	A03LV	10	23	$0	$0	$956,151	$956,151		
	A03LV	20	46	$0	$0	$37,093	$37,093		
2023	A01LV	10	30	$0	$0	$1,897,586	$1,897,586	YEAR 5	$ 1.9 M
2024	A01LV	40	44	$0	$0	$236,967	$236,967	YEAR 6	$ 1.2 M
	TWALV	10	44	$0	$0	$972,852	$972,852		
2025	RW1331LV	20S	51	$0	$0	$71,247	$71,247	YEAR 7	$ 2.8 M
	RW1331LV	20N	55	$0	$0	$70,942	$70,942		
	RW1331LV	30C	57	$0	$0	$483,171	$483,171		
	RW1331LV	10N	54	$0	$0	$325,222	$325,222		
	RW1331LV	30N	51	$0	$0	$493,018	$493,018		
	RW1331LV	10C	54	$0	$0	$323,913	$323,913		
	RW1331LV	20C	30	$0	$0	$174,993	$174,993		
	RW1331LV	30S	51	$0	$0	$503,198	$503,198		
	RW1331LV	10S	63	$0	$0	$309,943	$309,943		
2026	TWA2LV	10	61	$0	$0	$84,967	$84,967	YEAR 8	$ 1.4 M
	TWA3LV	10	60	$0	$0	$81,651	$81,651		
	TWA3LV	20	61	$0	$0	$68,644	$68,644		
	TWALV	20	59	$0	$0	$79,780	$79,780		
	TWALV	30	59	$0	$0	$480,894	$480,894		
	TWALV	40	57	$0	$0	$628,937	$628,937		
2027	TWB5LV	10	58	$0	$0	$87,578	$87,578	YEAR 9	$ .8 M
	TWB6LV	10	62	$0	$0	$89,289	$89,289		
	TWBLV	10	62	$0	$0	$491,725	$491,725		
	TWELV	10	65	$0	$0	$104,609	$104,609		
	TWELV	20	62	$0	$0	$55,871	$55,871		
2028	A01LV	20	65	$96,141	$0	$0	$96,141	YEAR 10	$ 1.0 M
	AHPRW31LV	10	70	$53,796	$0	$0	$53,796		
	ATERMLV	50	70	$5,609	$19,374	$0	$24,982		
	ATERMLV	60	73	$16,935	$0	$0	$16,935		
	ATERMLV	110	73	$7,068	$0	$0	$7,068		
	TWB1LV	10	71	$3,990	$0	$0	$3,990		
	TWB3LV	20	60	$0	$0	$151,001	$151,001		
	TWB4LV	10	71	$7,207	$0	$0	$7,207		
	TWBLV	20	65	$34,709	$0	$0	$34,709		
	TWCLV	30	75	$9,860	$0	$0	$9,860		
	ANSGALV	10	40	$0	$0	$591,860	$591,860		

TOTAL =	$ 16.5 M

M&R COST SUMMARY

YEAR	TOTAL	DESCRIPTION
TOTAL M&R COST FOR YEAR - 1 (2019)	$1.5 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 2 (2020)	$2.0 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 3 (2021)	$2.0 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 4 (2022)	$1.9 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 5 (2023)	$1.9 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 6 (2024)	$1.2 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 7 (2025)	$2.8 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 8 (2026)	$1.4 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 9 (2027)	$.8 M	MAJOR REHABILITATION
TOTAL M&R COST FOR YEAR - 10 (2028)	$1.0 M	LOCALIZED PREVENTIVE MAINTENANCE



LEGEND

- BRANCH IDENTIFIER
- SECTION IDENTIFIER
- RW1533-R06C02
- SECTION BREAK LINE

M&R WORK PLAN

- YEAR-1 (2019)
- YEAR-2 (2020)
- YEAR-3 (2021)
- YEAR-4 (2022)
- YEAR-5 (2023)
- YEAR-6 (2024)
- YEAR-7 (2025)
- YEAR-8 (2026)
- YEAR-9 (2027)
- YEAR-10 (2028)
- REHABILITATION DESIGN UNDERWAY, CONSTRUCTION EXPECTED IN YEARS (2019-2022)
- SECTIONS WITH PCI GREATER THAN 75 (NO REHABILITATION)

CONSULTANTS:
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AIRPORT DESIGN CONSULTANTS
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LOCATION:

LEHIGH VALLEY INTERNATIONAL AIRPORT
ALLENTOWN, PENNSYLVANIA

PAGE TITLE: 2018 M&R PLAN

PROJECT DATE:	CREATION DATE:	PROJECT MANAGER:	JOB NUMBER:
JUNE 2017	JAN 2018		2017-0801
DRAWING SCALE:	LAST MODIFIED DATE:	REVISED BY:	DRAWN BY:
1" = 300'	FEB 2018		
FILENAME: Lehigh Valley International Airport.dwg		LAYOUT NAME/NUMBER: M&R 24x36	PAGE_FIG

FILE NAME: P:\Airport\ABE\PROJECTS\2017-0801\CAD\EXHIBITS\M&R_EXHIBITS\Lehigh Valley International Airport.dwg PLOTTED: Tuesday, February 06, 2018 - 2:30pm USER: rkondapalli

APPENDIX - D

PAVEMENT DISTRESSES DESCRIPTION

Appendix C - PCI Distress Descriptions

1. Alligator Cracking (AC)

Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. The cracking initiates at the bottom of the asphalt concrete surface (or stabilized base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks. After repeated traffic loading, the cracks connect, forming pieces that coalesce into a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 feet (0.6 meters) on the longest side.

Severities:

- Low - Fine longitudinal hairline cracks running parallel to one another with none or only a few interconnecting cracks. The cracks are not spalled.
- Medium - Further development of light alligator cracking into a network of cracks that may be lightly spalled. Medium-severity alligator cracking is defined by an apparent pattern of interconnecting cracks, where all pieces are securely held in place (good aggregate interlock between pieces).
- High – Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges; some of the pieces may rock under traffic and may cause FOD potential.

Repair options:

- Low - No action, surface seal or overlay for low severity distress;
- Medium – A partial or full depth patch, overlay or reconstruct;
- High - partial or full depth patch, overlay, or reconstruct.

2. Bleeding (AC)

Bleeding is a film of bituminous material on the pavement surface that creates a glass- like surface that usually becomes sticky. Bleeding is caused by excessive amounts of asphaltic cement or tars in the mix or low-air void content, or both. It occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

Severities: No degrees of severity are defined.

Repair Policies: Do nothing; sand blot the distressed area by applying heat and roll sand into the areas affected with bleeding, remove the excess material; patch.

3. Block Cracking (AC)

Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from 1 foot by 1 foot to 10 feet by 10 feet (0.3 meters by 0.3 meters to 3 meters by 3 meters). Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling (that results in daily stress/strain cycling). It is not load associated. The occurrence of block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large proportion of pavement area, but will sometimes occur only in the non-traffic areas. This type of distress differs from alligator cracking in that the alligator cracks form smaller, many-sided pieces with sharp
angles. Also unlike block cracks, alligator cracks are caused by repeated traffic loadings and are therefore located only in traffic areas (that is, wheel paths).

Severities:

- Low – Blocks are defined by cracks that are at non-spalled (sides of the cracks are vertical) or lightly spalled, causing no FOD potential. Non-filled cracks have 1/4 inch (6 mm) or less mean width and filled cracks have filler in satisfactory condition;
- Medium – Blocks are defined by either: filled or non-filled cracks that are moderately spalled (some FOD potential); non-filled cracks that are not spalled or have only minor spalling (some FOD potential), but have a mean width greater than approximately 1/4 inch (6 mm); or filled cracks greater than 1/4 inch that are spalled or have only minor spalling (some FOD potential), but have filler in unsatisfactory condition;
- High – Blocks are well defined by cracks that are severely spalled, causing a definite FOD potential.

Repair Policies:

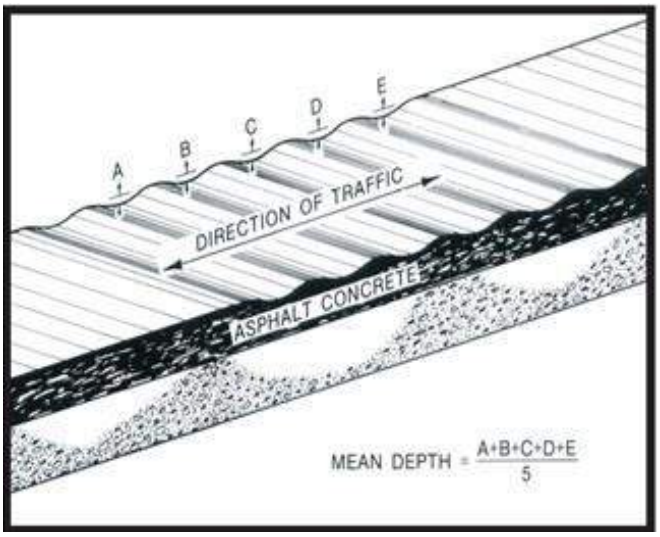
- Low - No action;
- Medium - seal cracks, apply rejuvenator, recycle surface or heat scarify and overlay;
- High - recycle surface or heat scarify and overlay.

4. Corrugation (AC)

Corrugation is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals, usually less than 5 feet (1.5 meters) along the pavement. The ridges are perpendicular to the traffic direction. Traffic action combined with an unstable pavement surface or base usually causes this type of distress.

Severities:

- Low - Corrugations are minor and do not significantly affect ride quality (see measurement criteria below).
- Medium - Corrugations are noticeable and significantly affect ride quality (see measurement criteria below).
- High - Corrugations are easily noticed and severely affect ride quality (see measurement criteria below).



5. Depression (AC)

Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. In many instances, light depressions are not noticeable until after a rain, when ponding water creates "birdbath" areas; but the depressions can also be located without rain because of stains created by ponding of water. Depressions can be caused by settlement of the foundation soil or can be built during construction. Depressions cause roughness and when filled with water of sufficient depth, could cause hydroplaning of aircraft.

Severities:

- Low - Depression can be observed or located by stained areas, only slightly affects pavement riding quality, and may cause hydroplaning potential on runways. Maximum depth 1/8 to 1/2 inch for runways, 1/2 to 1 inch for taxiways and aprons;
- Medium - The depression can be observed, moderately affects pavement riding quality, and causes hydroplaning potential on runways. Maximum depth 1/2 to 1 inch for runways, 1 to 2 inches for taxiways and aprons;
- High - The depression can be readily observed, severely affects pavement riding quality, and causes definite hydroplaning potential; Depth greater than 1 inch for runways, greater than 2 inches for taxiways and aprons;.

Repair Policies:

- Low - No action;
- Medium - Shallow, partial or full depth patch;
- High - Shallow, partial or full depth patch.

6. Jet Blast (AC)

Jet blast erosion causes darkened areas on the pavement surface when bituminous binder has been burned or carbonized. Localized burned areas may vary in depth up to approximately 1/2 inch (13 millimeters).

Severities:

No degrees of severity are defined. It is sufficient to indicate that jet blast erosion exists.

7. Joint Reflection Cracking (AC)

This distress occurs only on pavements having an asphalt or tar surface over a PCC slab. This category does not include reflection cracking from any other type of base (that is, cement stabilized, lime stabilized). Such cracks are listed as longitudinal and transverse cracks. Joint-reflection cracking is caused mainly by movement of the PCC slab beneath the AC surface because of thermal and moisture changes; it is not load related. However, traffic loading may cause a breakdown of the AC near the crack, resulting in spalling and FOD potential. If the pavement is fragmented along a crack, the crack is said to be spalled. Knowledge of slab dimensions beneath the AC surface will help to identify these cracks.

Severities:

- Low - Cracks have only light spalling (little or no FOD potential) or no spalling and can be filled or non-filled. If non-filled, the cracks have a mean width of 1/4 inch (6 millimeters) or less; filled cracks are of any width, but their filler material is in satisfactory condition.
- Medium - One of the following conditions exists: (1) cracks are moderately spalled (some FOD potential) and can be either filled or non-filled of any width; (2) filled cracks are not spalled or are only lightly spalled, but the filler is in unsatisfactory condition; (3) non-filled cracks are not spalled or are only lightly spalled, but the mean crack width is greater than 1/4 inch (6 millimeters); or (4) light random cracking exists near the crack or at the corner of intersecting cracks.
- High - Cracks are severely spalled with pieces loose or missing causing definite FOD potential. Cracks can be either filled or non-filled of any width.

8. Longitudinal and Transverse Cracking (AC)

Longitudinal cracks are parallel to the pavement's centerline or laydown direction. They may be caused by (1) a poorly constructed paving lane joint, (2) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or (3) a reflective crack caused by cracks beneath the surface course, including cracks in PCC slabs (but not PCC joints). Transverse cracks extend across the pavement at approximately right angles to the pavement centerline or direction of laydown. They may be caused by (2) or (3) (as stated above). These types of cracks are not usually load associated. If the pavement is fragmented along a crack, the crack is said to be spalled.

Severities:

- Low - Cracks have only light spalling (little or no FOD potential) or no spalling, the cracks have a mean width of 1/4 inch (6 mm) or less; cracks are any width but their filler is in satisfactory condition.
- Medium - One of the following conditions exists: (1) cracks are moderately spalled (some FOD potential) and can be either filled or non-filled of any width; (2) filled cracks are not spalled or are lightly spalled, but filler is in unsatisfactory condition; (3) non-filled cracks are not spalled or are only lightly spalled, but the crack width is greater than 1/4 inch (6 mm); or (4) light random cracking exists near the crack or at the corner of the intersecting cracks;
- High – Cracks are severely spalled and pieces are loose or missing causing definite FOD potential. Cracks can be either filled or non-filled of any width.

Repair Policies:

- Low - No action;
- Medium - seal cracks;
- High - seal cracks or perform a full depth patch.

9. Oil Spillage (AC)

Oil spillage is the deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.

Severities: No degrees of severity are defined. It is sufficient to indicate that oil spillage exists.

Repair Policies:

- Do nothing;
- Partial or full depth patch.

10. Patching (AC)

A patch is considered a defect, no matter how well it is performing.

Severities:

- Low - In good condition and is performing satisfactorily;
- Medium - Patch is somewhat deteriorated and affects ride quality to some extent. Moderate amount of distress is present within the patch or has FOD potential, or both.
- High - Patch is badly deteriorated and affects ride quality significantly or has high FOD potential. Patch soon needs replacement.

Repair options:

- Low - No action.
- Medium - seal cracks, repair the distresses in the patch or replace the patch;
- High - replace the patch.

11. **Polished Aggregate** (AC)

Aggregate polishing is caused by repeated traffic applications. Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small, or there are no rough or angular aggregate particles to provide good skid resistance.

Severities:

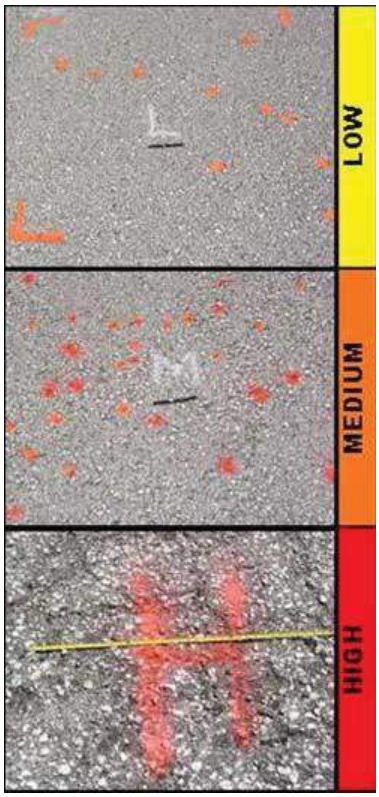
No degrees of severity are defined. However, the degree of polishing should be clearly evident in the sample unit, in that the aggregate surface should be smooth to the touch.

12. Raveling (AC)

Definition
Raveling is the dislodging of coarse aggregate particles from the pavement surface.

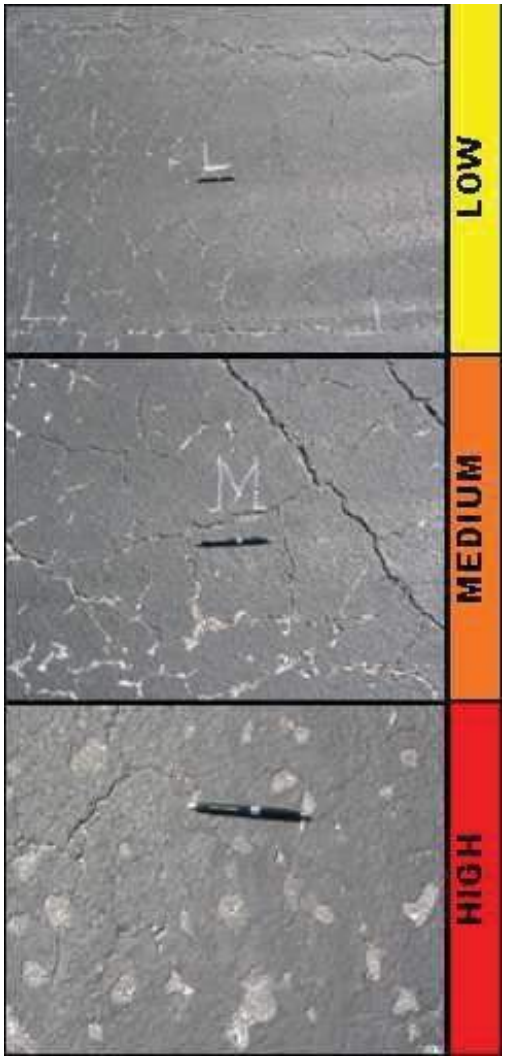
Dense Mix Severities:
As used herein, coarse aggregate refers to predominant coarse aggregate sizes of the asphalt mix. Aggregate clusters refer to when more than one adjoining coarse aggregate piece is missing. If in doubt about a severity level, three representative areas of one square yard each (one square meter) should be examined and the number of missing coarse aggregate particles counted.

- Low – (1) In a square yard (square meter) representative area, the number of coarse aggregate particles missing is between 5 and 20, and/or (2) missing aggregate clusters are less than 2 percent of the examined square yard (square meter) area. In low severity raveling, there is little or no FOD potential.
- Medium - (1) In a square yard (square meter) representative area, the number of coarse aggregate particles missing is between 21 and 40 and/or (2) missing aggregate clusters are between 2 and 10 percent of the examined square yard (square meter) area. In medium severity raveling, there is some FOD potential.
- High - (1) In a square yard (square meter) representative area, the number of coarse aggregate particles missing is over 40, and/or (2) missing aggregate clusters are more than 10 percent of the examined square yard (square meter) area. In high severity raveling, there is significant FOD potential.



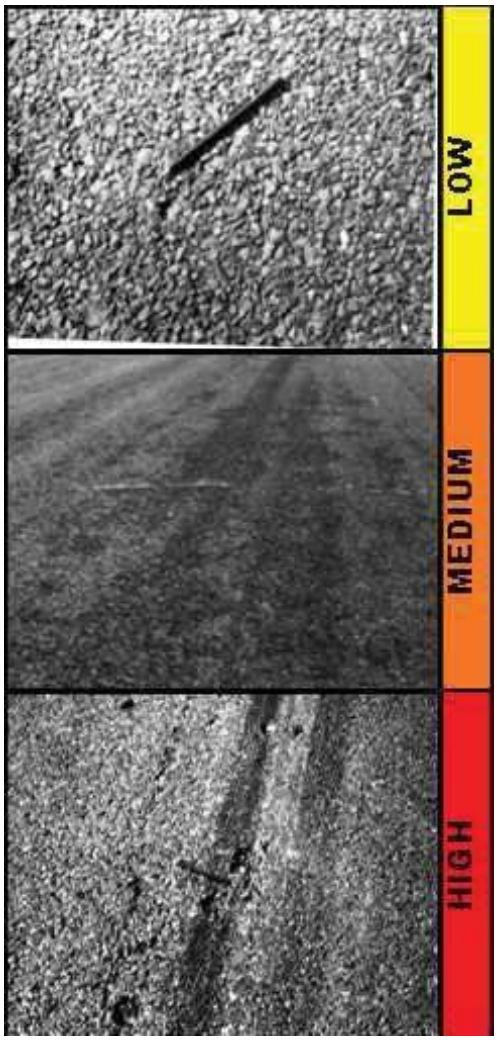
Slurry Seal/ Coal Tar over Dense Mix Severities:

- Low – (1) The scaled area is less than 1 percent. (2) In the case of coal tar where pattern cracking has developed, the surface cracks are less than 1/4 inch (6 mm) wide.
- Medium - (1) The scaled area is between 1 and 10 percent. (2) In the case of coal tar where pattern cracking has developed, the cracks are 1/4 inch (6 mm) wide or greater.
- High - (1) The scaled area is over 10 percent. (2) In the case of coal tar the surface is peeling off.



Porous Friction Course Severities:

- Low - In a 1 square foot (1/10 square meter) representative sample, the number of aggregate pieces missing is between 5 and 20 and/or the number of missing aggregate clusters does not exceed 1.
- Medium - In a 1 square foot (1/10 square meter) representative sample, the number of aggregate pieces missing is between 21 and 40 and/or the number of missing aggregate clusters is greater than 1 but does not exceed 25 percent of the area.
- High - In a 1 square foot (1/10 square meter) representative sample, the number of aggregate pieces missing is over 40 and/or the number of missing aggregate clusters is greater than 25 percent of the area.



13. Rutting (AC)

A rut is a surface depression in the wheel path. Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or sub-grade; usually caused by consolidation or lateral movement of the materials due to traffic loads. Significant rutting can lead to major structural failure of the pavement.

Severities (based on rut depth):

- Low - between ¼ and ½ inch in depth (< 6 to 13 mm);
- Medium - between ½ and 1 inch in depth (> 13 to < 25 mm);
- High - exceeds 1 inch in depth (> 25 mm).

Repair options:

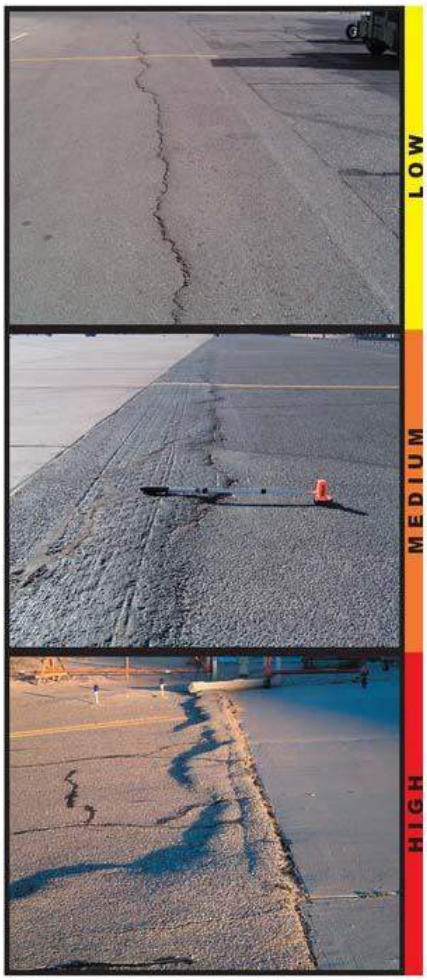
- Low - No action;
- Medium - patch and/or overlay;
- High - patch and/or overlay.

14. Shoving (AC)

PCC pavements occasionally in length at ends where they adjoin flexible pavements (commonly referred to as "pavement growth"). This "growth" shoves the asphalt or tar surfaced pavements, causing them to swell and crack. The PCC slab "growth" is caused by a gradual opening up of the joints as they are filled with incompressible materials that prevent them from reclosing.

Severities:

- Low - A slight amount of shoving has occurred and no breakup of the asphalt pavement; < ¾ inch in depth (< 20 mm).
- Medium - A significant amount of shoving has occurred, causing moderate roughness and little or no breakup of the asphalt pavement; between ¾ and 1½ inches in depth (> 20 mm to 40 mm).
- High – A large amount of shoving has occurred, causing severe roughness or breakup of the asphalt pavement; > 1½ inches in depth (> 40mm).



15. Slippage Cracking (AC)

Slippage cracks are crescent- or half-moon shaped cracks having two ends pointed away from the direction of traffic. They are produced when braking or turning wheels cause the pavement surface to slide and deform. This usually occurs when there is a low-strength surface mix or poor bond between the surface and next layer of pavement structure.

Severities:

No degrees of severity are defined. It is sufficient to indicate that a slippage crack exists.

Repair Policies:

- Do nothing;
- Partial or full depth patch.

16. Swelling (AC)

Description

A swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell can be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil, but a small swell can also occur on the surface of an asphalt overlay (over PCC) as a result of a blow- up in the PCC slab.

Severity Levels

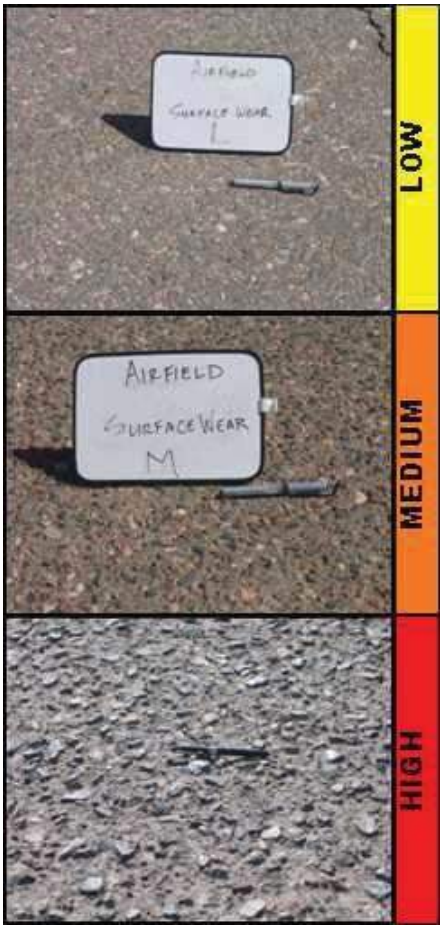
- Low - Swell is barely visible and has a minor effect on the pavement's ride quality. (Low-severity swells may not always be observable, but their existence can be confirmed by driving a vehicle over the section. An upward acceleration will occur if the swell is present).
- Medium - Swell can be observed without difficulty and has a significant effect on the pavement's ride quality.
- High - Swell can be readily observed and severely affects the pavement's ride quality.

17. Weathering (AC)

The wearing away of the asphalt binder and fine aggregate matrix from the pavement surface.

Severities:

- Low - Asphalt surface beginning to show signs of aging which may be accelerated by climatic conditions. Loss of the fine aggregate matrix is noticeable and may be accompanied by fading of the asphalt color. Edges of the coarse aggregates are beginning to be exposed (less than 0.05 inches or 1 mm). Pavement may be relatively new (as new as 6 months old).
- Medium - Loss of fine aggregate matrix is noticeable and edges of coarse aggregate have been exposed up to 1/4 width (of the longest side) of the coarse aggregate due to the loss of fine aggregate matrix.
- High - Edges of coarse aggregate have been exposed greater than 1/4 width (of the longest side) of the coarse aggregate. There is considerable loss of fine aggregate matrix leading to potential or some loss of coarse aggregate.

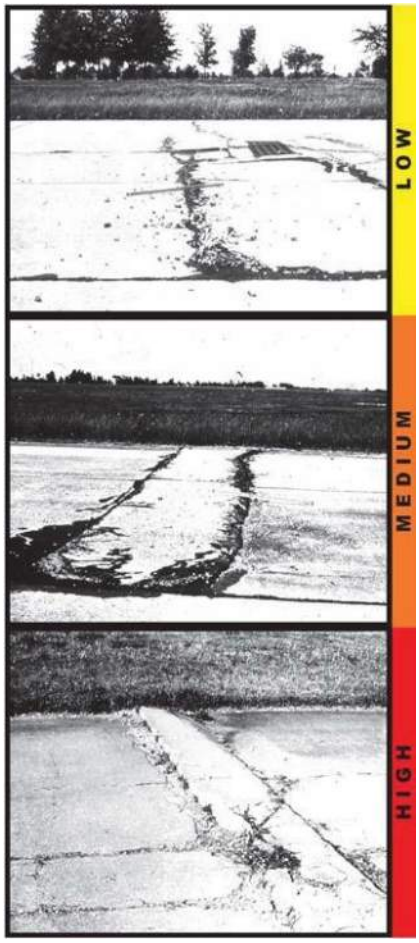


18. Blow-Up (PCC)

Blowups occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion by the concrete slabs. The insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups can also occur at utility cuts and drainage inlets. This type of distress is almost always repaired immediately because of severe damage potential to aircraft. Blowups are included for reference when closed sections are being evaluated for reopening.

Severities:

- Low - Buckling or shattering has not rendered the pavement inoperable, and only a slight amount of roughness exists.
- Medium - Buckling or shattering has not rendered the pavement inoperable, but a significant amount of roughness exists.
- High - Buckling or shattering has rendered the pavement inoperable.



19. Corner Breaks (PCC)

A corner break is a crack that intersects the joints at a distance less than or equal to one half of the slab length on both sides, measured from the corner of the slab. For example, a slab with dimensions of 25 by 25 feet (7.5 by 7.5 meters) that has a crack intersecting the joint 5 feet (1.5 meters) from the corner on one side and 17 feet (2 meters) on the other side is not considered a corner break; it is a diagonal crack. However, a crack that intersects 7 feet (2 meters) on one side and 10 feet (3 meters) on the other is considered a corner break. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle. Load repetition combined with loss of support and curling stresses usually causes corner breaks.

Severities:

- Low - Crack has little or minor spalling (no FOD potential). If non-filled, it has a mean width less than approximately 1/8 inch (3 mm). A filled crack can be of any width, but the filler material must be in satisfactory condition. The area between the corner break and the joints is not cracked.
- Medium - One of the following conditions exists: (1) filled or non-filled crack is moderately spalled (some FOD potential), (2) a non-filled crack has a mean width between 1/8 and 1 inch (3 and 25 mm), (3) a filled crack is not spalled or only lightly spalled, but the filler is in unsatisfactory condition, or (4) the area between the corner break and the joints is lightly cracked. Lightly cracked means one low-severity crack dividing the corner into two pieces.
- High - One of the following conditions exists: (1) filled or non- filled crack is severely spalled, causing definite FOD potential; (2) a non- filled crack has a mean width greater than approximately 1 inch (25 millimeters), creating potential tire damage, or (3) the area between the corner break and the joints is severely cracked.

Repair options:

- Low - No action or seal cracks;
- Medium - seal cracks;
- High - seal cracks, apply a full depth patch or replace the slab.

20. Cracks: Longitudinal, Transverse and Diagonal (PCC)

These cracks, which divide the slab into two or three pieces, are usually caused by a combination of load repetition, curling stresses, and shrinkage stresses. (For slabs divided into four or more pieces, see Shattered Slab/Intersecting Cracks.) Low-severity cracks are usually warping or friction related and are not considered major structural distresses. Medium or high severity cracks are usually working cracks and are considered major structural distresses.

Severities:

- Low - Crack has no spalling or minor spalling (no FOD potential). If non-filled, it is less than 1/8 inch (3 mm) wide; a filled crack can be of any width, but its filler material must be in satisfactory condition; or the slab is divided into three pieces by low-severity cracks;
- Medium - One of the following conditions exists: (1) filled or non-filled crack is moderately spalled (some FOD potential), (2) a non-filled crack has a mean width between 1/8 and 1 inch (3 and 25 mm), (3) a filled crack is not spalled or only lightly spalled, but the filler is in unsatisfactory condition, or (4) the slab is divided into three pieces by two or more cracks; one of which is at least medium severity.
- High - One of the following conditions exists: (1) a filled or non-filled crack is severely spalled, causing definite FOD potential, (2) a non-filled crack has a mean width greater than approximately 1 inch (25 millimeters), creating tire damage potential, or (3) the slab is divided into three pieces by two or more cracks, one of which is at least high severity.

Repair options:

- Low - No action or seal cracks;
- Medium - seal cracks;
- High - seal cracks, apply a full depth patch or replace the slab.

21. Durability Cracks

Durability cracking is caused by the concrete's inability to withstand environmental factors, such as freeze-thaw cycles. It usually appears as a pattern of cracks running parallel to a joint or linear crack. A dark coloring can usually be seen around the fine durability cracks. This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 feet (300 to 600 millimeters) of the joint or crack.

Severities:

- Low - "D" cracking is defined by hairline cracks occurring in a limited area of the slab, such as one or two corners or along one joint. Little or no disintegration has occurred. No FOD potential.
- Medium - "D" cracking has developed over a considerable amount of slab area with little or no disintegration or FOD potential; or "D" cracking has occurred in a limited area of the slab, such as in one or two corners or along one joint, but pieces are missing and disintegration has occurred; accumulating some FOD potential.
- High - "D" cracking has developed over a considerable amount of slab area with disintegration of FOD potential.

22. Joint Seal Damage (PCC)

Joint seal damage is any condition that enables soil or rocks to accumulate in the joints or allow significant infiltration of water. Accumulation of incompressible materials prevents the slab from expanding and may result in buckling, shattering, or spalling. Pliable joint filler bonded to the edges of the slabs protects joints from the accumulation of materials and also prevents water from seeping down and softening the foundation supporting the slab. Typical types of joint seal damage are: (1) stripping the 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) lack or absence of sealant in the joint.

Severities:

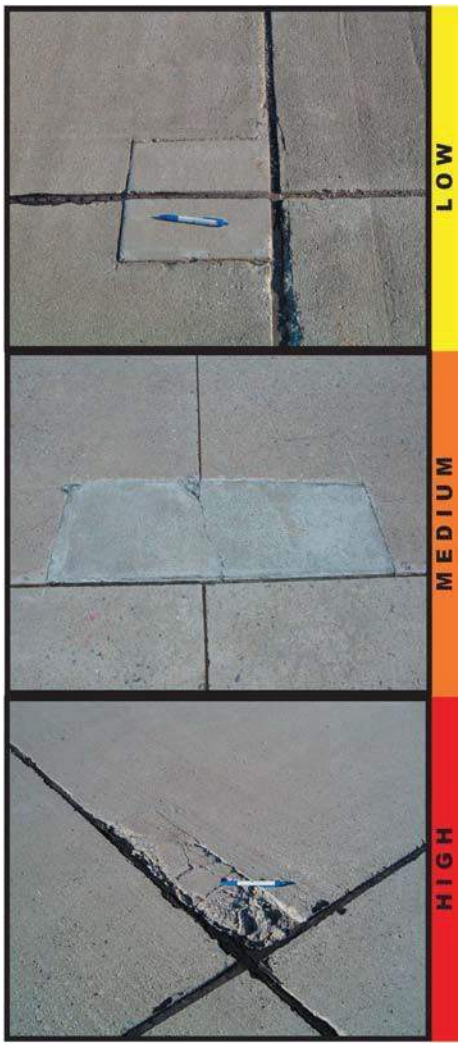
- Low - Joint sealer is in generally good condition throughout the sample. Sealant is performing well with only a minor amount of any of the above types of damage present. Joint seal damage is at a low severity if a few of the joints have sealer which has detached from, but is still in contact with, the joint edge. This condition exists if a knife blade can be inserted between sealer and joint face without resistance;
- Medium - Joint sealer is in generally fair condition over the entire surveyed sample with one or more of any of the above types of damage present occurring to a moderate degree. Sealant needs replacement within two years. Joint seal damage is a medium severity if a few of the joints have any of the following conditions: (1) joint sealer is in place, but water access is possible through visible openings no more than 1/8 inches (3 mm) wide; if a knife blade cannot be inserted easily between sealer and joint face, this condition does not exist, (2) pumping debris are evident at the joint, (3) joint sealer is oxidized and "lifeless", but pliable (like a rope), and generally fills the joint opening, or (4) vegetation in the joint is obvious, but does not obscure the joint opening.
- High - Joint sealer is in generally poor condition over the entire surveyed sample with one or more of any of the above types of damage present occurring to a severe degree. Sealant needs immediate replacement. Joint seal damage is at high severity if 10 percent or more of the joint sealer exceeds limiting criteria listed above, or if 10 percent or more of the sealer is missing.

Repair options:

- Low - No action;
- Medium - seal joints;
- High - seal joints.

23. Small Patch (PCC)

A patch is an area where the original pavement has been removed and replaced by a filler material. For condition evaluation, patching is divided into two types: small (less than 5 square feet (0.5 m^2)) and large (over 5 square feet). Large patches are described in the next section.



Severities:

- Low - Patch is functioning well, with little or no deterioration;
- Medium - Patch that has deteriorated or moderate spalling, or both, can be seen around the edges. Patch material can be dislodged, with considerable effort (minor FOD potential);
- High - Patch has deteriorated, either by spalling around the patch or cracking within the patch, to a state which warrants replacement.

Repair options:

- Low – Do Nothing;
- Medium - Replace patch or replace the slab;
- High – Replace patch or replace the slab.

24. Large Patch (PCC)

Patching is the same as defined in the previous section. A utility cut is a patch that has replaced the original pavement because of placement of underground utilities. The severity levels of a utility cut are the same as those for regular patching.

Severities:

- Low - Patch is functioning well, with little or no deterioration;
- Medium - Patch has deteriorated or moderate spalling, or both, can be seen around the edges. Patch material can be dislodged, with considerable effort (minor FOD potential);
- High - Patch has deteriorated to a state that that causes considerable roughness or high FOD potential, or both. The extent of the deterioration warrants replacement of the patch.

Repair options:

- Low – Do Nothing;
- Medium - Replace patch or replace the slab;
- High – Replace patch or replace the slab.

25. Popouts (PCC)

A popout is a small piece of pavement that breaks loose from the surface due to freeze-thaw action in combination with expansive aggregates. Popouts usually range from approximately 1 to 4 inches (25 to 100 mm) in diameter and from 1/2 to 2 inches (13 to 51 mm) deep.

Severities:

No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; that is, average popout density must exceed approximately three popouts per square yard (square meter) over the entire slab area.

26. Pumping (PCC)

Pumping is the ejection of material by water through joints or cracks caused by deflection of the slab under passing loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt and results in a progressive loss of pavement support. Surface staining and base or subgrade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates poor joint sealer and loss of support, which will lead to cracking under repeated loads. The joint seal must be identified as defective before pumping can be said to exist. Pumping can occur at cracks as well as joints.

Severities:

No degrees of severity are defined. It is sufficient to indicate that pumping exists.

27. Scaling (PCC)

Surface deterioration is caused by construction defects, material defects, and environmental factors. Generally scaling is exhibited by delamination or disintegration of paste on the slab surface to the depth of the defect. Construction defects include: over-finishing, addition of water to the pavement surface during finishing, lack of curing, attempted surface repairs of fresh concrete with mortar. Generally this occurs over a portion of a slab. Material defects include: inadequate air entrainment for the climate. Generally this occurs over several slabs that were affected by the concrete batches. Environmental factors: freezing of concrete before it gains adequate strength or thermal cycles from certain aircraft. Generally, freezing occurs over a large area, and thermal effects occur in isolated areas. Typically, the FOD from scaling is removed by sweeping, but the concrete will continue to scale until the affected depth is removed or expended.

Severities:

- Low - Minimal loss of surface paste that poses no FOD hazard, limited to less than 1 percent of the slab area. No FOD potential;
- Medium - The loss of surface paste that poses some FOD potential including isolated fragments of loose mortar, exposure of the sides of coarse aggregate (less than 1/4 of the width of the coarse aggregate), or evidence of coarse aggregate coming loose from the surface. Surface paste loss is greater than 1 percent of the slab area but less than 10 percent;
- High – High severity is associated with low durability concrete that will continue to pose a high FOD hazard; normally the layer of surface mortar is observable at the perimeter of the scaled area, and is likely to continue to delaminate or disintegrate due to environmental or other factors. Routine sweeping is not sufficient to avoid FOD issues, is an indication that high FOD hazard present. Surface paste loss is greater than 10 percent of the slab area.

28. Faulting (PCC)

Settlement or faulting is a difference of elevation at a joint or crack caused by upheaval or consolidation.

Severities:

Severity levels are defined by the difference in elevation across the fault and the associated decrease in ride quality and safety as severity increases.

	Runways/Taxiways	**Aprons**
L	< 1/4 inch (6 mm)	1/8 – 1/2 inch (3 to 13 mm)
M	1/4 – 1/2 inch (6 to 13 mm)	1/2 - 1 inch (13 to 25 mm)
H	> 1/2 inch (13 mm)	> 1 inch (25 mm)

Repair Options:

- Low - No action;
- Medium – Grinding along the joint;
- High – Grinding or joint load transfer restoration.

29. Shattered Slab/Intersecting Cracks (PCC)

Intersecting cracks are cracks that break into four or more pieces due to overloading or inadequate support, or both. The high-severity level of this distress type is referred to as a shattered slab. If all pieces or cracks are contained within a corner break, the distress is categorized as a severe corner break.

Severities:

- Low - Slab is broken into four or five pieces predominantly defined by low-severity;
- Medium - Slab is broken into four or five pieces with over 15 percent of the cracks of medium severity (no high-severity cracks); slab is broken into six or more pieces with over 85 percent of the cracks of low-severity;
- High - At this level of severity, the slab is called shattered: (1) slab is broken into four or five pieces with some or all of the cracks of high severity; (2) slab is broken into six or more pieces with over 15 percent of the cracks of medium or high severity.

Repair options:

- Low – Seal Cracks;
- Medium - Full depth patch or replace the slab;
- High - Full depth patch or replace the slab.

30. Shrinkage Crack (PCC)

Shrinkage cracking is typically categorized in two forms; drying shrinkage that occurs over time as moisture leaves the pavement and plastic shrinkage that occurs shortly after the pavement is placed and rapid drying of the surface occurs while the pavement is still plastic. Drying shrinkage cracks occur when a hardened pavement continues to shrink as excess water needed for cement hydration evaporates. They form when subsurface resistance to the shrinkage is present and may extend through the entire depth of the slab. Plastic shrinkage occurs when there is rapid loss of water in the surface of a recently placed pavement caused by evaporation. High winds, low humidity, high ambient and/or concrete temperatures are contributing factors to evaporation. These cracks can appear as a series of parallel cracks, usually 1 to 3 feet (300 to 900 mm) apart and do not extend very deep into the pavement's surface. Another form of plastic shrinkage occurs while pavement is still plastic and can result from over finishing /overworking the pavement while bleed water is on the surface.
This results in an increase in mortar, fines, and higher water content at the surface, making the immediate surface weak and susceptible to shrinkage. The shrinkage cracks appear as a series of inter-connected hairline cracks, or pattern cracking, and are often observed over a majority of the slab surface. This condition is also referred to as map cracking or crazing.

Severities:

No degrees of severity are defined. It is sufficient to indicate that shrinkage cracks exist.

Repair options:

- Do Nothing

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31. Joint Spalls (PCC)

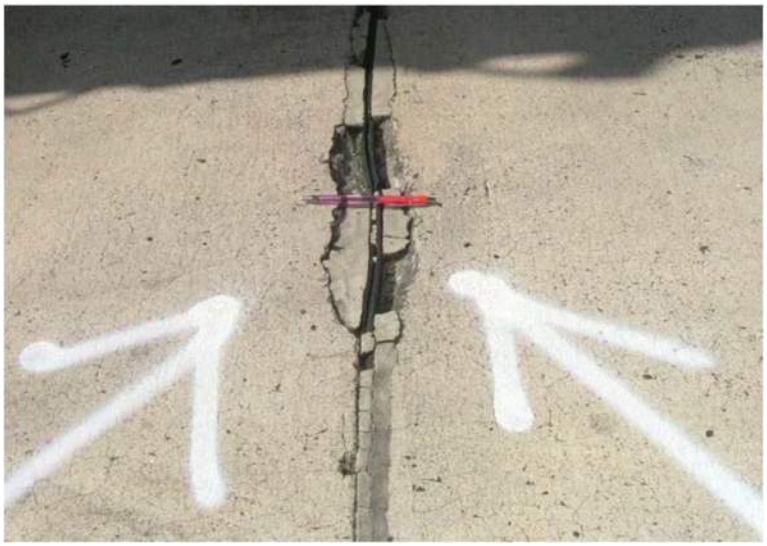
Joint spalling is the disintegration of the slab edges within 2 feet (0.6 m) of the side of the joint. A joint spall usually does not extend vertically through the slab, but intersects the joint at an angle. Spalling results from excessive stresses at the joint or crack caused by infiltration of incompressible materials or traffic loads. Weak concrete at the joint (caused by overworking) combined with traffic loads is another cause of spalling.

Severities:

- Low – Spall over 2 feet (0.6 m) long: (1) spall broken into no more than three pieces defined by low- or medium-severity cracks, with little or no FOD potential, or is (2) joint is lightly frayed; little or no FOD potential. Spall less than 2 feet long is broken into pieces or fragmented with little FOD or tire damage potential exists. Lightly frayed means he upper edge of the joint is broken away leaving a spall no wider than 1 inch (25 mm) and no deeper than 1/2 inch (13 mm). The material is missing an the joint creates little or no FOD potential;
- Medium – Spall over 2 feet (0.6 m) long: (1) spall is broken into more than three pieces defined by light or medium cracks; (2) spall is broken into no more than three pieces with one or more of the cracks being severe with some FOD potential existing; or (3) joint is moderately frayed, with some FOD potential. Spall less than 2 feet long: spall is broken into pieces or fragmented, with some of the pieces loose or absent, causing considerable FOD or tire damage potential;
- High - Spall over 2 feet (0.6 m) long: (1) spall is broken into more than three pieces defined by one or more high-severity cracks with high FOD potential and high possibility of pieces becoming dislodged; or (2) joint is severely frayed, with high FOD potential.

Repair Options:

- Low - No action;
- Medium - perform a partial depth patch;
- High - perform a partial depth patch.



32. Corner Spalls (PCC)

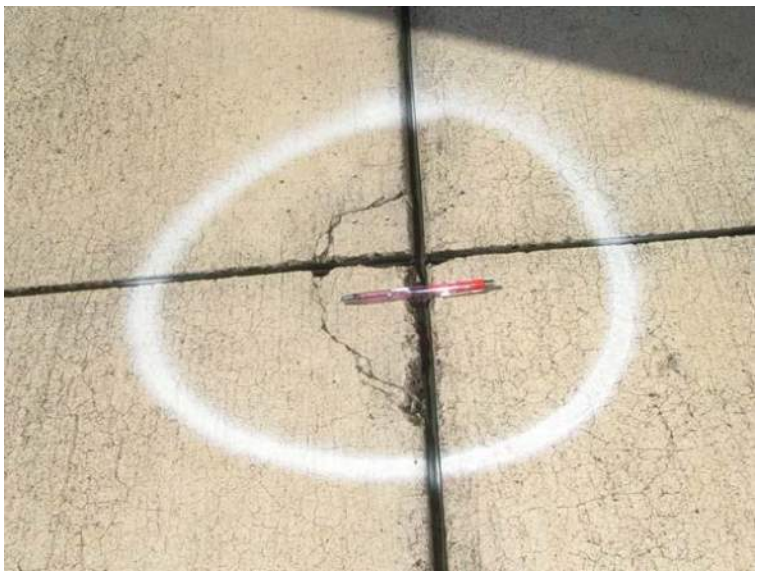
Corner spalling is the raveling or breakdown of the slab within approximately 2 feet (0.6 m) of the corner. A corner spall differs from a corner break in that the spall angles downward to intersect the joint while the break extends vertically through the slab.

Severities:

- Low - One of the following conditions exists: (1) spall is broken into one or two pieces defined by low-severity cracks (little or no FOD potential), (2) spall is defined by one medium-severity crack (little or no FOD potential);
- Medium – One of the following conditions exists: (1) spall is broken into two or more pieces defined by medium- severity crack(s), and a few small fragments may be absent or loose; (2) spall is defined by one severe, fragmented crack that may be accompanied by a few hairline cracks; or (3) spall has deteriorated to the point where loose material is causing some FOD potential;
- High – One of the following conditions exists: (1) spall is broken into two or more pieces defined by high- severity fragmented crack(s), with loose or absent fragments; (2) pieces of the spall have been displaced to the extent that a tire damage hazard exists; or (3) spall has deteriorated to the point where loose material is causing high FOD potential.

Repair Options:

- Low - No action;
- Medium - partial depth patch;
- High - partial depth patch.



33. ASR (PCC)

ASR is caused by chemical reaction between alkalis and certain reactive silica minerals which form a gel. The gel absorbs water, causing expansion which may damage the concrete and adjacent structures. Alkalis are most often introduced by the portland cement within the pavement. ASR cracking may be accelerated by chemical pavement deicers.

Visual indicators that ASR may be present include:

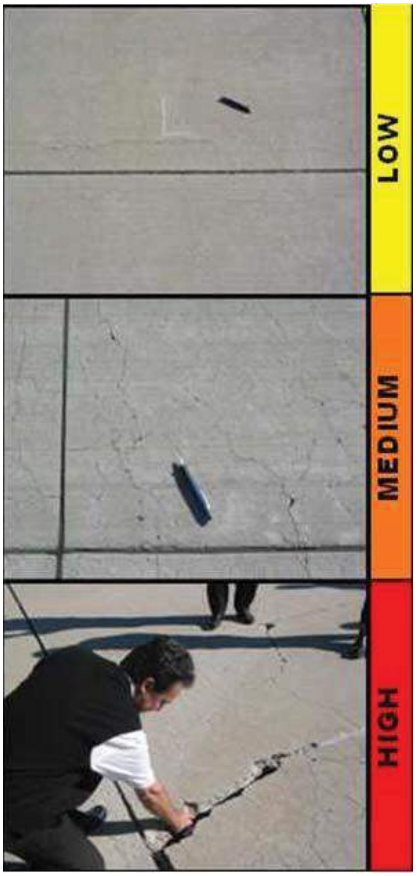
1. Cracking of the concrete pavement (often in a map pattern)
2. White, brown, gray or other colored gel or staining may be present at the crack surface
3. Aggregate popouts
4. Increase in concrete volume (expansion) that may result in distortion of adjacent or integral structures or physical elements. Examples of expansion include shoving of asphalt pavements, light can tilting, slab faulting, joint misalignment, and extrusion of joint seals or expansion joint fillers.

Because ASR is material-dependent, ASR is generally present throughout the pavement section. Coring and concrete petrographic analysis is the only definitive method to confirm the presence of ASR. The following should be kept in mind when identifying the presence of ASR through visual inspection:

1. Generally, ASR distresses are not observed in the first few years after construction. In contrast, plastic shrinkage cracking can occur the day of construction and is apparent within the first year.
2. ASR is differentiated from D-Cracking by the presence of cracking perpendicular to the joint face. D-Cracking predominantly develops as a series of parallel cracks to joint faces and linear cracking within the slab.
3. ASR is differentiated from Map Cracking/ Scaling by the presence of visual signs of expansion.

Severities:

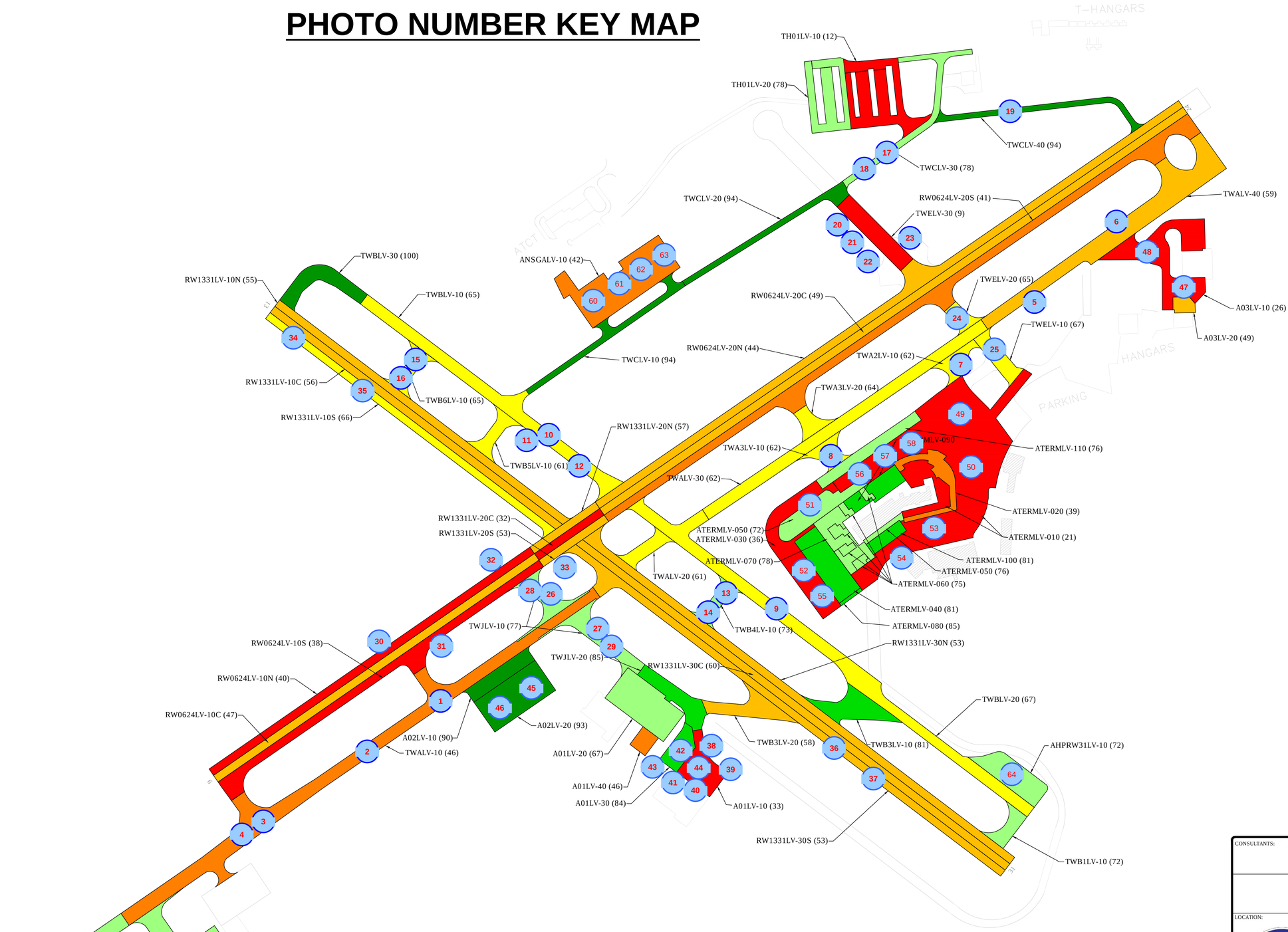
- Low - Minimal to no FOD potential from cracks, joints or ASR related popouts; cracks at the surface are tight (predominantly 1 mm or less). There is little to no evidence of movement in pavement or surrounding structures or elements.
- Medium - Some FOD potential; but increased sweeping or other FOD removal methods may be required. There may be evidence of slab movement or some damage (orbith) to adjacent structures or elements. Medium ASR distress is differentiated from low by having one or more of the following: increased FOD potential, cracking density increases, some fragments along cracks or at crack intersections present, surface popouts of concrete may occur, pattern of wider cracks (predominantly 1 mm or wider) that may be subdivided by tighter cracks.
- High - One or both of the following exist: (1) Loose or missing concrete fragments and poses high FOD potential, (2) Slab surface integrity and function significantly degraded and pavement requires immediate repair; may also require repairs to adjacent structures or elements.



APPENDIX - E

PHOTOS FROM SITE INSPECTION -JUNE 2017

PHOTO NUMBER KEY MAP



LEGEND

RW1533-R06C02 (67)
- BRANCH IDENTIFIER
- SECTION IDENTIFIER
- PCI VALUE

SECTION BREAK LINE

1 PHOTO NUMBER (TYP)

PAVEMENT CONDITION INDEX

91-100
81-90
71-80
61-70
51-60
41-50
0-40

CONSULTANTS: ADCI
AIRPORT DESIGN CONSULTANTS
6031 UNIVERSITY BLVD., SUITE 330
ELLICOTT CITY, MD 21043
PHONE: 410.465.9600
FAX: 410.465.9602

LOCATION:

LEHIGH VALLEY INTERNATIONAL AIRPORT
ALLENTOWN, PENNSYLVANIA

PAGE TITLE: 2017 INSPECTION PHOTOS MAP

PROJECT DATE:	CREATION DATE:	PROJECT MANAGER:	JOB NUMBER:
JUNE 2017	JUNE 2017		2017-0801
DRAWING SCALE: 1" = 300'	LAST MODIFIED DATE: JUNE 2017	REVISED BY:	DRAWN BY:
FILENAME: Lehigh Valley International Airport.dwg	LAYOUT NAME/NUMBER: PCI 24x46	PAGE_FIG: JUNE 2017	

FILE NAME: P:\Airport\ABE\PROJECTS\2017-0801\CAD\EXHIBITS\Lehigh Valley International Airport-copy.dwg PLOTTED: Thursday, July 06, 2017 - 4:10pm USER: RKondapalli

Taxiway A – South of Runway 13-31 – Photos

Low Severity Longitudinal Cracking

Low Severity Longitudinal Cracking, Weathering, and Raveling

Taxiway A – South of Runway 13-31 – Photos

Low severity Weathering and Low Severity Alligator Cracking

Low Severity Alligator Cracking

Taxiway A North of Taxiway E- Photos

Medium Severity Weathering and Cracking

Medium Severity Block Cracking

Taxiway A2 and Taxiway A3 – Photos

Bleeding

Weathering and Bleeding Taxiway A

Taxiway B Western and Eastern Portions – Photos

Low severity Longitudinal Cracking Western Portion

Low Severity Longitudinal Cracking Eastern Portion

Taxiway B Eastern Portions – Photos

Longitudinal Cracking

Cracking and Weathering

Taxiway B4 – Photos

Medium Severity Weathering

Overview

Taxiway B6 – Photos

Overview

Longitudinal Cracking

Taxiway C between Taxiway E and T Hangars – Photos

Overview

Weathering

Taxiway C between T Hangars and Runway 6-24 - Photos

Overview

Taxiway E -TWE-30 – Photos

Depression, Raveling

Alligator Cracking and Rutting

Taxiway E -TWE-30 Section – Photos

Medium Severity Alligator Cracking, Depression, Rutting, and Patching

Medium Severity Alligator Cracking, Raveling

Taxiway E South of Runway 6-24 - Photos

Longitudinal Cracking

Longitudinal Cracking

Taxiway J - Photos

Longitudinal Cracking

Longitudinal Cracking

Taxiway J - Photos

Longitudinal Cracking

Weathering and Alligator Cracking

Runway 6-24 - Photos

Alligator Cracking, Weathering, and Longitudinal Cracking

Medium Severity Block Cracking, Alligator Cracking, and Weathering

Runway 6-24 – Photos

Weathering and Raveling

Low severity Weathering, Raveling, and Longitudinal Cracking

Runway 13-31 - Photos

Low severity Longitudinal Cracking and Weathering

Low Severity Weathering and Longitudinal Cracking

Runway 13-31 – Photos

Patching, Weathering, and Raveling

Patching, Weathering, and Longitudinal Cracking

Apron 1 Northern and Southwestern Portion adjacent to Southernmost Portion – Photos

Linear Cracking Northern

Corner Spalls

Apron 1 Southwestern Portions – Photos

Joint Seal Damage and Joint Spalls Southwestern Portion

Apron 1 - Photos

Corner Break

Corner Break and Joint Seal Damage

Apron 1 Southernmost Portion – Photos

Shattered Slabs

Joint Seal Damage and Spalling

Apron 2 – Photos

Weathering AC Section

Joint Seal Damage PCC Section

Apron 3 Northern Section - Photos

Medium Severity Alligator Cracking, Bleeding, and Weathering

Medium Severity Alligator Cracking, Bleeding, Weathering, and Slippage Cracking

Terminal Apron – Photos

Medium Severity Bleeding and Weathering East Apron

Medium Severity Weathering, Longitudinal Cracking, and Alligator Cracking East Apron

Terminal Apron – Photos

Medium Severity Alligator Cracking

Weathering East Section

Terminal Apron – Photos

Longitudinal Cracking, Bleeding, and Weathering West Section

Alligator Cracking and Raveling at AC/PCC Transitional Pavement

Terminal Apron – Photos

Longitudinal Cracking, Bleeding, and Weathering East Section

Weathering and Raveling East section

Terminal Apron – Photos

Shattered Slabs East Section-PCC

Shattered Slabs- East Section PCC

Cargo Apron – Photos

Joint Seal Damage and Spalling PCC Apron

North Side General Aviation Apron – Photos

High Severity Weathering and Raveling

Medium Severity Joint Reflection Cracking

North Side General Aviation Apron– Photos

Medium Severity Longitudinal Cracking and Weathering

Pavement Separation Gap

Runway 31 Hold Pad- Photos

Joint Spalling

APPENDIX - F

E70 PAVER DATABASE FILE-SUBMITTED ELECTRONICALLY.