2022 ODA Pavement Evaluation Program
Malin Airport

Malin, Oregon

December 30, 2022
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Prepared for

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1 OVERVIEW

GRI assisted with updating the Oregon Department of Aviation (ODA) airport pavement management system and developing a five-year plan for global maintenance and rehabilitation (M&R) and preservation work for the Malin Airport in Malin, Oregon. This project was implemented as a part of the ODA and Federal Aviation Administration (FAA) *Oregon Continuous Aviation System Plan*. The information provided in this report ensures compliance with FAA Grant Assurance Number 11, which outlines that an airport shall have an effective airport pavement maintenance-management program in place to receive federal financial assistance for the construction, reconstruction, or repair of airport pavements.

GRI conducted surveys of the airside pavement at Malin Airport in 2022 in accordance with the procedures of Advisory Circular 150/5380-7B and ASTM International (ASTM) D5340. We uploaded the survey data into the PAVER database and used the software to provide a rapid calculation of the pavement condition index (PCI) rating. The PCI is a numerical indicator that defines the functional condition of the pavement based on visual inspection. The scale ranges from zero to 100, where zero represents a pavement in the worst possible condition with no remaining functional life and 100 represents a pavement in the best possible condition with no defects.

2 PAVEMENT INVENTORY

Malin Airport is located in Malin, Oregon, and is owned and operated by the City of Malin. The airport has one runway that serves a variety of general aviation aircraft. The general location of the airport is shown below on the Malin Airport Location Map, Figure 2.1.

Figure 2.1 – MALIN AIRPORT LOCATION MAP

Malin Airport contains one runway, one taxiway, and one apron. The airside pavements at Malin Airport are comprised of asphalt concrete (AC)and portland cement concrete (PCC). The airport pavements, delineated by surface type and branch use, are shown on the Malin Airport Pavement Area by Surface Type, Figure 2.2 and the Malin Airport Pavement Area by Branch Use, Figure 2.3. The pavement inventory, including work history for each pavement section, is displayed spatially on the Malin Airport Pavement Inventory, Figure 2.4. The pavement facilities summarized by branch and section are listed in Tables 1A and 2A, respectively, in Appendix A. The sample unit layout for each section is shown on Figure 1A in Appendix A. We used the sampling rates outlined in Table 3A of Appendix A in our survey. The pavement inventory, including work history for individual airport pavement sections, is provided in the Work History Report, Appendix F.

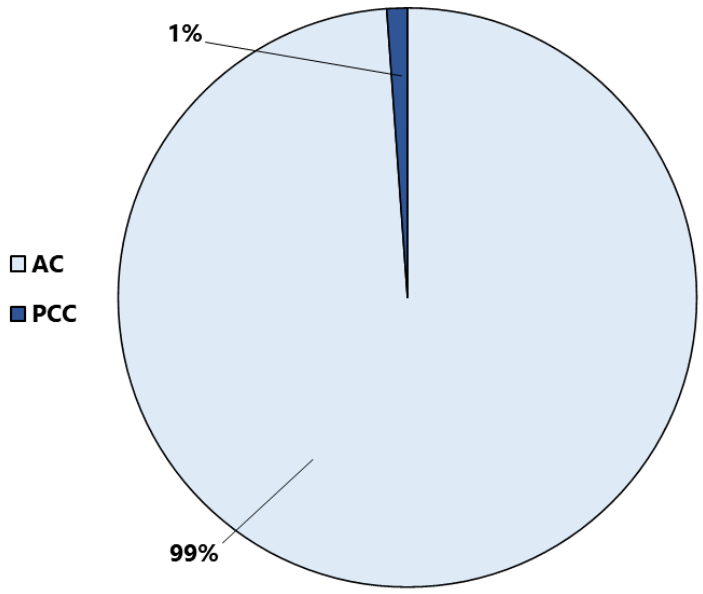

Figure 2.2 – MALIN AIRPORT PERCENT OF PAVEMENT AREA BY SURFACE TYPE

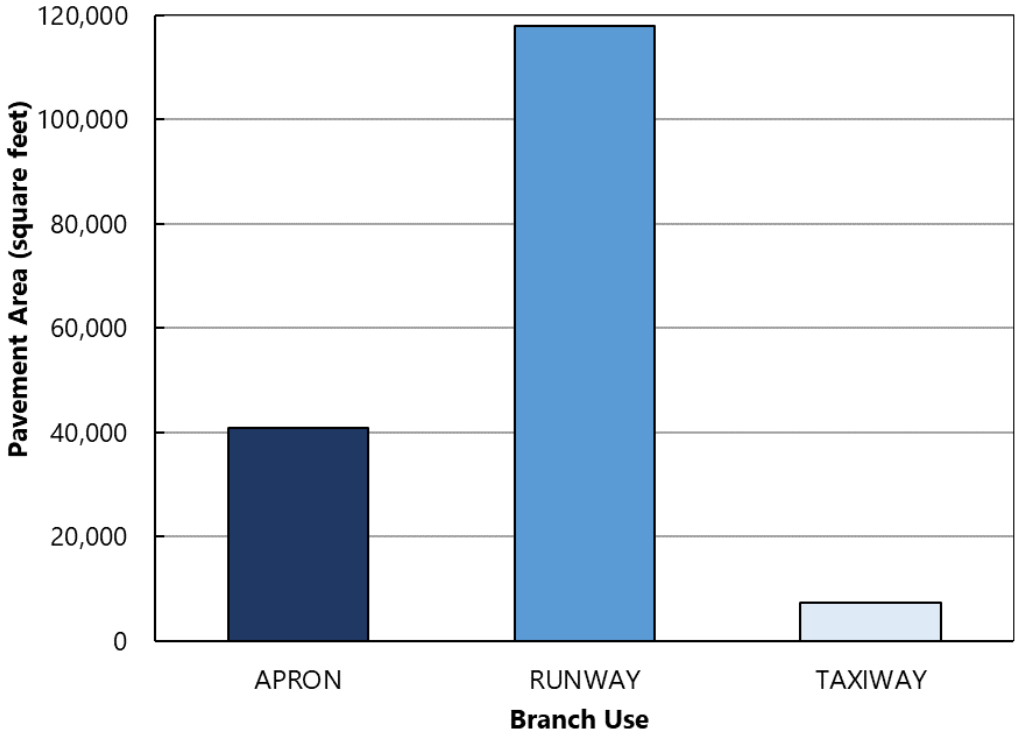

Figure 2.3 – MALIN AIRPORT PAVEMENT AREA BY BRANCH USE

Abbreviations: AC = Asphalt Concrete; PCC = Portland Cement Concrete; est. = Estimated

N

0 200 400 FEET

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MALIN AIRPORT
PAVEMENT INVENTORY

DEC. 2022 JOB NO. 6593-B FIG. 2.4

3 PAVEMENT CONDITION INSPECTION RESULTS

3.1 Introduction

GRI conducted a visual PCI survey of the airside pavements at Malin Airport in March 2022. The 2022 survey work was performed on sections that had not been previously inspected. GRI performed the 2022 PCI survey in accordance with the methods described in FAA Advisory Circular 150/5380-6C and ASTM D5340, and further discussed in Appendix B of this report.

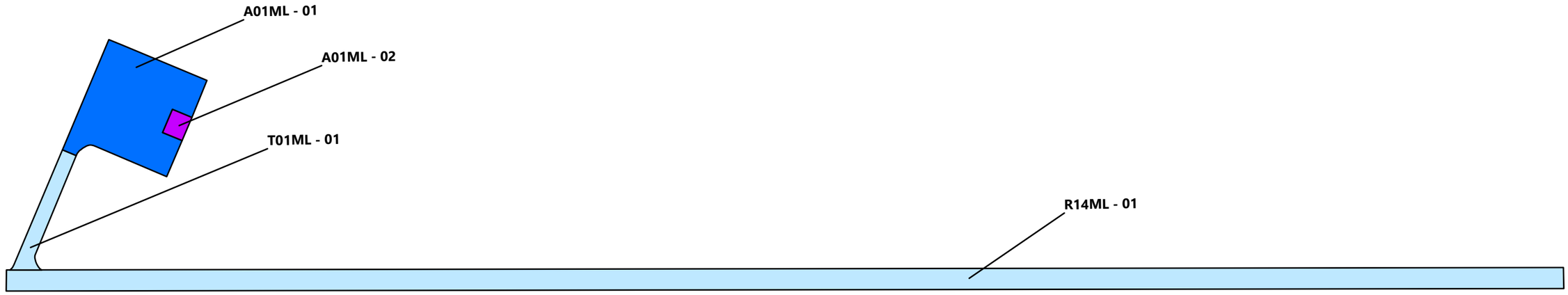
The PCI is based on the type, severity, and quantity of each distress found in an inspected sample unit. Further discussion of distress types for flexible and rigid pavement is provided in Appendix B and summarized in Table 1B. The results of the PCI survey are displayed using a seven-category rating scale in accordance with ASTM D5340. Details of the ASTM PCI rating scale are provided in Table 3-1 below.

Table 3-1: ASTM PCI RATING SCALE

PCI Color Legend	PCI Range	PCI Rating and Definition
	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.
	56 – 70	FAIR: Pavement has a combination of generally low- and medium-severity distresses. Maintenance and repair needs may range from routine to major.
	41 – 55	POOR: Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. M&R needs will be major.
	26 – 40	VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance and operational problems. M&R needs will be major.
	11 – 25	SERIOUS: Pavement has mainly high-severity distresses that may affect operational safety; 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.

3.2 Pavement Condition Index Survey Results

The area-weighted average PCI for all airport pavements at Malin Airport is approximately 71. The section PCIs ranged from a low of 66 to a high of 88. The primary distresses observed during the inspection were weathering and longitudinal and transverse cracking for flexible pavements, and spalling and shrinkage cracking on rigid pavements. Section PCIs following our pavement survey are displayed below spatially on the 2022 PCI Survey Results, Figure 3.1.



2022 SECTION PCI

- (86 - 100) GOOD
- (71 - 85) SATISFACTORY
- (56 - 70) FAIR
- (41 - 55) POOR
- (26 - 40) VERY POOR
- (11 - 25) SERIOUS
- (0 - 10) FAILED

N

0 200 400 Feet

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STATEWIDE PAVEMENT EVALUATION PROGRAM

2022 PCI SURVEY RESULTS

MALIN AIRPORT

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The condition distribution of the network by the percent of total pavement area is provided on the Malin Airport Pavement Condition Rating by Percent of Pavement Area, Figure 3.2. A summary of the pavement condition results by branch and section are included in Tables 2B and 3B of Appendix B, respectively. The Re-Inspection Report that includes inspection details for individual sample units is provided in Appendix E.

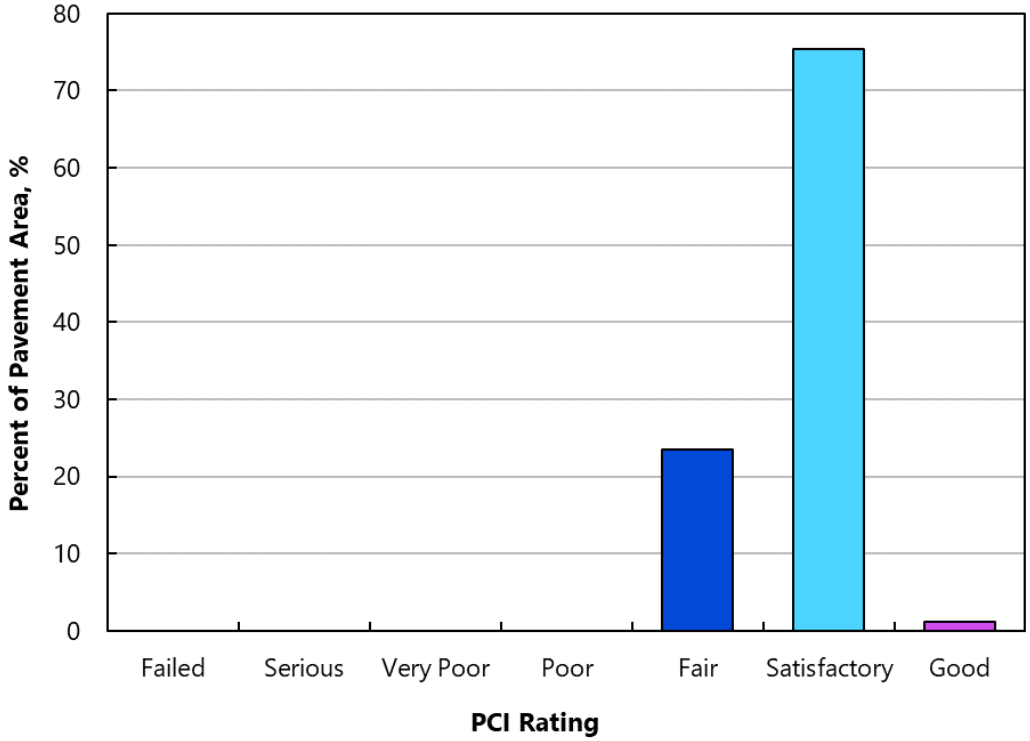


Figure 3.2 – MALIN AIRPORT PAVEMENT CONDITION RATING BY PERCENT OF AREA

4 FUTURE PAVEMENT CONDITION ANALYSIS

4.1 Introduction

In addition to assessing the current condition of a pavement, it is very important from a planning standpoint to be able to predict with reasonable accuracy the future condition. Additional details regarding our future pavement condition analysis, including pavement condition prediction models, are provided in Appendix C. PCI performance curves developed for Malin Airport are displayed on Figures 1C through 4C in Appendix C.

4.2 Future Condition Analysis

Using the condition prediction models discussed above, the projected condition of each pavement section was determined for 5- and 10-year periods. Based on this analysis, we project the PCI to decrease from a current value of 71 to a value of 59 in the year 2027 and 47 in the year 2032 if no maintenance or rehabilitation work is performed. The projected pavement condition in 5 years and 10 years for each pavement section at Malin

Airport is displayed spatially on the Future Pavement Condition, Figure 4.1 and listed in Table 1C in Appendix C, along with the present PCI values for the pavement network.

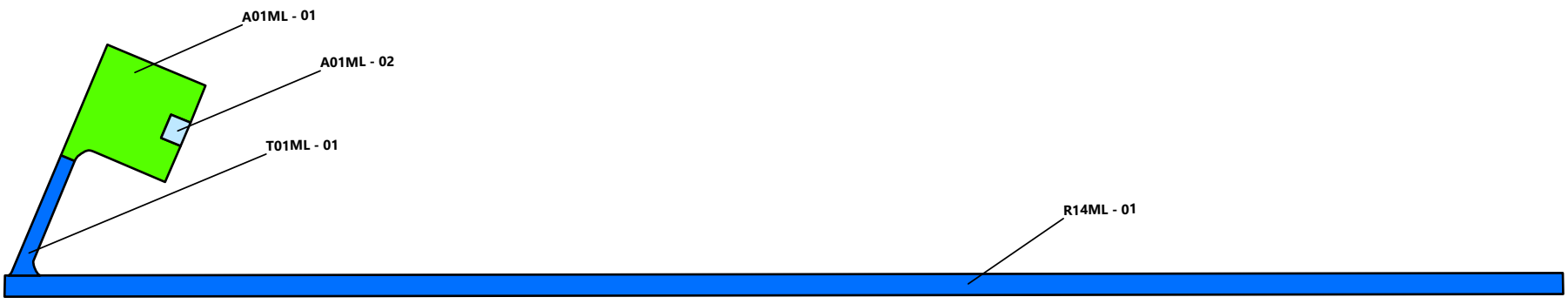
4.3 Functional Remaining Life

The functional remaining life is the practical amount of time a pavement is in service before requiring rehabilitation, as estimated based solely on visual condition. This is not to be confused with structural remaining life, which requires analysis of the structural capacity of a pavement and typically a field exploration and testing program that includes core explorations and falling weight deflectometer (FWD) deflection tests.

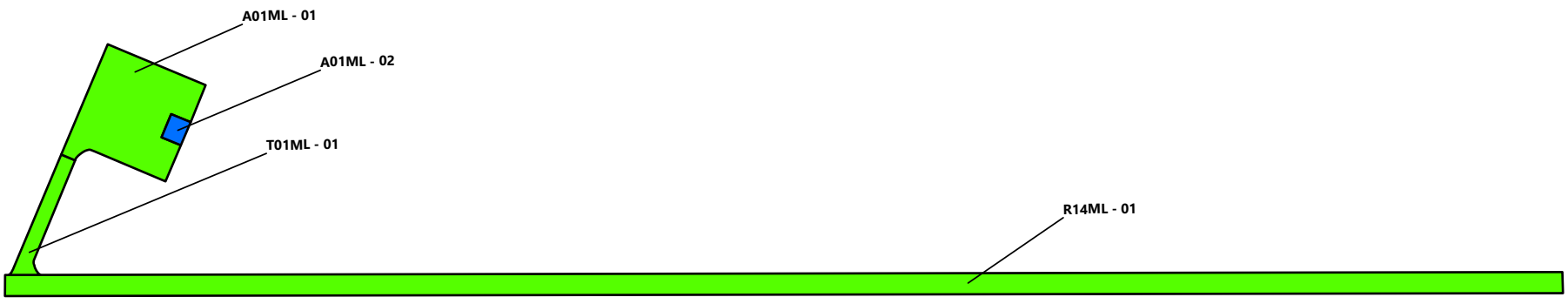
We calculated two forms of functional remaining life based on the current visual condition surveys of the pavement at Malin Airport. The first type of functional remaining life is the time until rehabilitation such as an overlay is needed. The critical PCI, further discussed in Section C.3 of Appendix C, is the threshold used for this type of functional remaining life analysis. The second type of functional remaining life is the time until the pavement is no longer operational due to high foreign object debris (FOD) potential and increased safety concerns for trafficking aircraft. A PCI of 40 was set as the trigger point for the end of the pavement's functional service life with regard to FOD potential.

The two types of functional remaining life for each section at Malin Airport are summarized in Table 2C in Appendix C.

PREDICTED CONDITION IN 2027



PREDICTED CONDITION IN 2032



SECTION PCI

- (86 - 100) GOOD
- (71 - 85) SATISFACTORY
- (56 - 70) FAIR
- (41 - 55) POOR
- (26 - 40) VERY POOR
- (11 - 25) SERIOUS
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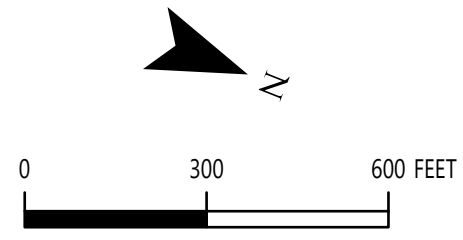

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FUTURE PAVEMENT CONDITION

MALIN AIRPORT

DEC. 2022 JOB NO. 6593-B FIG. 4.1

5 MAINTENANCE AND REHABILITATION PROJECT RECOMMENDATIONS

5.1 Introduction

We evaluated Maintenance and Rehabilitation (M&R) needs, as determined from the PAVER analysis results, in order to develop localized maintenance, global maintenance, and rehabilitation needs. Details of our M&R work priority and unit costs for work activities are provided in Tables 1D and 2D, respectively, in Appendix D.

Based on the 2022 PCI-survey results, the Malin Airport Pavement Network General Treatment Type Distribution Based on PCI, Figure 5.1 displays a breakdown of the Malin Airport network pavement condition by percent of pavement area and general M&R treatment categories. Approximately 77%, 23%, and 0% of the area requires preservation, rehabilitation, and reconstruction treatments, respectively.

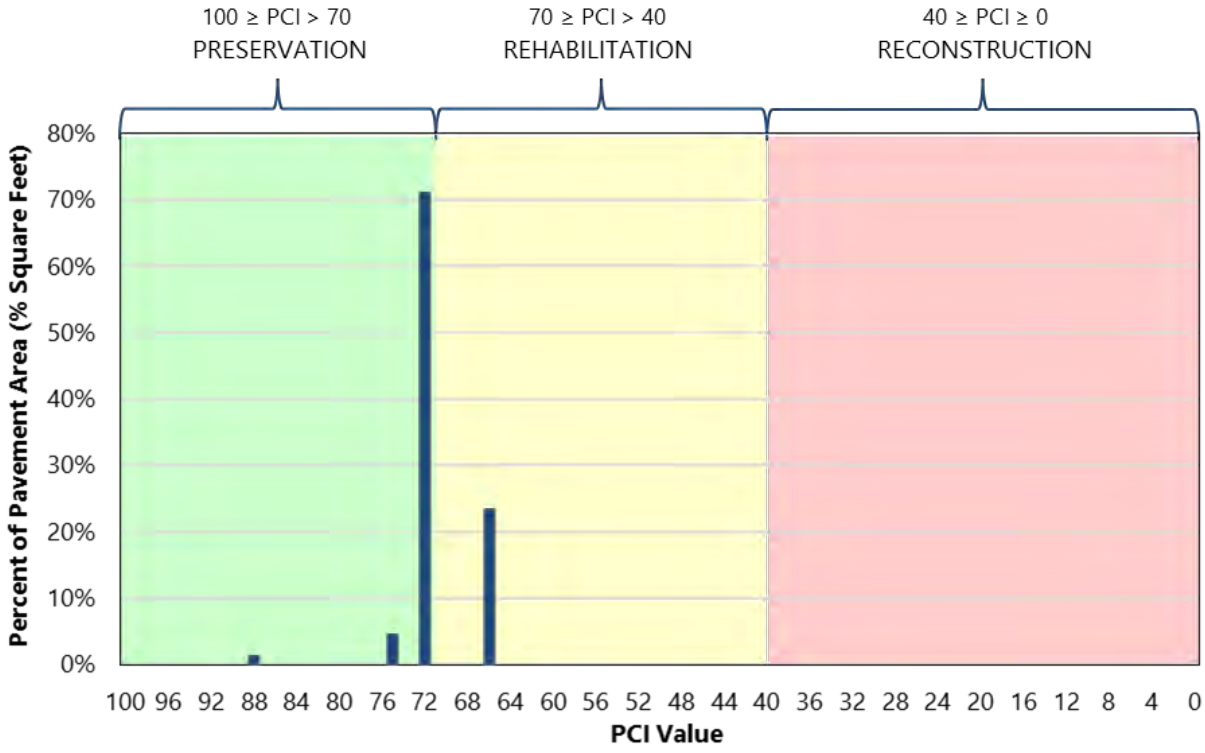


Figure 5.1 – MALIN AIRPORT PAVEMENT NETWORK GENERAL TREATMENT TYPE DISTRIBUTION BASED ON PCI

5.2 Recommended Localized Maintenance

Localized maintenance refers to activities such as crack sealing and patching, which should be performed annually in order to properly maintain aging pavements. Using the PAVER Localized Distress Maintenance Analysis tool, we developed a list of recommended localized maintenance. This list is shown in Table 3D in Appendix D and is independent of the global maintenance and rehabilitation projects associated with the five-year global

maintenance and rehabilitation work plan. A summary of the approximate total localized maintenance quantities is provided in Table 5-1 below.

Table 5-1: LOCALIZED MAINTENANCE QUANTITIES

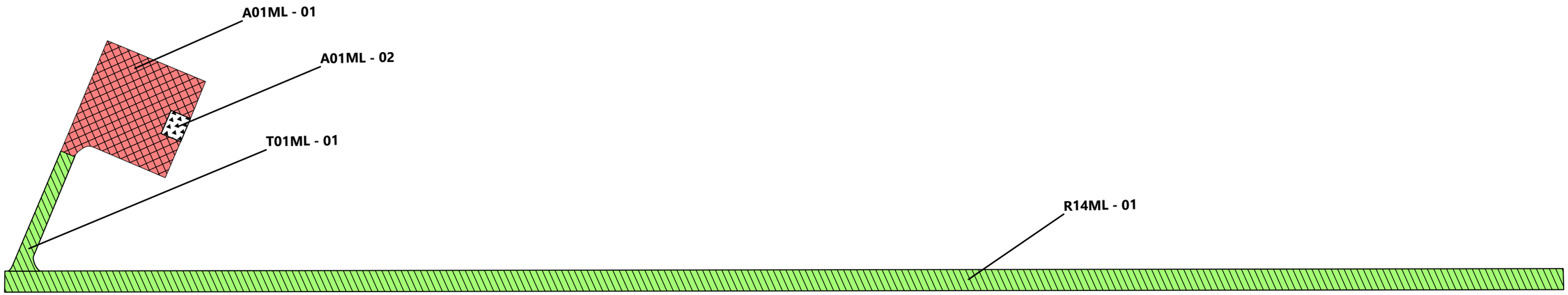
Localized Maintenance Operation	Approximate Quantity
Asphalt Concrete Crack Sealing	3,570 linear feet
Asphalt Concrete Crack Sealing – Wide Cracks	1,636 linear feet

5.3 Global Maintenance and Rehabilitation Plan

To develop the five-year work plan, we first ran the eliminate backlog scenario with the PAVER M&R Work Planning Module in order to generate a list, organized by year, of global M&R projects. We then reviewed the project list and refined it into practical construction projects for each year. A summary of global M&R quantities is provided in Table 5-2 below, and maps of the project locations by year are shown on the 5-Year Pavement Management Plan, Figure 5.2. The complete list of recommended global M&R projects is presented in Table 4D in Appendix D.

Table 5-2: GLOBAL MAINTENANCE AND REHABILITATION QUANTITIES

Global Maintenance or Rehabilitation Operation	Quantity, square feet
Fog Seal	38,951
Slurry Seal	125,332



ACTION TIMING

- 2023
- 2024
- 2025
- 2026
- 2027

ACTION

- FOG SEAL
- SLURRY SEAL
- OVERLAY
- RECONSTRUCTION
- ROUTINE MAINTENANCE

N

0 200 400 Feet

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5-YEAR PAVEMENT MANAGEMENT PLAN
MALIN AIRPORT

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6 LIMITATIONS

This report has been prepared to assist the Oregon Department of Aviation (ODA) with pavement-related project planning for the Malin Airport. The scope is limited to the specific pavement areas described in this report. The conclusions and recommendations provided in this report are based on information provided by ODA, estimated costs, and an understanding of the pavement conditions based solely on visual assessment. The global maintenance and rehabilitation recommendations and project selections provided in this report, as well as their corresponding cost estimates, are based on a practical grouping of projects and an estimate of the structural requirements. It is possible that recommendations based on a structural evaluation would differ materially from the recommendations given in this report. Therefore, the information included in this report should be used solely for project planning purposes, and it should be understood that rehabilitation costs may vary from the cost estimates given in this report.

Because the condition of the airport pavement network is dynamic, an effective maintenance and rehabilitation program should be reviewed and updated on a regular basis. In addition to regularly surveying and updating the pavement condition, completed construction activities should be tracked in the PAVER database. If Malin Airport would like to know more about the results presented in this report, please contact the undersigned.

Submitted for GRI,

RENEWS 06/2023

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This document has been submitted electronically.

APPENDIX A

Pavement Inventory Reports and Maps

APPENDIX A

PAVEMENT INVENTORY REPORTS AND MAPS

A.1 PAVEMENT NETWORK

Malin Airport is located in Malin, Oregon, and is owned and operated by the City of Malin. The pavement network/facilities at Malin Airport serve a variety of general aviation aircraft. Malin Airport contains one runway, one taxiway and one asphalt concrete (AC) and portland cement concrete (PCC) apron. The airside pavements at Malin Airport are comprised of AC and PCC.

The current airport pavement management system (APMS) network at Malin Airport has an approximate area of 166,000 square feet of paved airside facilities. Since no previous inspection had been conducted at Malin Airport, we divided the pavement network into a hierarchical order of branches, sections, and sample units that facilitate inspection and maintenance planning. The pavement facilities summarized by branch and section are listed in Tables 1A and 2A, respectively. Pavement sections and the sample unit layout for each section are shown on Figure 1A in this appendix.

A.2 BRANCHES

A branch, as defined in the PAVER system, is a facility that is a readily identifiable part of a pavement system and has a distinct function. For airports, branches typically consist of individual runways, taxiways, and aprons. The current pavement network for Malin Airport contains 3 branches, tabulated in Table 1A and shown on Figure 1A.

A.3 SECTIONS AND SAMPLE UNITS

A pavement section is the smallest management unit used when considering the application and selection of maintenance and rehabilitation (M&R) repairs and treatments and is defined by Section 2.1.8 of ASTM International (ASTM) D5340 as *"a contiguous pavement area having uniform construction, maintenance, usage history, and condition."* All sections should also have the same traffic volume and load intensity. The current pavement network included in the PAVER database for Malin Airport contains four sections that are managed by the City of Malin, which are tabulated in Table 2A and shown spatially on Figure 1A.

PAVER assigns a rank, which designates that pavement's prioritization in receiving maintenance and repair. The highest use or priority pavements, such as runways, taxiways, and terminal aprons, are ranked *Primary*, while the surrounding aprons and shoulders are ranked *Secondary* and low-use areas are ranked *Tertiary*. The ranks for all sections are shown in Table 2A.

To facilitate the visual survey of the airport pavement, each section is further subdivided into smaller areas called sample units. Similar sizing of these units is critical, and studies have found that maintaining the size of the sample units to within 40% of the established normal distribution reduces the standard error of the average pavement condition index (PCI) values. To meet this criterion, the ASTM method recommends sample units for flexible pavements be 5,000 ± 2,000 square feet and 20 slabs ± 8 slabs for rigid pavements. The delineation of sample units for each section is displayed on Figure 1A.

A.4 SAMPLE UNIT DELINEATION

For an APMS survey, a PCI confidence level of 92% and an allowable error (e) of eight PCI points are used for all airport pavements. To determine the number of sample units that need to be inspected to achieve the required confidence level and allowable error, the following equation is used:

$$n = \frac{N \times s^2}{\left(e^2/_4\right)(N-1)+s^2} \qquad \text{(Equation 1)}$$

where:

n = number of sample units to be inspected
N = total number of samples in the pavement sections
e = allowable error
s = section standard deviation

For the 2022 Malin Airport PCI survey, Table 3A was used as a guideline in developing sampling rates for flexible (e.g., AC) and rigid (e.g., PCC) pavement that reflect similar rates used for other large airport pavement networks. In general, this sampling rate distribution provides a 92% confidence level with a standard error of eight PCI points.

Sample unit locations at Malin Airport were selected using a systematic random sampling model method. This technique is implemented by first determining the number of sample units needed based on the confidence interval calculated using Equation 1. The first sample unit is randomly placed in the section and then the remaining sample units are systematically spaced throughout the section at an equal distance apart.

Table 1A – MALIN AIRPORT PAVEMENT BRANCHES

Facility Designation (Branch ID)	Branch Name	Number of Sections	Approximate Area, square feet
A01ML	Apron 01	2	40,854
R14ML	Runway 14/32	1	118,027
T01ML	Taxiway 01	1	7,305

Table 2A - MALIN AIRPORT CURRENT PAVEMENT INVENTORY

BranchID	Branch Name	Branch Use	SectionID	From	To	Rank	Length, feet	Width, feet	Approximate Area, square feet	LCD[1]	Surface Type
A01ML	Apron 01	APRON	01	T01ML-01	A01ML-02	S	200	200	38,951	1/1/1900	AC
A01ML	Apron 01	APRON	02	A01ML-01	End	S	40	48	1,903	1/1/1900	PCC
R14ML	Runway 14/32	RUNWAY	01	T01ML-01	End	P	2,950	40	118,027	1/1/1900	AC
T01ML	Taxiway 01	TAXIWAY	01	R14ML-01	A01ML-01	S	240	30	7,305	1/1/1900	AC

Abbreviations:
P = Primary pavement, S = Secondary pavement, AC = Asphalt Concrete, PCC = Portland Cement Concrete

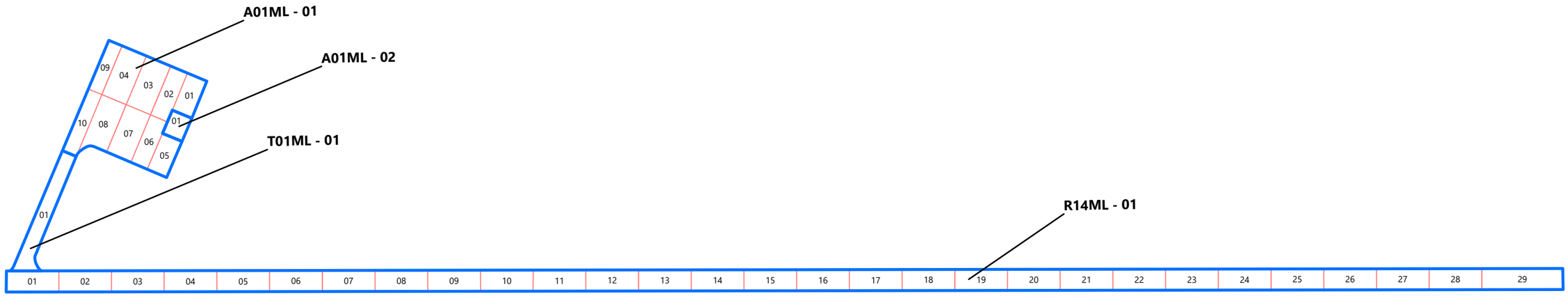
Notes:
[1] LCD = Last Construction Date. The date of the last major rehabilitation (e.g. overlay)

Table 3A: EXAMPLE SAMPLE RATES FOR AC AND PCC PAVEMENTS

AC Sampling Rate	
Total Number of Sample Units, N	**Sample Units to Survey, n**
1	1
2-3	2
4-6	3
7-13	4
14-38	5
39+	6

PCC Sampling Rate	
Total Number of Sample Units, N	**Sample Units to Survey, n**
1	1
2	2
3-4	3
5-6	4
7-8	5
9-11	6
12-14	7
15-19	8
20-27	9
28-38	10
39-58	11
59-104	12
105-313	13
314+	14

Note: AC = Asphalt Concrete
PCC = Portland Cement Concrete



SECTION

SAMPLE UNIT

N

0 200 400 Feet

GRI

SAMPLE UNIT LAYOUT

MALIN AIRPORT

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APPENDIX B

Pavement Condition Index Survey Results

APPENDIX B

PAVEMENT CONDITION INDEX SURVEY RESULTS

B.1 METHODOLOGY

As previously discussed, the PCI is a measure of the pavement's functional surface condition and provides a methodology for assessing the causes of distress and whether the distress is related to a load or climatic conditions. Although the PCI is not a direct measure of structural capacity, it provides a suggestion of the structural needs of the pavement.

The PCI is based on the type, severity, and quantity of each distress found in an inspected sample unit. The results are displayed using a seven-category rating scale in accordance with ASTM D5340. Flexible (e.g., AC) and rigid (e.g., PCC) pavement distress types are presented in Table 1B. A summary of the pavement condition results by branch and section are included in Tables 2B and 3B of Appendix B, respectively.

Table 1B: PAVER DISTRESS CODES FOR FLEXIBLE AND RIGID PAVEMENT

Flexible Pavement			Rigid Pavement		
PAVER Code	Pavement Distress	Related Cause	PAVER Code	Pavement Distress	Related Cause
41	Alligator Cracking	Load	61	Blow-Up	Load
42	Bleeding	Other	62	Corner Break	Load
43	Block Cracking	Climate/ Durability	63	Longitudinal, Transverse, & Diagonal Cracks	Climate/ Durability
44	Corrugation	Other	64	Durability Cracking	Climate/ Durability
45	Depression	Other	65	Joint Seal Damage	Other
46	Jet Blast	Other	66	Small Patch	Other
47	Joint Reflection Cracking	Climate/ Durability	67	Large Patch	Other
48	Longitudinal & Transverse Cracking	Climate/ Durability	68	Pop Outs	Other
49	Oil Spillage	Other	69	Pumping	Other
50	Patching	Climate/ Durability	70	Scaling	Other
51	Polished Aggregate	Other	71	Faulting	Other
52	Raveling	Climate/ Durability	72	Shattered Slab	Load

Flexible Pavement		
PAVER Code	Pavement Distress	Related Cause
53	Rutting	Load
54	Shoving	Other
55	Slippage Cracking	Other
56	Swelling	Other
57	Weathering	Climate/ Durability

Rigid Pavement		
PAVER Code	Pavement Distress	Related Cause
73	Shrinkage Cracking	Other
74	Joint Spalls	Other
75	Corner Spalls	Other
76	Alkali-Silica Reactivity (ASR)	Other

To obtain the section PCI, we extrapolated the PCI of each selected sample unit over the entire section area. Distresses found in sample units classified as "additional"– defined as nonrepresentative instead of random- are not extrapolated over the entire section but merely added to the extrapolated quantity. The PCI rating scale presented previously in Table 3-1 of Section 3.1 and are based on ASTM D5340.

Section 4.1 of ASTM D5340 governing PCI surveys offers this caution:

*"The PCI is a numerical indicator that rates the surface condition of the pavement. The PCI provides a measure of the **present condition** of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety). The PCI **cannot** measure the structural capacity; neither does it provide a direct measurement of skid resistance or roughness. It provides an objective and rational basis for determining maintenance and repair needs and priorities. Continuous monitoring of the PCI is used to establish the rate of pavement deterioration, which permits early identification of major rehabilitation needs. The PCI provides feedback on pavement performance for validation or improvement of current pavement design and maintenance procedures."*

Based on the limitations of the PCI method, it is imperative that engineers and planners treat the PCI as a tool that will assist them during the M&R planning process. Any major project should always be preceded by an up-to-date, detailed, 100% project-level inspection of the pavement in order to reevaluate maintenance needs prior to the project design process.

B.2 DISTRESS TYPES

Distress tends to fall into one of the following four cause categories:

- **Load-related:** Flexible pavement distresses include alligator/fatigue cracking, corrugation, depression, polished aggregate, rutting, and slippage cracking. Rigid

pavement distresses include corner breaks, longitudinal cracking, divided slabs, polished aggregate, pumping, and joint spalling.

- **Climate- and durability-related:** Flexible pavement distresses include bleeding, block cracking, joint reflection cracking, longitudinal and transverse (L&T) cracking, swelling, and raveling/weathering. Rigid pavement distresses include blow-ups, durability cracking, longitudinal cracking, pop-outs, pumping, scaling, shrinkage cracks, and joint and corner spalling.

- **Moisture- and drainage-related:** Flexible pavement distresses include alligator/ fatigue cracking, depressions, potholes, and swelling. Rigid pavement distresses include corner breaks, divided slabs, and pumping.

- **Other factors:** Oil spillage, jet blast erosion, bleeding, patching, and concrete slab joint faulting.

As described above, a distress may be the result of more than one cause. For example, depressions may be caused by incorrect compaction during construction or by subgrade softening due to environmental factors. In addition, a distress may be initiated by one cause but may progress to a distress of higher severity by another cause. Therefore, engineering judgment is critical in analyzing the actual cause or causes of the distress.

B.3 PAVEMENT CONDITION INDEX SURVEY RESULTS

The evaluated Malin Airport pavement network consists of three branches and four sections. A total of 13 sample units were visually inspected in the field. Data from the inspected sample units were input into the PAVER database, and a resultant PCI for each section was computed. Additional details regarding the PCI and distress types observed for each surveyed sample unit are provided in the re-inspection report, Table 1E, in Appendix E. Based on the 2022 PCI survey, the area-weighted average PCI for the entire pavement network at Malin Airport is approximately 71, which corresponds to a PCI rating of Satisfactory.

Table 2B - MALIN AIRPORT CURRENT BRANCH CONDITION REPORT

Branch ID	Number of Sections	Approximate Area, square feet	Use	Area Weighted Average Branch PCI	PCI Category
A01ML	2	40,854	APRON	67	Fair
R14ML	1	118,027	RUNWAY	72	Satisfactory
T01ML	1	7,305	TAXIWAY	75	Satisfactory

Use Category	Number of Sections	Total Area, square feet	Area Weighted Average PCI
APRON	2	40,854	67
RUNWAY	1	118,027	72
TAXIWAY	1	7,305	75
ALL	**4**	**166,186**	**71**

Table 3B - MALIN AIRPORT 2022 PAVEMENT CONDITION INDEX SURVEY RESULTS

BranchID	SectionID	Last Construction Date	Surface Type	Use	Last Inspection Date	Age at Inspection	PCI	PCI Category	PCI % Climate	PCI % Load	PCI % Other
A01ML	01	Unknown	AC	APRON	3/1/2022	Unknown	66	Fair	100	0	0
A01ML	02	Unknown	PCC	APRON	3/1/2022	Unknown	88	Good	0	0	100
R14ML	01	Unknown	AC	RUNWAY	3/1/2022	Unknown	72	Satisfactory	100	0	0
T01ML	01	Unknown	AC	TAXIWAY	3/1/2022	Unknown	75	Satisfactory	100	0	0

Abbreviations:
PCI = Pavement Condition Index, AC = Asphalt Concrete, PCC = Portland Cement Concrete

APPENDIX C

Future Pavement Condition Analysis

APPENDIX C

FUTURE PAVEMENT CONDITION ANALYSIS

C.1 METHODOLOGY

In addition to assessing the current condition of a pavement, it is very important from a planning standpoint to be able to predict with reasonable accuracy its future condition. In a pavement management plan (PMP), this is done with the aid of a prediction model. When an APMS is initially implemented, the default models are typically used to predict the future condition of a pavement. However, after PCI surveys are completed, the historical data are then used to refine the models, so they better represent the deterioration of a particular class of pavement based on local climatic conditions, loading, material sources, construction procedures, etc. The importance of accurate prediction models is part of the reason it is essential to conduct periodic, routine surveys in order to track the rate of deterioration.

In PAVER, the pavement deterioration curves are developed based on the "family" model procedure. A pavement "family" is defined as a group of pavements with similar deterioration characteristics. The procedure for developing the prediction models is:

1. Define the pavement families.
2. Review the data.
3. Conduct a data outlier analysis.
4. Model the data.

C.2 PREDICTION MODELS

We developed separate condition prediction models for each pavement "family" at Malin Airport. The delineation is based on branch use, surface type, section rank, and structural design life. We use two distinct models for the following "families" of pavements at Malin Airport. For each model, we reviewed the data in order to filter out any suspicious or inaccurate data or any data that fall outside boundary values set by PAVER. After outliers are removed and the data are checked for accuracy and reasonableness, the PAVER program calculates a best-fit curve using a fourth-order, polynomial-constrained, least-squares analysis procedure. This best-fit curve for each family is used in the analysis to predict the average behavior of all sections within each "family." Our condition prediction models for each "family" are provided on Figures 1C through 4C below.

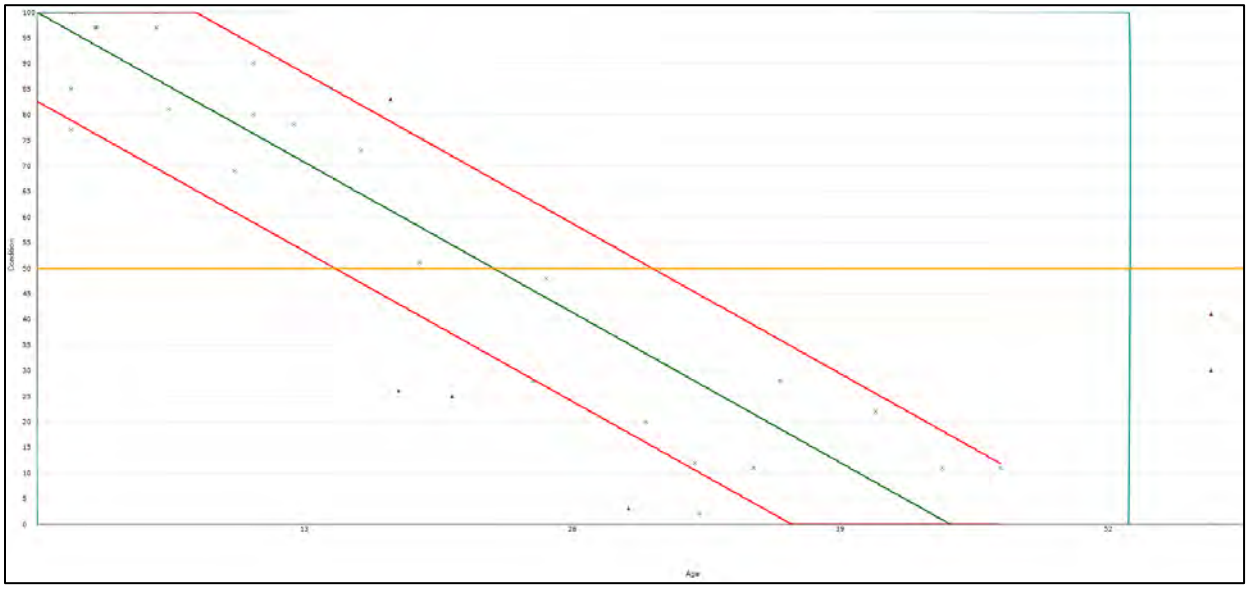

Figure 1C – CONDITION PREDICTION MODEL FOR CENTRAL CATEGORY 4/5 PCC - ALL USES

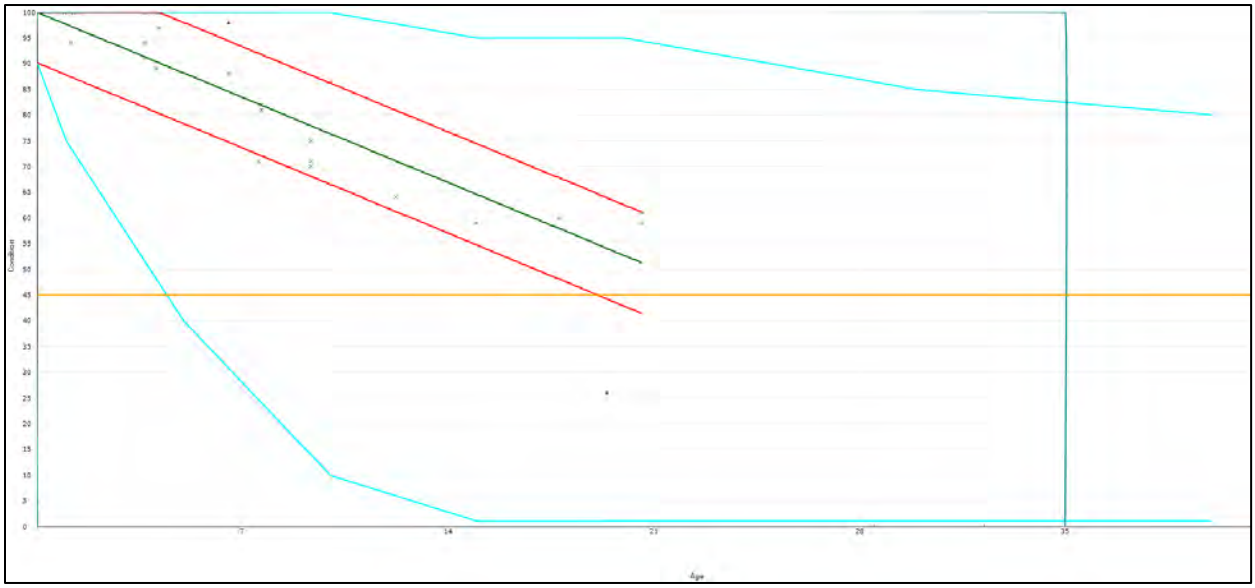

Figure 2C – CONDITION PREDICTION MODEL FOR CENTRAL CATEGORY 5 AC APRONS

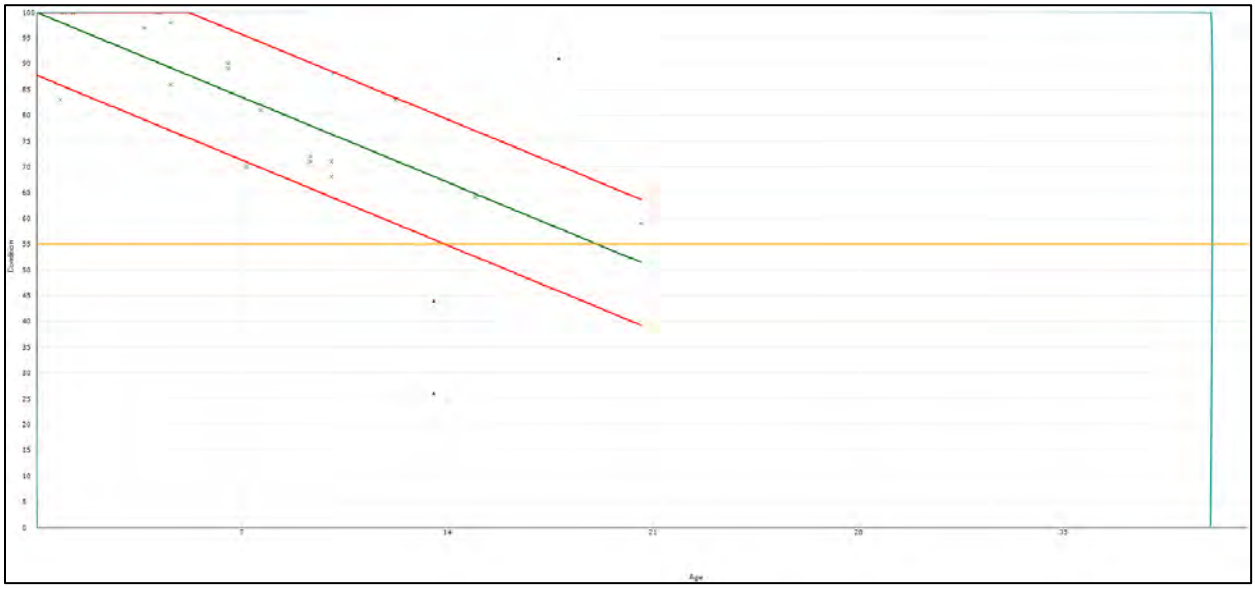

Figure 3C – CONDITION PREDICTION MODEL FOR CENTRAL CATEGORY 5 AC RUNWAYS

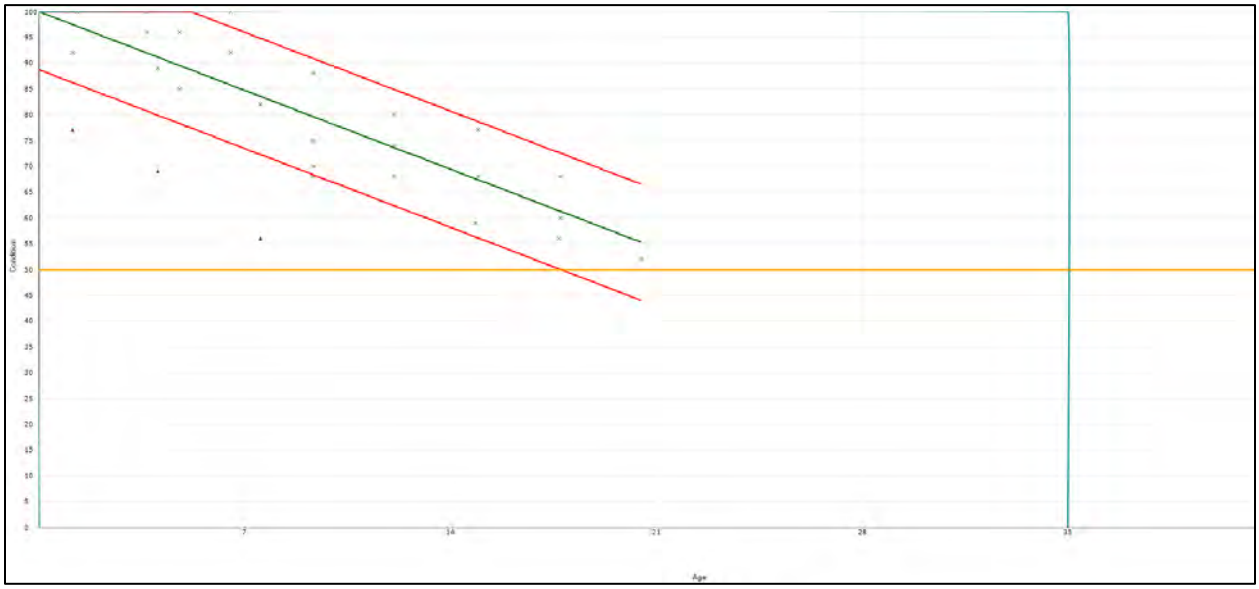

Figure 4C – CONDITION PREDICTION MODEL FOR CENTRAL CATEGORY 5 AC TAXIWAYS

C.3 CRITICAL PAVEMENT CONDITION INDEX

Each of the condition-prediction models have an assigned critical PCI. The critical PCI is the point at which the pavement condition begins to deteriorate more quickly over time. As the condition deteriorates to a worse state, major M&R is triggered because the cost to apply localized M&R increases significantly. Pavement sections with PCI above the critical value are given a higher priority for funding during budget analysis in order to

prevent them from deteriorating to the point where more costly rehabilitation is necessary. We used the following critical PCI values at Malin Airport:

- Runways – 55
- Taxiways/Taxilanes – 50
- Aprons – 45

C.4 FUTURE CONDITION ANALYSIS

As previously discussed, the projected condition of each pavement section was determined for 5- and 10-year periods. The projected pavement conditions in 5 years and 10 years for each pavement section at Malin Airport are listed in Table 1C.

C.5 FUNCTIONAL REMAINING LIFE

As mentioned above, functional remaining life is the practical amount of time a pavement is in service before requiring rehabilitation, as estimated based solely on visual condition. This is not to be confused with structural remaining life, which requires analysis of the structural capacity of a pavement.

We calculated two forms of functional remaining life based on the current visual condition surveys of the pavement at Malin Airport, the time until rehabilitation, and the time until the pavement is no longer operational due to high foreign object debris potential and increased safety concerns for trafficking aircraft (PCI less than 40). The results of the functional life analysis are provided in Table 2C.

Table 1C - PRESENT AND FUTURE PCI

BranchID	SectionID	Current PCI 2022	Predicted Future PCI 2027	2032
A01ML	01	66	54	42
A01ML	02	88	77	65
R14ML	01	72	60	48
T01ML	01	75	64	53

Abbreviations:
PCI = Pavement Condition Index

Table 2C - MALIN AIRPORT FUNCTIONAL REMAINING LIFE ANALYSIS

Branch ID	Section ID	Surface Type	Current PCI	Years to Major M&R	Major M&R Trigger PCI[1]	Years to End of Functional Service
A01ML	01	AC	66	6 - 10	45	6 - 10
A01ML	02	PCC	88	> 20	45	> 20
R14ML	01	AC	72	6 - 10	55	11 - 15
T01ML	01	AC	75	11 - 15	50	16 - 20

Abbreviations:
M&R = Maintenance and Rehabilitation, AC = Asphalt Concrete, PCC = Portland Cement Concrete
[1] Major M&R Trigger PCI = Critical PCI

APPENDIX D

Unit Cost Data and Maintenance and Rehabilitation Plan

APPENDIX D

UNIT COST DATA AND MAINTENANCE AND REHABILITATION PLAN

D.1 ANALYSIS METHODOLOGY

We evaluated the M&R needs, as determined from the PAVER analysis results, in order to develop project recommendations for the next five years. The purpose of this analysis is to determine the M&R needs of the Malin Airport pavement network condition over time. We used PAVER v7 software to develop network-level project recommendations for the next five years.

The PAVER M&R Work Planning Module identifies when and where M&R is required and how much it will cost. M&R plans can be developed either by assuming an annual budget or by identifying specific constraints, such as a condition goal to determine the budget required to meet the goal. The M&R work planning analysis was based on a five-year period beginning on August 1, 2023. A backlog elimination analysis scenario was selected to generate a list of global maintenance and rehabilitation projects in order to optimize the allocation of capital and establish preservation-based project recommendations. The repair strategies considered for pavement sections in our analysis are as follows:

- Reconstruction – Considered for pavements with a PCI less than 40.
- Flexible Overlay – Considered for pavements between 40 PCI and the critical PCI, and for pavements exhibiting significant load-related distresses.
- Global Maintenance – Treatments (fog seal, slurry seal, thin AC overlay) applied to an entire pavement section with the intent of slowing the rate of deterioration.
- Localized Maintenance – Maintenance performed on a routine basis such as crack sealing, wide crack repair, and patching.

It should be noted that the five-year list of recommended projects only includes the highest-cost maintenance items and does not include routine localized maintenance (e.g., crack sealing) work that should also be conducted in addition to and concurrently with the five-year work plan.

D.1.1 Pavement Rank and Use Prioritization

Pavement sections are assigned a rank to establish their relative importance in the overall pavement network, which is most commonly defined by their use (e.g., Taxiway, Apron, Runway). The PAVER analysis uses the combination of the section rank and the branch use

to define the priority of each section during the M&R analysis. Table 1D displays the branch use and section rank prioritization schema we used for analysis.

Table 1D: M&R WORK PRIORITY BY BRANCH USE AND SECTION RANK

Branch Use	Section Rank		
	Primary	Secondary	Tertiary
RUNWAY	1	3	6
TAXIWAY	2	5	8
APRON	4	7	9

D.2 MAINTENANCE POLICIES AND UNIT COSTS

The distress-maintenance policies are policies that determine what type of work should be applied to a specific distress type and severity. For example, on an AC pavement, a medium-severity longitudinal/transverse crack would be repaired by crack sealing. Policies for all distress types and severities are established by ASTM D5340.

Although our work scope does not include budget analysis, we did assign construction costs to the maintenance work so that PAVER would allocate M&R projects that were approximately equal in cost for each year of the five-year period. The anticipated cost of performing M&R is based on cost tables that relate M&R work type cost to PCI. We reviewed the bid tabulations for recent projects within the vicinity of Malin Airport and information provided by the project team. The costs for reconstruction are based on the existing pavement sections present within each branch use at Malin Airport. The costs represent the fully loaded costs and include aspects of the project such as administration, contingencies, mobilization, and striping. The cost tables used in the analysis are presented in Table 2D below.

Table 2D: MALIN AIRPORT UNIT COST DATA

Type of M&R	Work Type	Unit Cost	Work Unit
Major M&R	Complete Reconstruction with AC	$11.10	Sq Ft
	Cold Mill and Overlay – 3 Inches Thick	$4.90	Sq Ft
Global M&R	Surface Treatment - Slurry Seal	$0.33	Sq Ft
	Surface Treatment - Fog Seal	$0.20	Sq Ft
Localized Preventive M&R	Crack Sealing - AC	$2.00	Ft
	Crack Sealing - PCC	$15.00	Ft
	Crack Sealing – Wide Cracks	$33.00	Ft
	AC Patching – Full Depth	$50.00	Sq Ft
	PCC Patching – Full Depth	$100.00	Sq Ft

D.3 RECOMMENDED LOCALIZED MAINTENANCE

In order to properly maintain aging pavements, localized M&R activities such as crack sealing and patching should be performed on a routine basis. A list of recommended localized maintenance activities is provided in Table 3D of this appendix.

D.4 RECOMMENDED GLOBAL MAINTENANCE AND REHABILITATION PROJECTS

Global maintenance and rehabilitation projects refer to activities such as slurry seal and thin AC overlays, as well as thick AC overlays and reconstruction. A list of recommended global M&R activities is provided in Table 4D of this appendix.

Table 3D - MALIN AIRPORT NETWORK MAINTENANCE REPORT

Network	Branch ID	Section ID	Distress	Severity	Action	Work Quantity	Unit	Unit Cost	Work Cost	Section Total
Malin	A01ML	01	Long. & Trans. Cracking	High	Crack Seal - Wide Cracks	593	Ft	$33.00	$19,557	$20,510
Malin	A01ML	01	Long. & Trans. Cracking	Low	Crack Sealing - AC	87	Ft	$2.00	$174	
Malin	A01ML	01	Long. & Trans. Cracking	Medium	Crack Sealing - AC	389	Ft	$2.00	$779	
Malin	R14ML	01	Long. & Trans. Cracking	High	Crack Seal - Wide Cracks	993	Ft	$33.00	$32,768	$38,897
Malin	R14ML	01	Long. & Trans. Cracking	Low	Crack Sealing - AC	754	Ft	$2.00	$1,508	
Malin	R14ML	01	Long. & Trans. Cracking	Medium	Crack Sealing - AC	2,311	Ft	$2.00	$4,622	
Malin	T01ML	01	Long. & Trans. Cracking	High	Crack Seal - Wide Cracks	50	Ft	$33.00	$1,650	$1,708
Malin	T01ML	01	Long. & Trans. Cracking	Medium	Crack Sealing - AC	29	Ft	$2.00	$58	

Long. = Longitudinal; Trans. = Transverse; AC = Asphalt Concrete; Ft = Feet

Table 4D - FIVE-YEAR GLOBAL MAINTENANCE AND REHABILITATION PLAN

Action Year	Branch ID	Section ID	Branch Use	Surface Type	Current PCI	Action	Area, square feet	Unit Cost per square foot	Total Cost
2023	A01ML	01	APRON	AC	66	Fog Seal	38,951	$0.20	$7,790
2025	R14ML	01	RUNWAY	AC	72	Slurry Seal	118,027	$0.33	$38,949
	T01ML	01	TAXIWAY	AC	75	Slurry Seal	7,305	$0.33	$2,411

Abbreviations:
PCI = Pavement Condition Index, AC = Asphalt Concrete

Cost Summary	
2023 Total Project Cost	$7,790
2024 Total Project Cost	$0
2025 Total Project Cost	$41,360
2026 Total Project Cost	$0
2027 Total Project Cost	$0
Total 5-Year Project Cost	**$49,150**

APPENDIX E

Re-Inspection Report

Re-Inspection Report

ODA_WOC3_9-1-2022_PostBendAnalysis
Generated Date 9/30/2022

Network: Malin **Name:** Malin Airport

Branch: A01ML **Name:** Apron 01 **Use:** APRON **Area:** 40,854 SqFt

Section: 02 of 2 **From:** A01ML-01 **To:** End **Last Const.:** 1/1/1900

Surface: PCC **Family:** 2022_Central_Cat4/5_All Uses_PCC **Zone:** **Category:** **Rank:** S

Area: 1,903 SqFt **Length:** 40 Ft **Width:** 48 Ft

Slabs: 16 **Slab Length:** 10 Ft **Slab Width:** 12 Ft **Joint Length:** 262 Ft

Shoulder: **Street Type:** **Grade:** 0 **Lanes:** 0

Section Comments:

Work Date: 1/1/1900 **Work Type:** New Construction - Initial **Code:** NU-IN **Is Major M&R:** True

Last Insp. Date: 3/1/2022 **TotalSamples:** 1 **Surveyed:** 1

Conditions: **PCI:** 88

Inspection Comments:

Sample Number: 01 **Type:** R **Area:** 16.00 Slabs **PCI:** 88

Sample Comments:

74	JOINT SPALL	L	2.00	Slabs
73	SHRINKAGE CR	N	6.00	Slabs
75	CORNER SPALL	L	1.00	Slabs

Network: Malin **Name:** Malin Airport

Branch: A01ML **Name:** Apron 01 **Use:** APRON **Area:** 40,854 SqFt

Section: 01 of 2 **From:** T01ML-01 **To:** A01ML-02 **Last Const.:** 1/1/1900

Surface: AC **Family:** 2022_Central_Cat4/5_Apron_AC/AAC **Zone:** **Category:** **Rank:** S

Area: 38,951 SqFt **Length:** 200 Ft **Width:** 200 Ft

Slabs: **Slab Length:** Ft **Slab Width:** Ft **Joint Length:** Ft

Shoulder: **Street Type:** **Grade:** 0 **Lanes:** 0

Section Comments:

Work Date: 1/1/1900 **Work Type:** New Construction - Initial **Code:** NU-IN **Is Major M&R:** True

Last Insp. Date: 3/1/2022 **TotalSamples:** 10 **Surveyed:** 5

Conditions: **PCI:** 66

Inspection Comments:

Sample Number: 01 **Type:** R **Area:** 3022.00 SqFt **PCI:** 73

Sample Comments:

48	L & T CR	H	39.00	Ft
57	WEATHERING	L	3022.00	SqFt

Sample Number: 03 **Type:** R **Area:** 4996.00 SqFt **PCI:** 74

Sample Comments:

57	WEATHERING	L	4996.00	SqFt
48	L & T CR	M	150.00	Ft
48	L & T CR	L	27.00	Ft

Sample Number: 06 **Type:** R **Area:** 3341.00 SqFt **PCI:** 59

Sample Comments:

48	L & T CR	H	121.00	Ft
57	WEATHERING	L	3341.00	SqFt

Sample Number: 08 **Type:** R **Area:** 5019.00 SqFt **PCI:** 64

Sample Comments:

48	L & T CR	H	57.00	Ft
48	L & T CR	H	55.00	Ft
48	L & T CR	M	18.00	Ft
57	WEATHERING	L	5019.00	SqFt

Sample Number: 09 **Type:** R **Area:** 2742.00 SqFt **PCI:** 59

Sample Comments:

48	L & T CR	L	24.00	Ft
48	L & T CR	H	45.00	Ft
57	WEATHERING	L	2742.00	SqFt
48	L & T CR	H	30.00	Ft
48	L & T CR	M	60.00	Ft

Network: Malin **Name:** Malin Airport

Branch: R14ML **Name:** Runway 14/32 **Use:** RUNWAY **Area:** 118,027 SqFt

Section: 01 of 1 **From:** T01ML-01 **To:** End **Last Const.:** 1/1/1900

Surface: AC **Family:** 2022_Central_Cat4/5_RW_AC/AAC **Zone:** **Category:** **Rank:** P

Area: 118,027 SqFt **Length:** 2,950 Ft **Width:** 40 Ft

Slabs: **Slab Length:** Ft **Slab Width:** Ft **Joint Length:** Ft

Shoulder: **Street Type:** **Grade:** 0 **Lanes:** 0

Section Comments:

Work Date: 1/1/1900 **Work Type:** New Construction - Initial **Code:** NU-IN **Is Major M&R:** True

Last Insp. Date: 3/1/2022 **TotalSamples:** 29 **Surveyed:** 6

Conditions: **PCI:** 72

Inspection Comments:

Sample Number: 01 **Type:** R **Area:** 4000.00 SqFt **PCI:** 68

Sample Comments:

57	WEATHERING	L	4000.00	SqFt
48	L & T CR	M	150.00	Ft
48	L & T CR	H	40.00	Ft

Sample Number: 07 **Type:** R **Area:** 4000.00 SqFt **PCI:** 66

Sample Comments:

57	WEATHERING	L	4000.00	SqFt
48	L & T CR	M	100.00	Ft
48	L & T CR	H	60.00	Ft

Sample Number: 13 **Type:** R **Area:** 4000.00 SqFt **PCI:** 70

Sample Comments:

48	L & T CR	M	92.00	Ft
48	L & T CR	H	40.00	Ft
57	WEATHERING	L	4000.00	SqFt

Sample Number: 19 **Type:** R **Area:** 4000.00 SqFt **PCI:** 70

Sample Comments:

48	L & T CR	H	40.00	Ft
57	WEATHERING	L	4000.00	SqFt
48	L & T CR	L	12.00	Ft
48	L & T CR	M	80.00	Ft

Sample Number: 25 **Type:** R **Area:** 4000.00 SqFt **PCI:** 70

Sample Comments:

48	L & T CR	H	40.00	Ft
57	WEATHERING	L	4000.00	SqFt
48	L & T CR	M	50.00	Ft

Sample Number: 29 **Type:** R **Area:** 6150.00 SqFt **PCI:** 81

Sample Comments:

57	WEATHERING	L	6150.00	SqFt
48	L & T CR	M	40.00	Ft
48	L & T CR	L	155.00	Ft

Network: Malin **Name:** Malin Airport

Branch: T01ML **Name:** Taxiway 01 **Use:** TAXIWAY **Area:** 7,305 SqFt

Section: 01 of 1 **From:** R14ML-01 **To:** A01ML-01 **Last Const.:** 1/1/1900

Surface: AC **Family:** 2022_Central_Cat4/5_Taxiway_AC/AAC **Zone:** **Category:** **Rank:** S

Area: 7,305 SqFt **Length:** 240 Ft **Width:** 30 Ft

Slabs: **Slab Length:** Ft **Slab Width:** Ft **Joint Length:** Ft

Shoulder: **Street Type:** **Grade:** 0 **Lanes:** 0

Section Comments:

Work Date: 1/1/1900 **Work Type:** New Construction - Initial **Code:** NU-IN **Is Major M&R:** True

Last Insp. Date: 3/1/2022 **TotalSamples:** 1 **Surveyed:** 1

Conditions: **PCI:** 75

Inspection Comments:

Sample Number: 01 **Type:** R **Area:** 7305.00 SqFt **PCI:** 75

Sample Comments:

57	WEATHERING	L	7305.00	SqFt
48	L & T CR	H	50.00	Ft
48	L & T CR	M	29.00	Ft

APPENDIX F

Work History Report

Pavement Database: ODA_WOC3_8-20-2022_PostSurvey

Network: Malin Airport **Branch:** A01ML Apron 01 **Section:** 01 **Surface:**AC

L.C.D. 1/1/1900 **Use:** APRON **Rank:** S **Length:** 200.00 (Ft) **Width:** 200.00 (Ft) **True Area:** 38951.00001 (SqFt

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
1/1/1900	NU-IN	New Construction - Initial	0.00	0.00	☑	

Network: Malin Airport **Branch:** A01ML Apron 01 **Section:** 02 **Surface:**PCC

L.C.D. 1/1/1900 **Use:** APRON **Rank:** S **Length:** 40.00 (Ft) **Width:** 48.00 (Ft) **True Area:** 1903.000000 (SqFt

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
1/1/1900	NU-IN	New Construction - Initial	0.00	0.00	☑	

Network: Malin Airport **Branch:** R14ML Runway 14/32 **Section:** 01 **Surface:**AC

L.C.D. 1/1/1900 **Use:** RUNWAY **Rank:** P **Length:** 2,950.00 (Ft) **Width:** 40.00 (Ft) **True Area:** 118027.0000 (SqFt

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
1/1/1900	NU-IN	New Construction - Initial	0.00	0.00	☑	

Network: Malin Airport **Branch:** T01ML Taxiway 01 **Section:** 01 **Surface:**AC

L.C.D. 1/1/1900 **Use:** TAXIWAY **Rank:** S **Length:** 240.00 (Ft) **Width:** 30.00 (Ft) **True Area:** 7305.000002 (SqFt

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
1/1/1900	NU-IN	New Construction - Initial	0.00	0.00	☑	

Summary:

Work Description	Section Count	Area Total (SqFt)	Thickness Avg (in)	Thickness STD (in)
New Construction - Initial	4	166,186.00	0.00	0.00