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Raton Municipal Airport (RTN)
Pavement Condition and Analysis

Submitted to:

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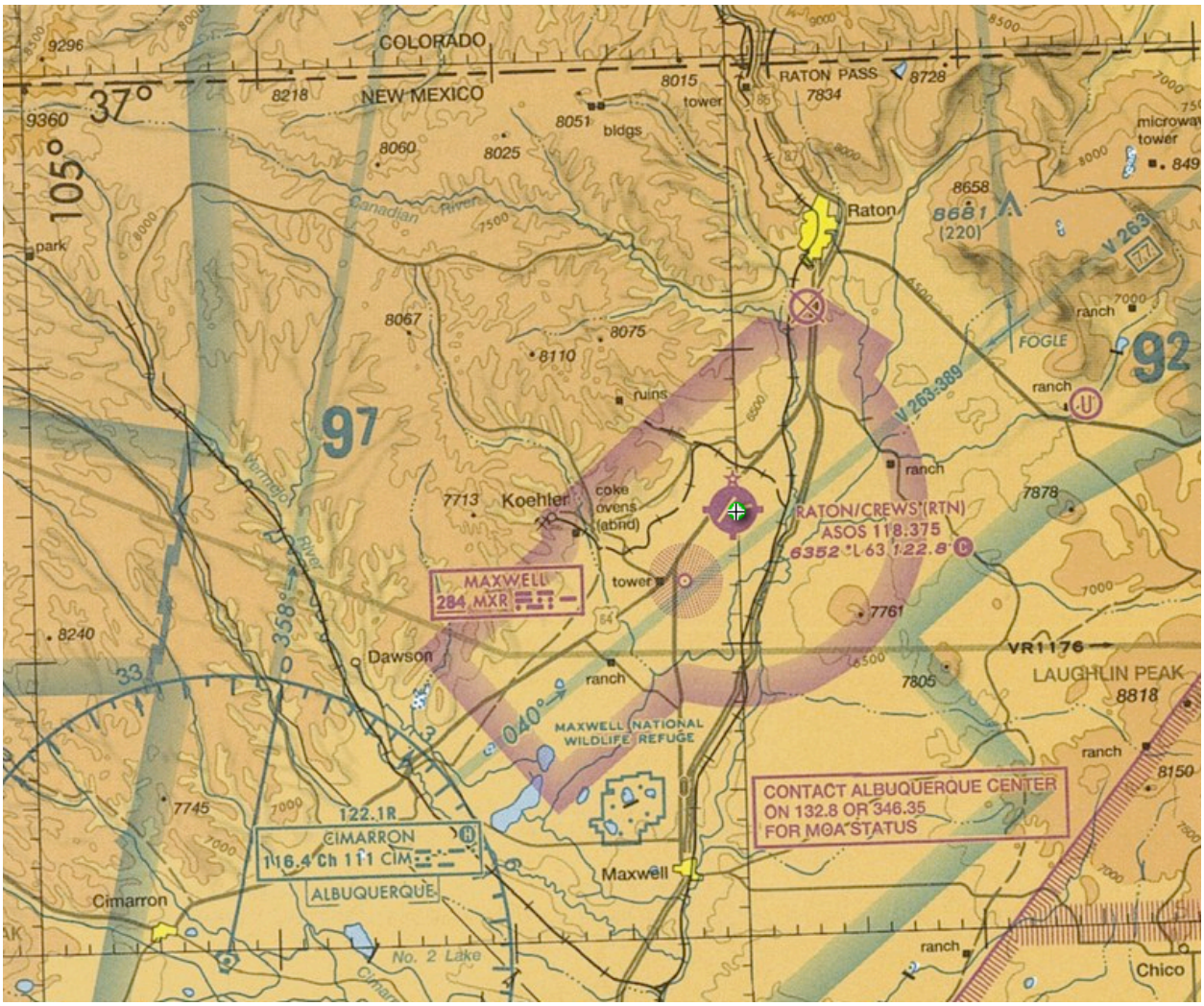
Contents

1. Conditions at Raton Municipal Airport (RTN)

Raton Municipal Airport (RTN) is located in Raton, NM about 220 miles northeast of Albuquerque, NM near the New Mexico and Colorado border (Figure 1).

Figure 1. Geographic Location of Raton Municipal Airport (RTN)



Source: www.skyvector.com

The estimated aircraft traffic at the Raton Municipal Airport (RTN), based on reported flight data from 2008, is presented in Table 1 and projected aircarft traffic is presented in Table 2. Air traffic is a mix of general aviation aircraft (single engine, twin engine and jets) and military helicopters. Jet traffic is typically Gulfstream IV, V or 550's.

Table 1. Raton Municipal Airport (RTN) Aircraft Operations (2008)

Aircraft Category	Yearly Traffic [no.]	Average Daily Traffic [no.]	Annual Aircraft [%]	Estimated Annual Departures [no.]
General Aviation-Single Engine	2,974	8.1	68.9%	1,487
General Aviation-Twin Engine	698	1.9	16.2%	349
Jets	446	0.5	10.3%	223
Military (helicopters)	198	0.5	4.6%	99
Total	**4316**			
Estimated Departures	**2158**			

Source: Based on air traffic operations data from 2008.

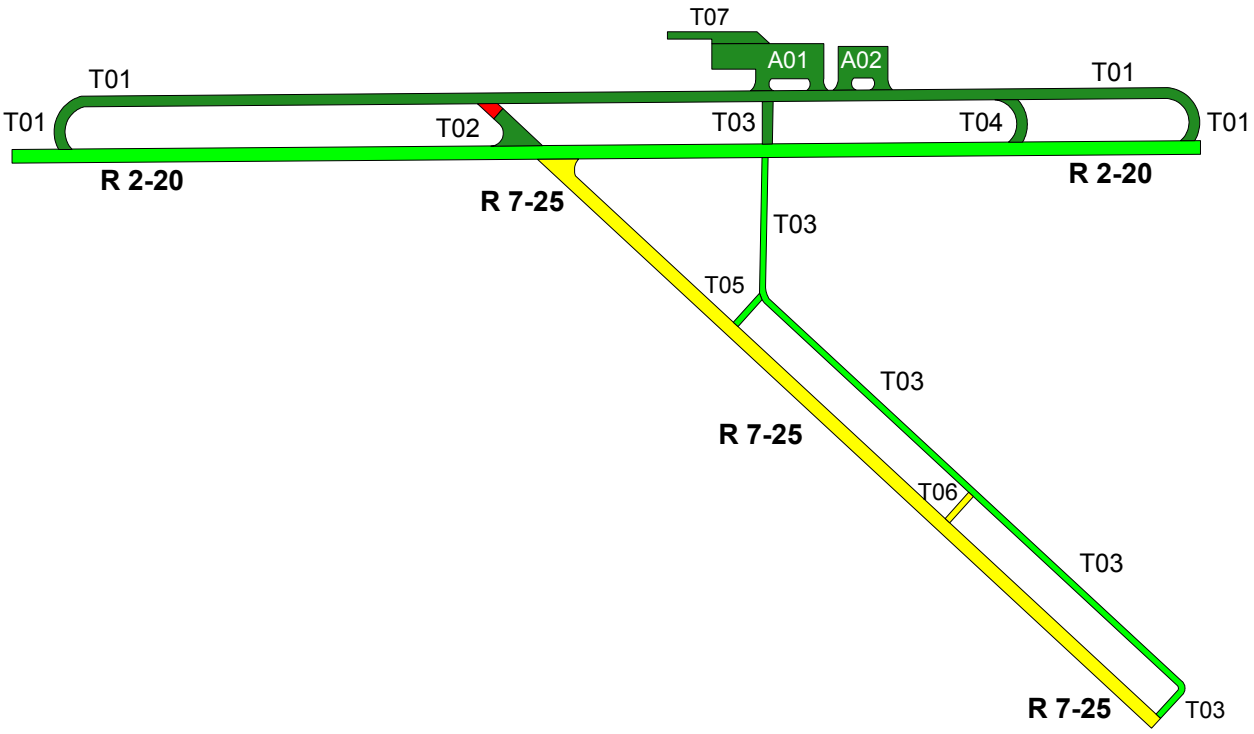
The asphalt concrete pavement on the runway, taxiways, and aprons was last inspected by New Mexico Tech (NMT) during June, 2007. Maps showing the general condition of these areas along with labels for the inspected areas are in presented in Figures 2 and 3. Table 3 shows the results of the June, 2007 pavement inspection, and the 2010 pavement condition index (PCI) estimates.

Table 2. Raton Municipal Airport (RTN) Predicted Aircraft Operations 2007-2027

	2007	2012	2017	2027
General Aviation Itinerant (Transient)	5,040	5,177	5,321	5,623
General Aviation Local	1,960	2,013	2,069	2,187
Air Taxi	483	494	506	532
Subtotal	7,483	7,684	7,896	8,342
Military Itinerant (helicopters)	550	550	550	550
Commercial Itinerant	0	0	0	0
Subtotal	550	550	550	550
Total Itinerant	6,073	6,221	6,377	6,705
Total Local	1,960	2,013	2,069	2,187
Total Annual Operations	8,033	8,234	8,446	8,892
Itinerant Operations Percentage	76%	76%	76%	75%
Local Operations Percentage	24%	24%	24%	25%
Annual Operations Growth Rate (5 year periods, e.g. 2007-2012)		0.5%	0.5%	0.5%
Average Annual Operations Growth Rate (2007-2027)	0.5%			

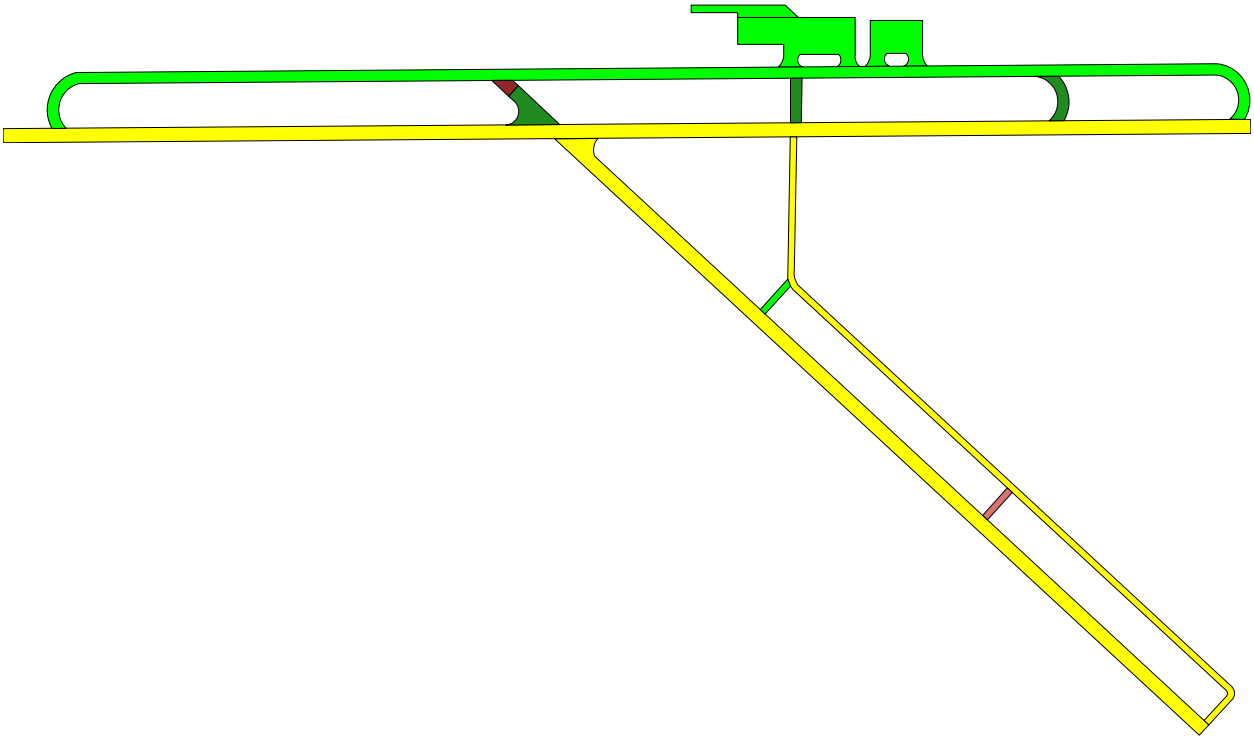
Note: Projections based on *New Mexico System Plan Update*, Wilbur Smith Associates, Inc. (2009).

Figure 2. Raton Municipal Airport (RTN) PCI Branch Map, June 23, 2007



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 3. Raton Municipal Airport (RTN) Predicted PCI Branch Map, June 27, 2010



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Table 3. Raton Municipal Airport (RTN) PCI Measurements for 2007 and 2010 Estimates

Branch ID	Area [ft^2]	PCI 2007	PCI 2010
ALL*	1,552,575	81	71
Apron 1	106,725	89	81
Apron 2	52,500	97	77
Runway 2-20	492,450	79	69
Runway 7-25	330,300	68	57
Taxiway 1	268,600	88	80
Taxiway 2	37,375	68	58
Taxiway 3	215,000	88	80
Taxiway 4	9,600	94	88
Taxiway 5	7,000	83	74
Taxiway 6	6,825	66	54
Taxiway 7	26,200	87	79

*weighted average PCI

Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

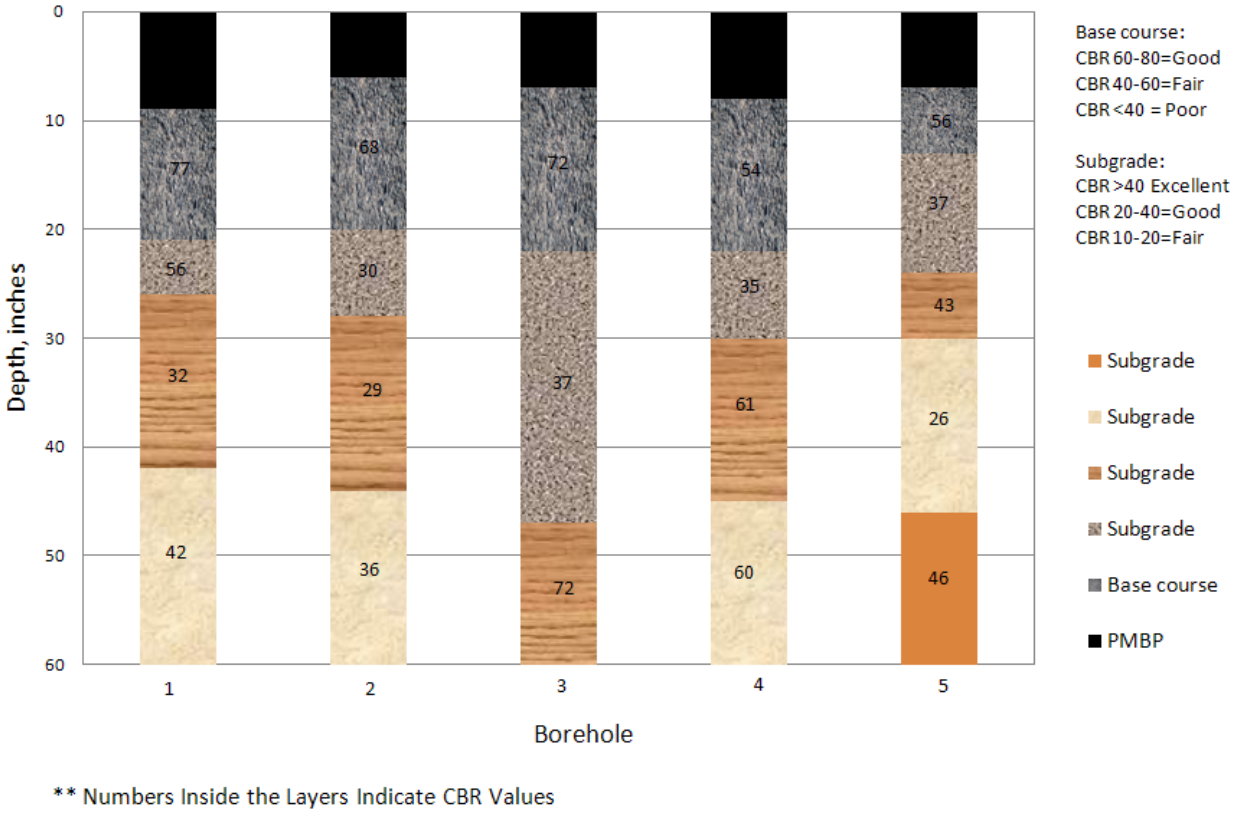
2. Soil and Aggregate Analysis

In March, 2009, the University of New Mexico (UNM) produced a report for the New Mexico Department of Transportation (NMDOT) – Aviation Division on the analysis of boreholes taken from the runways, taxiways and aprons at Raton Municipal Airport (RTN). The data consisted of asphalt concrete, base and subgrade thicknesses, generalized material compositions and California Bearing Ratio (CBR) for the materials underlying the pavement. In their analysis, samples from 20 boreholes were taken (Figure 4).

Figure 4. Borehole Locations at Raton Municipal Airport (RTN)

As part of the March, 2009 pavement and base analysis report, UNM examined Runway 7-25 (Figure 5).

Figure 5. Base and Subgrade Analysis for Runway 7-25



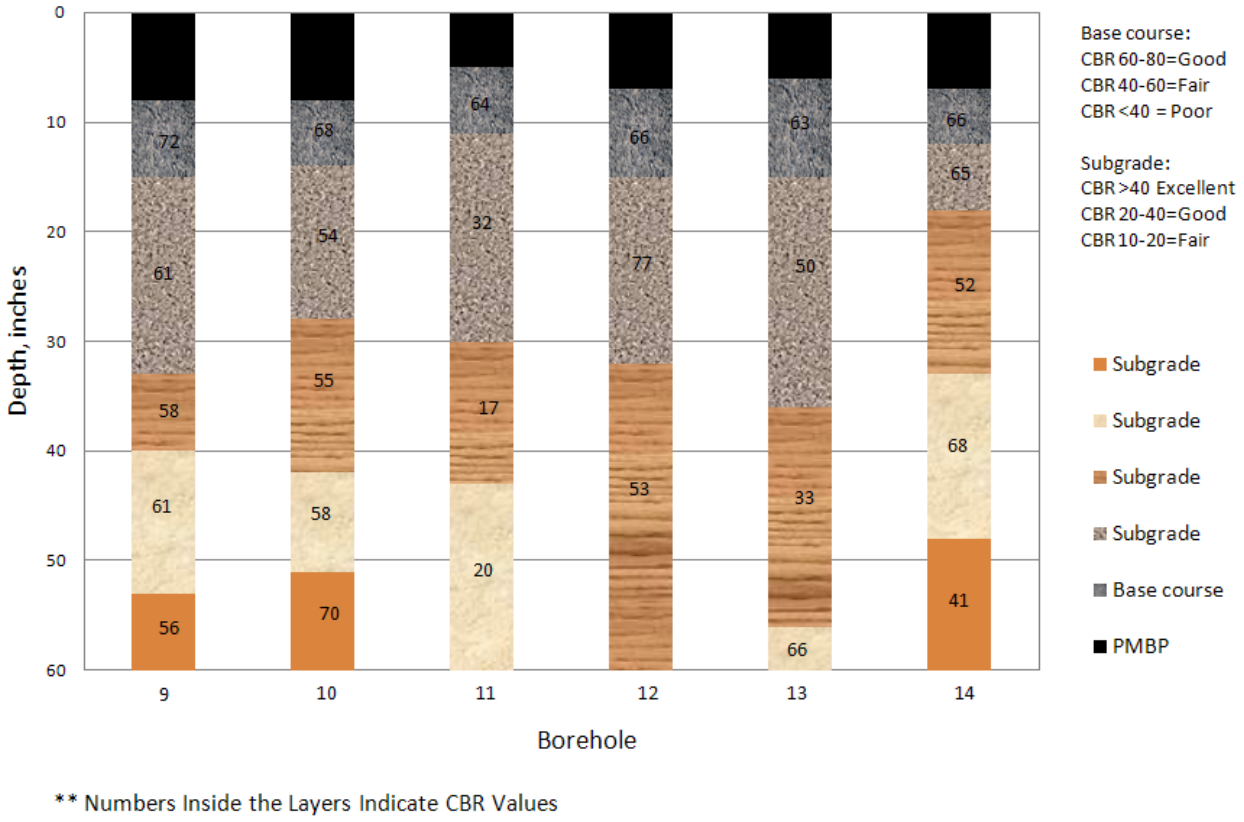
** Numbers Inside the Layers Indicate CBR Values

Runway 7-25

Five borehole samples were taken on *Runway 7-25*. The average asphalt concrete depth was 7.4-inches. The average base thickness was 12-inches, and the material composition was found to be either well-graded gravel or well-graded sand. The average CBR of the base was measured to be 65, with a range of values from 54 to 77. Overall the CBR of the base material is considered to be good. The subgrade material was composed of well-graded sand, poorly-graded sand, silty clay, or poorly-graded gravel. The average CBR of the subgrade material was 43 (range of 26 to 72), which is good to excellent.

As part of the March, 2009 pavement and base analysis report, UNM examined Runway 2-20 (Figure 6).

Figure 6. Base and Subgrade Analysis for Runway 2-20



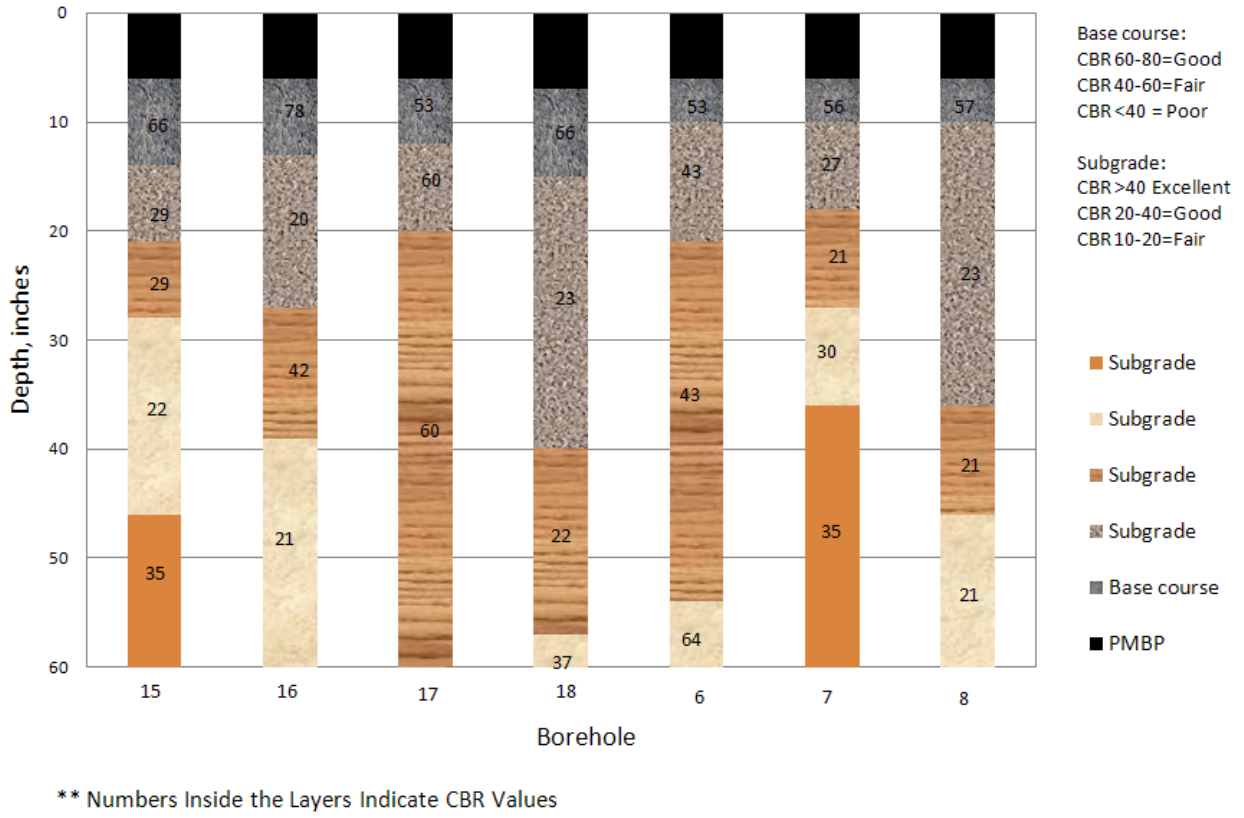
** Numbers Inside the Layers Indicate CBR Values

Runway 2-20

Six borehole samples were taken on *Runway 2-20*. The average asphalt concrete depth was 6.8-inches. The average base thickness was nearly 7-inches, and the material composition was found to be well-graded gravel. The average CBR of the base was measured to be 67, with a range of values from 63 to 72. Overall the CBR of the base material is considered to be good. The subgrade material was composed of well-graded sand, poorly-graded sand, silty clay, or poorly-graded gravel. The average CBR of the subgrade material was 52 (range of 17 to 77), which is good to excellent.

During March, 2009, the University of New Mexico (UNM) also produced an analysis of the base and subgrade materials underlying areas of *Taxiways A and B* and the *Aprons* (Figure 7).

Figure 7. Base and Subgrade Analysis for Taxiways and Apron



** Numbers Inside the Layers Indicate CBR Values

Taxiways A and B

Seven borehole samples were taken on *Taxiways A and B*. The average asphalt concrete depth was 6.1-inches. The average base thickness was nearly 6-inches, and the material composition was found to be well-graded gravel or poorly-graded sand. The average CBR of the base was measured to be 61, with a range of values from 53 to 78. Overall the CBR of the base material is considered to be good. The subgrade material was composed of poorly-graded sand, silty clay, or poorly-graded gravel. The average CBR of the subgrade material was 33 (range of 20 to 64), which is good to excellent.

Aprons

Two borehole samples were taken on the *Aprons*. The average asphalt concrete depth was 2.5-inches. The average base thickness was 10-inches, and the material composition was found to be well-graded gravel or well-graded sand. The average CBR of the base was measured to be 59, with a range of values from 51 to 66. Overall the CBR of the base material is considered to be fair to good. The subgrade material was composed of poorly-graded sand, silty clay, or poorly-

graded gravel. The average CBR of the subgrade material was 50 (range of 35 to 64), which is good to excellent.

FWD Analysis

In a March, 2009 report, the University of New Mexico (UNM) and the New Mexico Department of Transportation (NMDOT) presented data from the use of the falling weight deflectometer (*FWD*) method to analyze the structural capacity of the pavement wearing surface and the subgrade for Runways 2-20 and 7-25. As noted in the report, the modulus values for the asphalt concrete and base are satisfactory, but the subgrade modulus values were low in many areas, indicating a weak subgrade.

Skid Resistance

In the March, 2009 UNM report, the skid resistance of Runway 2-20 was tested at 59 points along its length on both sides of the runway. The skid resistance of asphalt concrete typically varies from a high of about 70, when the wearing surface is new to a low of about 30, which would be considered critically low. The measured values obtained on Runway 2-20 varied from about 50 to 60.

The skid resistance of Runway 7-25 was tested at 45 points along its length on both sides of the runway. The measured values obtained on Runway 7-25 varied from about 60-70.

3. Predicted Pavement Conditions Assuming No Maintenance

MicroPAVER 6 was used to predict the PCI values of the various pavement sections present at Raton Municipal Airport, assuming that no future maintenance occurs (Tables 4 and 8 and Figures 8-11). The pavement prediction relies on initial construction dates, when known, and the June, 2007 on-site pavement inspection. Additional inspection or construction data would increase the reliability of the predictive capabilities of the model.

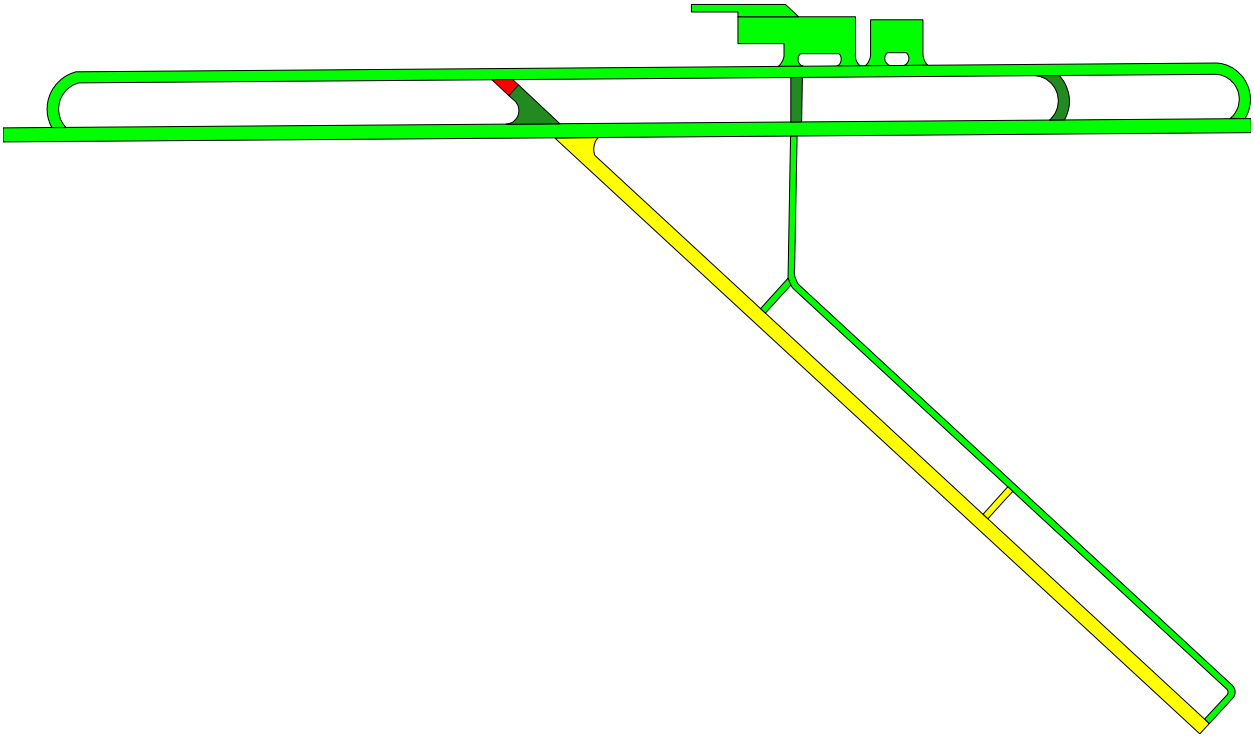
Table 4. Predicted Pavement Conditions (PCI) Assuming no Maintenance After 2007

Branch ID	2007	2009	2010	2013	2018
ALL*	81	74	71	60	39
Apron 1	89	84	81	72	53
Apron 2	97	82	77	68	62
Runway 2-20	79	73	69	58	36
Runway 7-25	68	61	57	43	18
Taxiway 1	88	83	80	71	52
Taxiway 2	68	61	58	46	35
Taxiway 3	88	83	80	71	52
Taxiway 4	94	90	88	80	63
Taxiway 5	83	77	74	64	43
Taxiway 6	66	58	54	41	15
Taxiway 7	87	82	79	69	50

*weighted average PCI

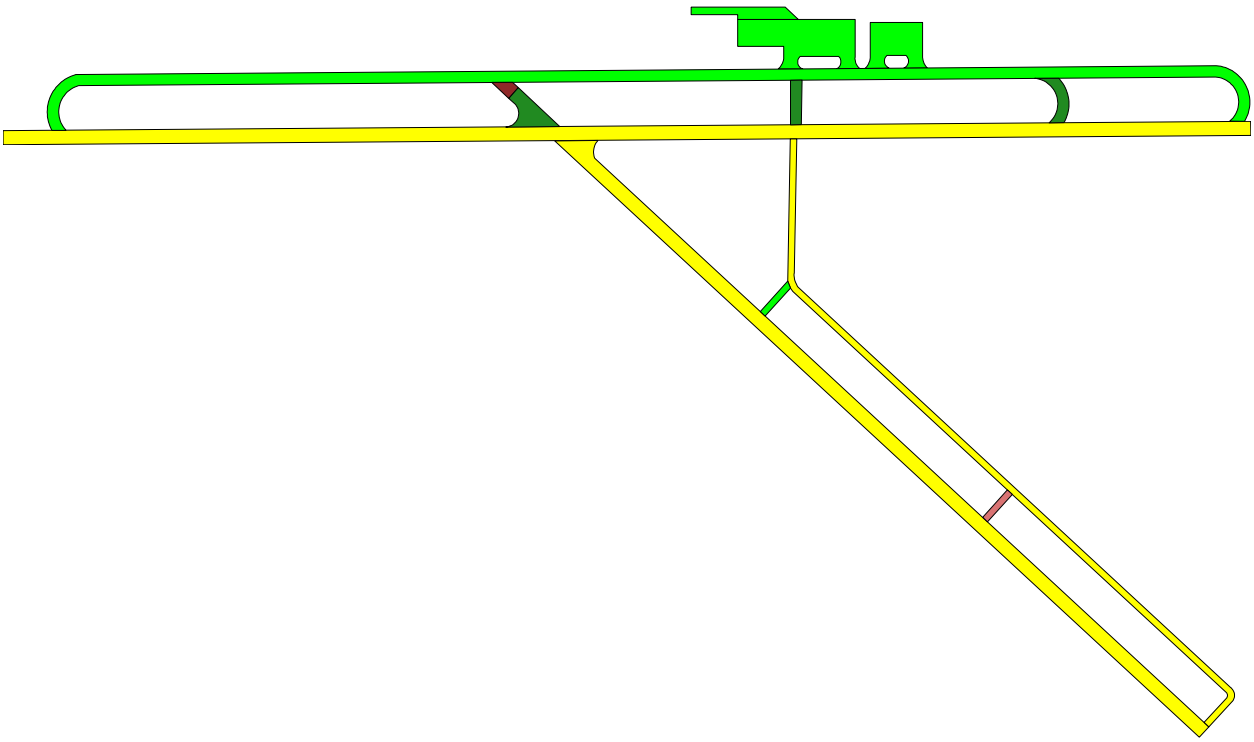
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 8. Raton Municipal Airport (RTN) Predicted PCI Branch Map for 2009



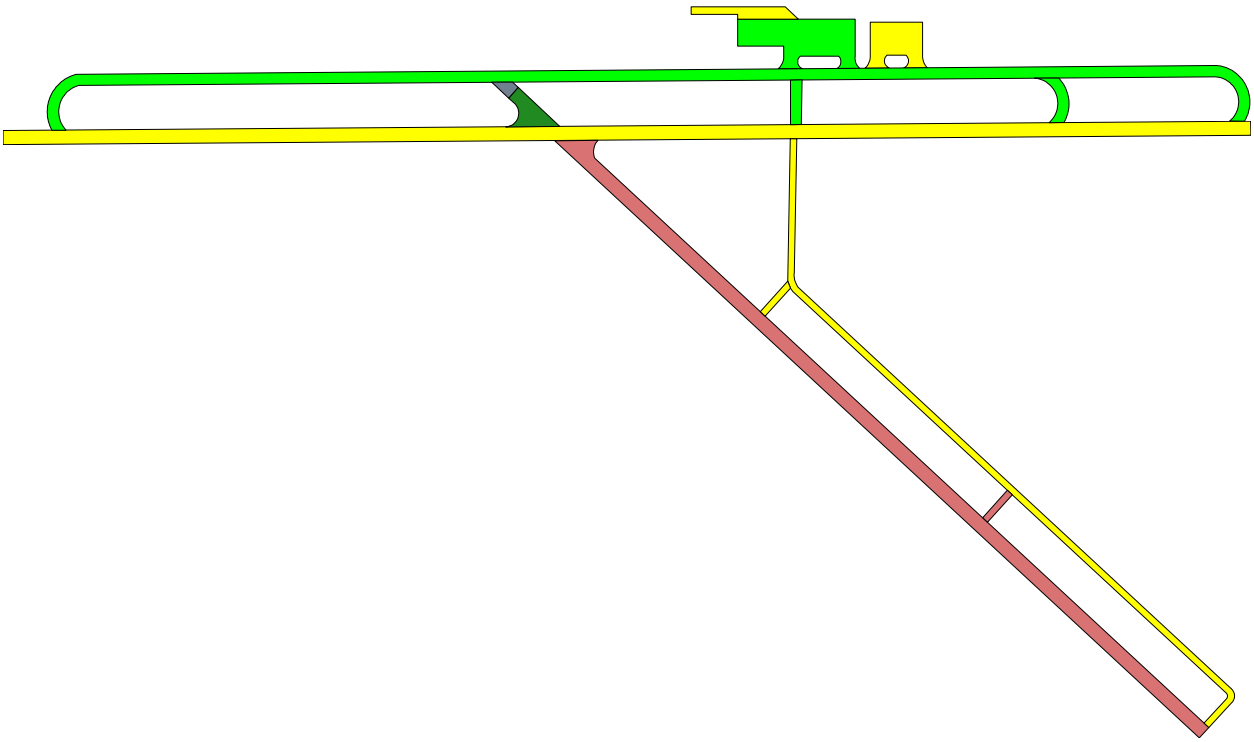
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 9. Raton Municipal Airport (RTN) Predicted PCI Branch Map for 2010



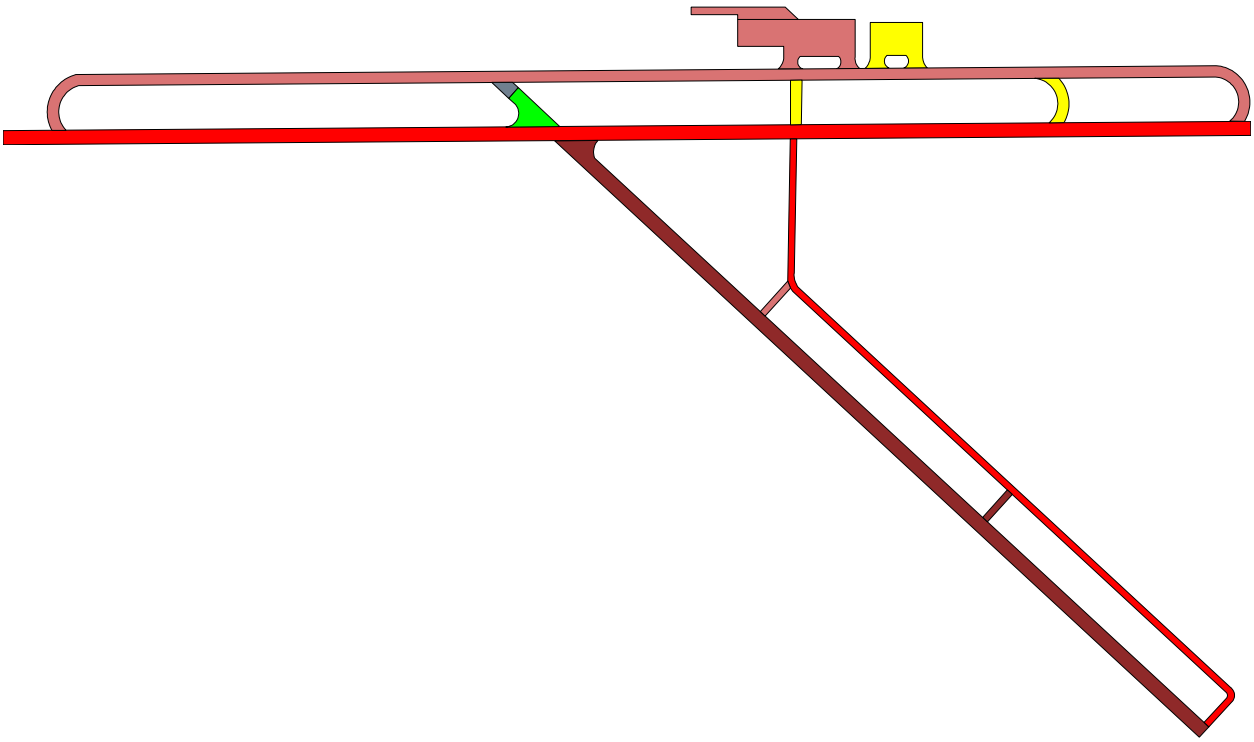
Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 10. Raton Municipal Airport (RTN) Predicted PCI Branch Map for 2013



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

Figure 11. Raton Municipal Airport (RTN) Predicted PCI Branch Map for 2018



Condition	Scale	Color
Good	100-86	
Satisfactory	85-71	
Fair	70-56	
Poor	55-41	
Very Poor	40-26	
Serious	25-11	
Failed	10-0	

4. Recommend Pavement Design

The recommend asphalt concrete pavement construction was determined using FAA design procedures for the design aircraft detailed in Table 5. FAA designs were completed using the *FAARFIELD version 1.302* airfield pavement design software. A normal FAA asphalt concrete design life of 20 years was assumed for the case listed below. The *CBR* of the subgrade was modeled at a value of 20, which is lower than the subgrade value measured at the Raton Municipal Airport. The design pavement and aggregate thicknesses were rounded up to the nearest 1/2-inch.

Table 5. Design Aircraft Used for Runway Pavement Design

Aircraft Category	Gross Weight [lb]	Estimated Annual Departures [number]	Annual Aircraft [%]	Annual Growth [%]
Cessna Skyhawk 172	2,558	3,000	77.9%	0.5%
Super King Air 350	15,100	500	13.0%	0.5%
Gulfstream V	90,900	350	9.1%	0.5%
Total		3,850	100.0%	

Table 6. Recommended Runway Pavement Design

Layer Material	Thickness [in]	Modulus [psi]
HMA Asphalt Concrete Surface (P-401/P-403)[1]	4	200,000
Crushed Aggregate (P-209)[2]	7.5	60,000
Subgrade[3]	CBR = 20	30,000

1. The asphalt concrete modulus is assumed to have a constant value of 200,000 psi.
2. The crushed aggregate modulus depends upon thickness, and it is estimated by the *FAARFIELD* program.
3. The subgrade modulus (E) is estimated from the *CBR*-value, where $E = 1500 \times CBR$ [psi].

5. Current Pavement Design for Runways 2-20 and 7-25

Runway 2-20 is currently constructed as follows (Table 7):

Table 7. Actual Design Conditions for Runway 2-20 (2010)

Layer Material	Thickness [in]
Asphalt Concrete (AC)	7.4
Base Course	12.0
Subgrade (avg. CBR = 43)	≥ 40

Runway 7-25 is currently constructed as follows (Table 8):

Table 8. Actual Design Conditions for Runway 7-25 (2010)

Layer Material	Thickness [in]
Asphalt Concrete (AC)	6.8
Base Course	6.8
Subgrade (avg. CBR = 52)	≥ 50

Using the design aircraft traffic specified in Table 6, and the data obtained from borehole analysis of the runways, it is determined that Runways 2-20 and 7-35 are well-designed for a lifetime of 20 years.

6. Maintenance and Rehabilitation (M&R) Schedule

The FAA recommends a 20-year lifespan for asphalt concrete airport pavements. As shown in Figure 12, it is much more expensive to perform maintenance on pavements that have deteriorated below a Pavement Condition Index (PCI) of about 60. At this PCI, a major rehabilitation or reconstruction (mill and overlay) is required to substantially increase the PCI-value. This type of treatment would incur a much greater expense compared to rehabilitating pavements with PCI values greater than 60. Rehabilitation of pavements with PCI values below 60 can cost 4 to 5 times as much compared to the rehabilitation of pavements with PCI values greater than 60. It is generally accepted that the maintenance and rehabilitation of taxiways and aprons is of a lower priority than runways, so a lower PCI threshold of around 40 could be used. Therefore, funding priorities typically favor runways.

A combination of data from *MicroPAVER* 6 and engineering judgment was used to generate the data for the estimated M&R schedule presented in Table 9. PCI-values where recommended maintenance should be performed are listed in the table legend. The M&R schedule relies greatly on the pavement inspection performed by NMT during June, 2007, but this inspection only represents a single set of pavement inspection data. Additional inspection data would increase the reliability of the predictive capabilities of the M&R model.

Figure 12. Typical Pavement Condition as a Function of Time

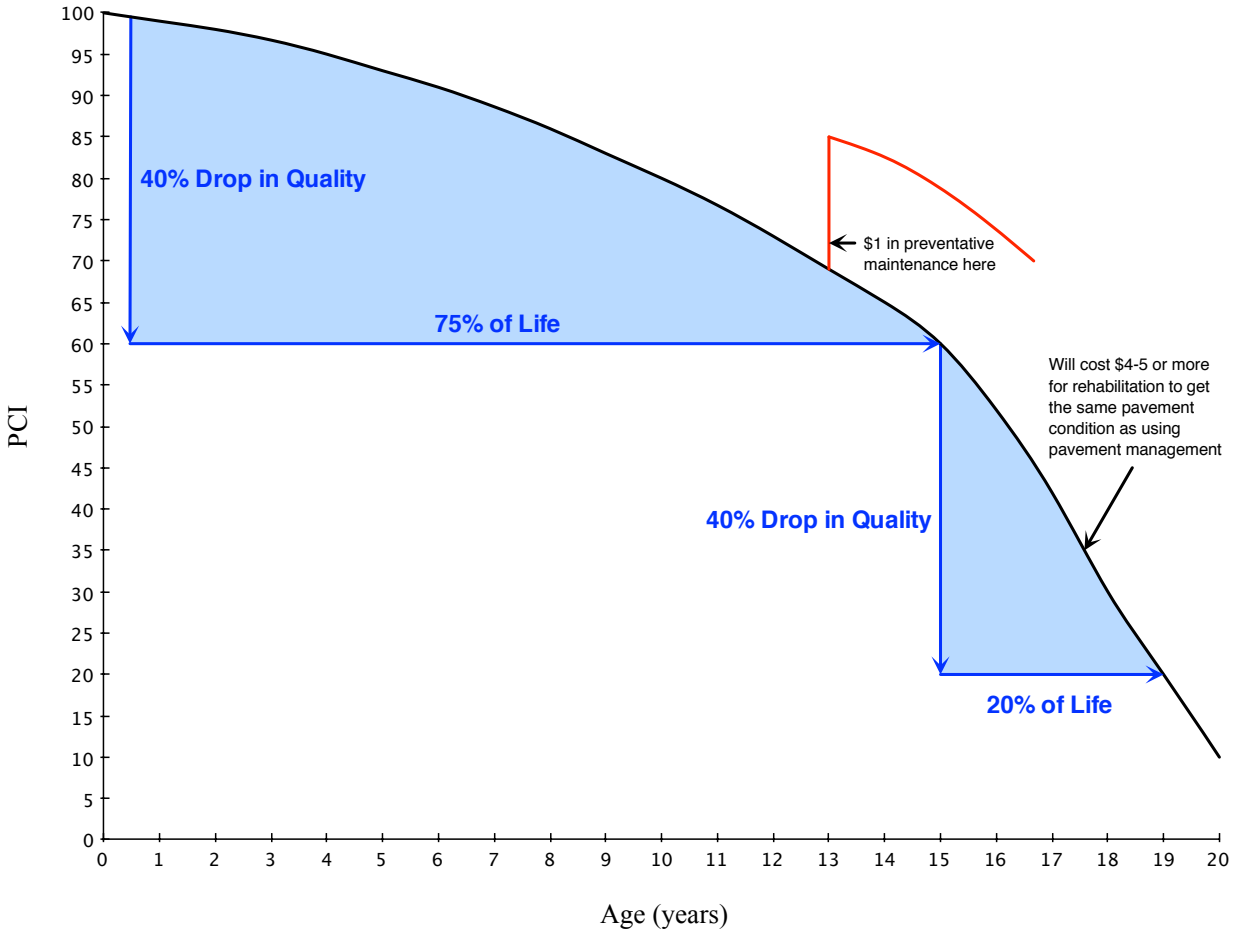


Table 9. Estimated Maintenance and Rehabilitation (M&R) Actions by Year

Branch ID	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ALL*	74	71	68	64	60	56	52	48	44	39
Apron 1	84	81	79	76	72	69	65	61	58	53
Apron 2	82	77	73	70	68	66	65	64	63	62
Runway 2-20	73	69	66	62	58	54	50	45	41	36
Runway 7-25	61	57	52	48	43	39	34	29	23	18
Taxiway 1	83	80	77	74	71	67	64	60	56	52
Taxiway 2	61	58	54	50	46	42	40	38	37	35
Taxiway 3	83	80	77	74	71	67	64	60	56	52
Taxiway 4	90	88	85	83	80	77	74	71	67	63
Taxiway 5	77	74	71	67	64	60	56	52	47	43
Taxiway 6	58	54	50	45	41	36	31	26	20	15
Taxiway 7	82	79	76	73	69	66	62	58	54	50

Legend (maintenance required – general condition)		
None - Excellent		PCI ≥ 90 – maintenance is probably not necessary.
Light - Very Good		80 ≤ PCI ≤ 90 – light maintenance, such as crack sealing may be necessary.
Medium - Good		65 ≤ PCI ≤ 80 – medium maintenance, such as crack sealing and surface coating.
Medium to Major - Fair		40 ≤ PCI ≤ 65 – thin mill (half-depth) and overlay.
Major to complete - Poor or worse		PCI ≤ 40 – full-depth mill and overlay, or entire rebuild, if not structurally sound.

7. Maintenance and Rehabilitation (M&R) Options

NMDOT-Aviation Division currently uses the following pavement maintenance options:

- **Seal coat** – an asphalt seal placed on the top surface of the asphalt concrete pavement. It is used to seal small cracks, reduce pavement binder oxidation at the surface, and improve friction. Typical lifetime is 3-6 years.
- **Crack sealing** – typically, compressed air is used to clean cracks in the pavement, and then the cracks are filled with a sealant. This method reduces water infiltration, and it can prevent cracks from developing into more serious distresses, such as larger pavement pieces breaking loose. Typical lifetime is 3 years.
- **Crack filling (Mastic)** – this method is similar to crack sealing, but the preparation may vary, since more material has to be removed from the cracked area. This method is used for wide cracks. Typical lifetime is 2-3 years.
- **Thermoplastic coal tar emulsion slurry seal** – a proprietary thermoplastic compound derived from coal tar that is also resistant to surface fuel spillage. The thermoplastic coal tar emulsion slurry seal is mixed with aggregate material, and placed on the pavement wearing surface. It can be used for new pavement construction and also for rehabilitation. Typical lifetime is 5-7 years for rehabilitated pavements, and 15 years for new pavements.
- **Emulsified pavement sealer and rejuvenator** – an emulsified sealer and binder that is placed on the pavement wearing surface. The seal provides an anti-oxidative seal for the asphalt pavement surface. Typical lifetime is 3-5 years.
- **Fog seal** – a diluted emulsion, typically 1 part emulsion and 1 part dilutant (e.g. water), is added to the pavement surface. This treatment is used to delay raveling and oxidation. Typical lifetime is 1-2 years.
- **Slurry seal** – a mixture of fine aggregate, asphalt emulsion, water and mineral filler added to the pavement surface. This treatment is used, when excessive oxidation and hardening of the surface is a problem. Slurry seals retard surface raveling, seal small cracks, and improve surface friction. Typical lifetime is 3-5 years.

Estimated and relative costs for typical maintenance options are presented in Table 10. Table 11 contains the cost estimates for seal coating of the various branches at Raton Municipal Airport (apron, runway, taxiway), assuming that the entire surface is coated. Since crack treatments depend upon the number and severity of cracks, any cost estimate would have to be based upon visual inspection of the affected areas.

Table 10. Current NMDOT-Aviation Division Pavement Maintenance Options

Crack Treatments	Estimated Cost (Applied) [linear ft]	Relative Cost	Estimated Additional Lifetime [years]
Crack sealing	$0.20	0.80	3
Crack filling	$0.25	1.00	2-3
Surface Treatments	[yd^2]		
Fog seal	$0.15	0.03	1-2
Coal tar sealer (seal coat)	$0.55	0.10	3-6
Emulsified pavement sealer and rejuvenator	$1.00	0.18	3-5
Slurry seal	$1.50	0.28	3-5
Thermoplastic coal tar emulsion slurry seal	$5.42	1.00	5-7

Table 11. Estimated Costs of Seal Coatings at Raton Municipal Airport (RTN)

Branch ID	Area [ft^2]	Fog Seal [$]	Seal Coat [$]	Emulsified Pavement Sealer [$]	Slurry Seal [$]	Thermoplastic Coal Tar Emulsion Slurry Seal [$]
Apron 1	106,725	$ 1,779	$ 6,522	$ 11,858	$ 17,788	$ 64,272
Apron 2	52,500	$ 875	$ 3,208	$ 5,833	$ 8,750	$ 31,617
Runway 2-20	492,450	$ 8,208	$ 30,094	$ 54,717	$ 82,075	$ 296,564
Runway 7-25	330,300	$ 5,505	$ 20,185	$ 36,700	$ 55,050	$ 198,914
Taxiway 1	268,600	$ 4,477	$ 16,414	$ 29,844	$ 44,767	$ 161,757
Taxiway 2	37,375	$ 623	$ 2,284	$ 4,153	$ 6,229	$ 22,508
Taxiway 3	215,000	$ 3,583	$ 13,139	$ 23,889	$ 35,833	$ 129,478
Taxiway 4	9,600	$ 160	$ 587	$ 1,067	$ 1,600	$ 5,781
Taxiway 5	7,000	$ 117	$ 428	$ 778	$ 1,167	$ 4,216
Taxiway 6	6,825	$ 114	$ 417	$ 758	$ 1,138	$ 4,110
Taxiway 7	26,200	$ 437	$ 1,601	$ 2,911	$ 4,367	$ 15,778

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