June 2009

Project No. 115896

GENERAL MITCHELL INTERNATIONAL AIRPORT

RUNWAYS 1L-19R AND 7R-25L INTERSECTION PAVEMENT STUDY FINAL REPORT

Project No. A135-08017

Prepared for

Milwaukee County Department of Transportation and Public Works

Milwaukee, Wisconsin

Prepared by

Baker

Michael Baker Jr., Inc.
Moon Township, Pennsylvania

TABLE OF CONTENTS

GENERAL MITCHELL INTERNATIONAL AIRPORT
RUNWAYS 1L-19R AND 7R-25L
INTERSECTION PAVEMENT STUDY

June 2009

1.0 EXECUTIVE SUMMARY

General Mitchell International Airport (GMIA) has over the years spent an increasingly large amount of maintenance dollars on rehabilitating the asphalt intersection of runways 1L-19R and 7R-25L. In a pavement survey conducted by the Wisconsin DOT in 2008, this pavement was determined to be at a state where normal maintenance could not keep up with the deterioration. The GMIA staff commissioned Michael Baker Jr. Inc. to study the pavement and determine alternatives to repair or replace the pavement. The intersection was surveyed for grades and profiles, cored to determine pavement sections and soil conditions, and tested with non-destructive testing methods to determine its expected life and structural capabilities.

The study's focus was on determining how best to repair or replace the pavement given its critical operational need. Requirements of operations, constructability, cost, life expectancy, and maintenance were considered in developing four alternatives for further review by the GMIA staff.

This report collects all of the study information including construction history, testing results, alternative development, estimates, constructability and maintenance to help the airport determine a course of action in the repair or replacement of the pavement. Using all the information gathered along with input from the GMIA staff, this report offers four alternatives for consideration for pavement rehabilitation and/or reconstruction.

The first alternative consists of removing sixteen inches of existing asphalt and replacing it with Portland Cement Concrete (PCC) pavement to a depth of sixteen inches, which will provide a life expectancy of approximately twenty years with an initial cost of $7,400,781.

The second alternative consists of milling and overlay of the intersection with asphalt to a depth of eight inches. This depth was predicated on the complete replacement of an existing weak layer of asphalt at the eight inch depth. This alternative has a life expectancy of approximately seven to ten years with an initial cost of $5,020,101.

The third alternate entails milling and overlay of the intersection with asphalt to a depth of three inches. This alternative does not correct the weak layer mentioned above, but provides a smooth riding surface with a life expectancy of approximately three to five years at an initial cost of $4,170,501.

All four of these alternatives include concrete reconstruction of the asphalt intersection area outside the runway safety area, to a depth of sixteen inches. This pavement is included in the estimates above and has a life expectancy of twenty years.

2.0 INTRODUCTION

2.1 AIRPORT DESCRIPTION

General Mitchell International Airport is located approximately 5 miles south of Milwaukee, Wisconsin and is one of two airports owned and operated by the Milwaukee County Department of Transportation and Public Works. The airfield consists of five runways, 1L-19R, 1R-19L, 7R-25L, 7L-25R and 13-31 as shown in Figure 2.1 below. The two primary runways used for commercial operations are 1L-19R, which is 9,690 feet long, and 7R-25L which is 8,012 feet long. Runway 1L-19R is 200 feet wide and Runway 7R-25L is 150 feet wide. Both runways have a concrete surface with the exception of the intersection which has a bituminous surface.

The airport (FAA Identifier MKE) is a medium hub airport which handled 7.9 million passengers in 2008 and recorded over 183,000 operations. There are 12 scheduled air carriers that operate from MKE- Air Canada, AirTran, American, Continental, Delta, Frontier, Great Lakes, Midwest, Midwest Connect, United Express, US Airways Express, and USA 3000. In addition, the Wisconson Air National Guard is located on the east side of the airfield, cargo operations are on the west and corporate aircraft are based at various locations on the airfield.

General Mitchell International Airport

FIGURE 2.1

Airport Plan

2.2 OPERATIONS

Runway 1L is a Category II/III runway and runway 19R is a Category I runway. Runway 7R is a Category I runway and runway 25L is a visual runway. Night time noise abatement practices are for arrivals on 1L and departures on 19R. The majority of commercial traffic uses these two runways as well as the Air National Guard which flies KC-135's and cargo operations which utilize A300 and B757's. The largest scheduled passenger aircraft to use the airport is B757. Passenger aircraft is lightest during September and October.

Due to the operations on this airport, maintenance of the intersection of Runways 1L-19R and 7R-25L takes place only two nights per week between Saturday at 11:30 PM and Sunday at 5:30 AM and between Monday at 12:15 AM and Monday at 5:30 AM. This severely limits the maintenance that can be done in the single most important intersection at the airport.

2.3 STUDY DESCRIPTION

This study consists of a detailed evaluation of the existing pavement within the intersection of the two primary runways used for daily operations, Runways 1L-19R and 7R-25L, in order to determine the best approach for pavement rehabilitation. The intersection consists of hot mix asphalt (HMA) pavement and its limits are physically defined by its termination at the Portland cement concrete (PCC) pavement portions of each runway. It is approximately 738 feet long along Runway 1L-19R and approximately 700 feet along Runway 7R-25L, as shown in Figure 2.2 below.

The area within this boundary has been repaired on a yearly basis by milling and overlaying various patch locations with approximately four inches of surface course. Yearly costs have been approximately $100,000, with the exception of 2008 in which approximately $300,000 was spent. The existing pavement continues to deteriorate and requires this yearly repair that has become extremely difficult to perform due to operational considerations mentioned above.

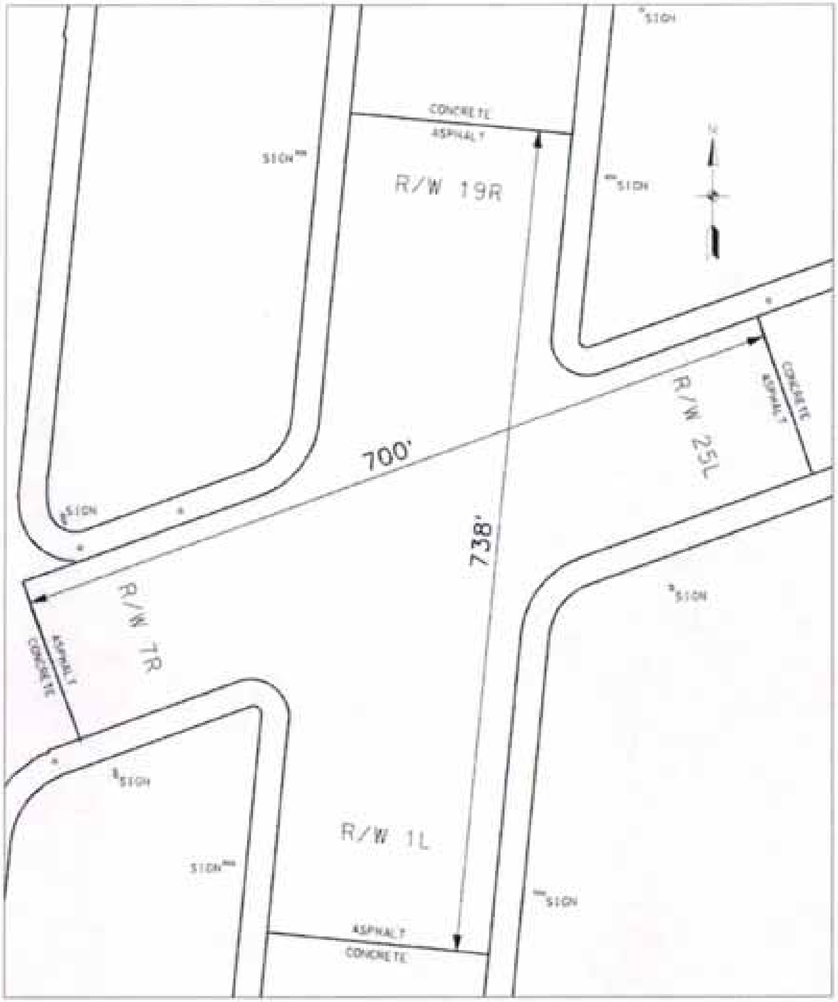


FIGURE 2.2

This study is intended to:

- Investigate the structural integrity of the pavement;
- Provide GMIA alternatives for a more permanent repair/replacement of the pavement, provide budget construction costs of the alternatives;
- Provide preliminary construction durations; and,
- Provide information for the airport to make a decision, in concert with the users, as to the best option to select.

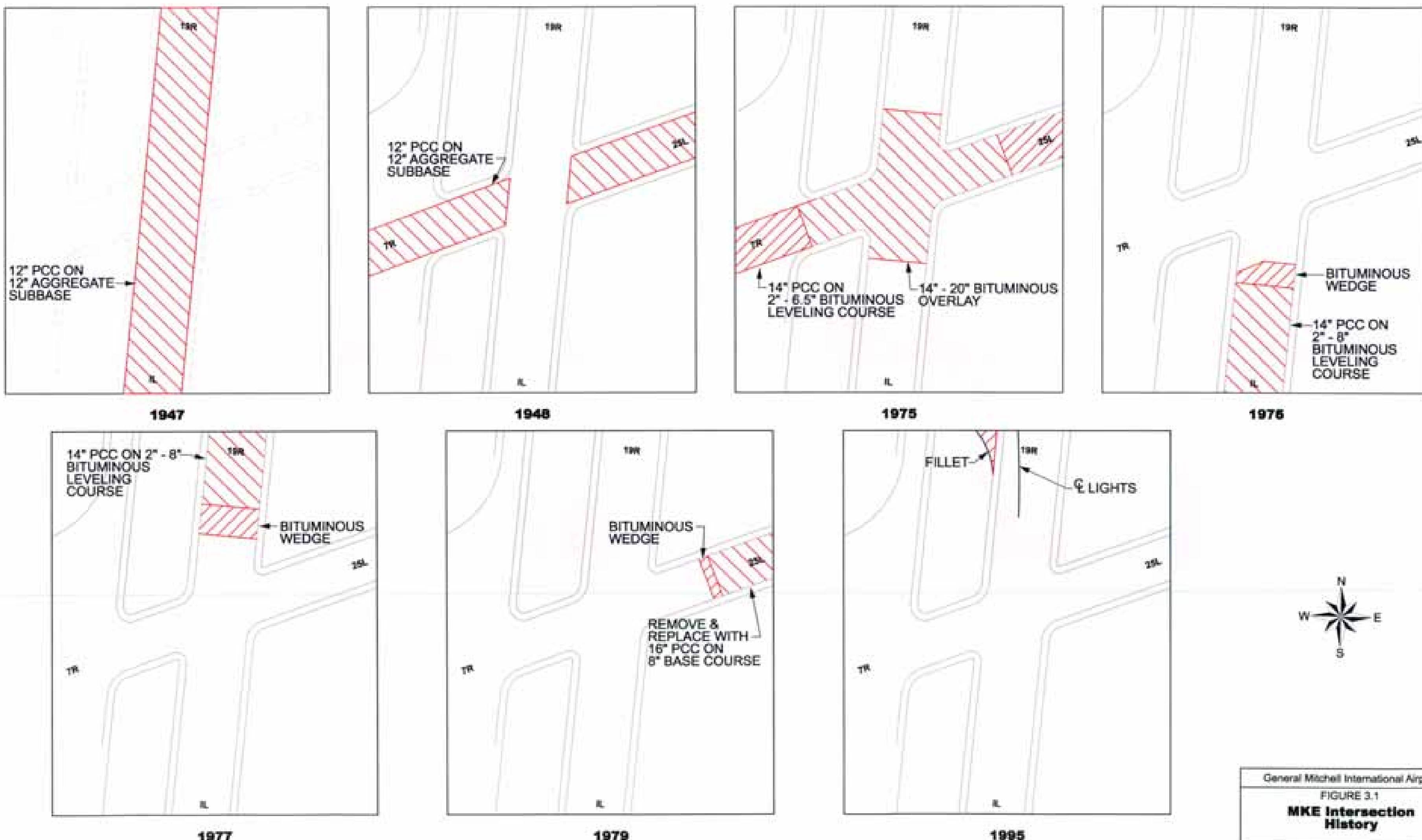
3.0 EXISTING PAVEMENT ASSESSMENT

3.1 PAVEMENT CONSTRUCTION HISTORY

A sketch of the construction history is shown in Figure 3.1 below. The original pavement section within the study area consists of 12 inches of concrete pavement over a 12-inch aggregate subbase. In the years since it was built, various bituminous overlays have been constructed providing a depth of bituminous pavement of 6 to 20 inches.

The construction history of the intersection is as shown on Figure 3.1 and as described below.

- 1947 – Runway 1L-19R was constructed with the original concrete pavement section mentioned above.
- 1948 – Runway 7R-25L was constructed with the original concrete pavement section mentioned above.
- 1975 – An asphalt overlay was placed in the intersection of the two runways that varied in thickness from 14 to 20 inches. This overlay was done in conjunction with the rehabilitation of the adjacent Runway 7R-25L pavement to the west of the intersection. This pavement (to the west of the intersection) was overlaid with 2 to 6.5 inches of bituminous leveling course and 14 inches of concrete pavement.
- 1976 – The Runway 1L-19R pavement just south of the intersection was overlaid with 2 to 8 inches of bituminous leveling course and 14 inches of concrete pavement. In addition, a bituminous wedge was constructed to tie into the existing bituminous pavement within the runway intersection.
- 1977 – The same construction method was performed on the Runway 1L-19R pavement just north of the intersection with Runway 7R-25L.
- 1979 – The Runway 7R-25L pavement to the east of the intersection with Runway 1L-19R was removed and replaced with 16 inches of concrete pavement on 8 inches of base course. A bituminous wedge was constructed in order to tie into existing grades.
- 1995 – The southern fillet between Runway 1L-19R and Taxiway M was widened and centerline lights were installed leading onto Taxiway M from Runway 1L-19R. Some of these centerline lights are located with the project study area.



General Mitchell International Airport

FIGURE 3.1

MKE Intersection History

Baker

0 50 100 150
Scale in Feet

...\MKE_Int_History.dgn 4/21/2009

Since 1979, various mill and overlay projects have been performed, primarily in the keel sections. In addition to the Taxiway M centerline lights, the intersection pavement also contains in-pavement runway centerline and edge lights.

3.2 PCI SURVEY RESULTS

The Wisconsin Bureau of Aeronautics performs pavement condition surveys of the airport pavements on approximate 5 year intervals. The survey data for 1999, 2004 and 2008 were reviewed to determine common distresses identified within the intersection pavement as well as the rate of deterioration. Figure 3.2 shows how the pavement is divided into sample units for survey purposes and the numeric name assigned to each sample unit.

These visual surveys of the pavement in this area typically reveal cracking and open joints over large areas of the pavement surface. The most significant distresses for both runways for all three years indicated above included alligator cracking and longitudinal and transverse cracking. The Pavement Condition Index (PCI) for 1999, 2004 and 2008 for each section are shown in Table 3.1 below.

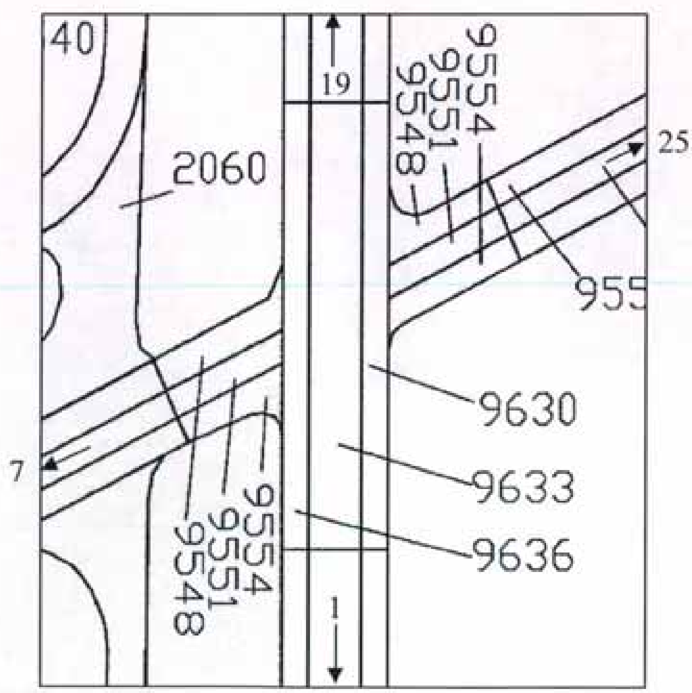


FIGURE 3.2

TABLE 3.1 – INSPECTION RESULTS

Runway 1L-19R				
Section	**Description**	**1999**	**2004**	**2008**
9630	East Edge (50')	46 – Fair	39 – Poor	44 – Fair
9633	Keel (100')	42 – Fair	35 – Poor	24 – Very Poor
9636	West Edge (50')	50 – Fair	57 – Good	32 – Poor

Runway 7R-25L				
Section	**Description**	**1999**	**2004**	**2008**
9548	North Edge (50')	63 – Good	53 – Fair	44 – Fair
9551	Keel (50')	55 – Fair	42 – Fair	35 – Poor
9554	South Edge (50')	59 – Good	45 – Fair	27 – Poor

In the 1999 visual survey the PCI for the intersection area was rated below the acceptable level of 65. According to the 2008 survey report, a PCI of 65 is the minimum acceptable rating established by the Wisconsin Bureau of Aeronautics. According to the AIRPAV software output, the noted distresses were related to "structural and materials" problems. Reconstruction of the intersection was recommended in the 2001 report.

In the 2004 visual survey, the identified distresses were primarily related to "structural" causes.

The latest visual survey was performed in the summer of 2008. This latest survey noted an increased trend in fatigue cracking which indicates acceleration of the pavement deterioration. Fatigue cracking is a load-related pavement failure that consists of cracks that start at the bottom of the pavement section and work their way upward. The report also indicates that the average PCI in the intersection is 32, with individual sample units that are as low as 2. This average PCI is well below the acceptable level of 65. The causes were noted to be "structural" failures in the pavement. The report describes high foreign object damage (FOD) potential. It further indicates that the deterioration will accelerate due to water-infiltration and the freeze and thaw cycles.

Based on the findings presented in the report the structural integrity of the pavement is of particular concern.

3.3 PAVEMENT TESTING

Comprehensive testing of the pavement was performed in order to adequately determine the existing pavement condition, evaluate the pavement's remaining life, and develop alternatives for the rehabilitation. Testing consisted of geotechnical investigation, non-destructive testing, materials testing and topographical surveys

3.3.1 GEOTECHNICAL INVESTIGATION

Soils and Engineering Services, Inc (SES) of Madison Wisconsin, performed coring and borings in ten (10) locations, throughout the intersection of Runway 1L -19R and Runway 7R-25L. Locations 1, 2, 3, 6, 7, 8 and 10 were cored, drilled and sampled on February 1, 2009. Locations 4, 5, and 9 were cored on February 8, 2009. For the locations, see the sketch in Appendix A.

Locations 1, 3, and 10 were soil borings and included a detailed description of the pavement's structure thickness, with a visual description of fill materials and existing soils found in the subgrade to a typical depth of 13 feet below the surface of the pavement. The borings data also included standard penetration test results and soil classification information. In general, the soil consisted of lean clays with a layer of topsoil at varying depths. The water table was not encountered in any of the borings. The ground was frozen to a depth of approximately 5 feet during the time of sampling.

Above the subgrade was a base course of brown silty sand and gravel of varying thicknesses.

The original pavement, above the base course, consists of 12 inches of PCC pavement. Visual inspection of the cores indicated the concrete to be in good condition.

The core data indicates HMA overlays were placed on top of the PCC varying from 13 to 27-inches in total depth which is consistent with the historical as-built plans. Extrapolation from profiles of the surface of the concrete indicates that the concrete may be only approximately 6 to 8 inches below the surface at the runway 25R concrete/asphalt interface (the east end of the intersection). It is recommended that the designer take a core at this location prior to developing a full design, since a stabilized base course may be required to complete the new pavement section. Depending upon the area affected by the increased section, the estimate may also change with the new pavement repair/replacement. Profiles of this area are shown in Appendix C.

Table 3.2 "Pavement Coring Results" summarizes the pavement thicknesses found in the intersection. A detailed analysis of the geotechnical investigation results are provided in Appendix A.

Table 3.2

PAVEMENT CORING RESULTS

Core No.	Thickness, in			Remarks
	Asphalt	Concrete	AGBS	
RW 1L-19R				
1	22.6	13.0	8.4	Delaminated at 3" and 9". Moisture present down to 4"
2	26.6	12.0	15.4	Delaminated at 22". Disintegration present at 5". Moisture present throughout core.
3	23.0	12.0	9.0	Disintegration present at 6". Moisture present from 2" to the bottom.
4	19.8	11.1		Delaminated at 4", 8" and 13". Loose aggregate at 8". Moisture present down to 15".
5	19.9	11.3		Delaminated at 6", 16" and 19". Moisture present between 16" to 22"
6	20.0	12.5	12.0	Delaminated at 17".
7	19.6	12.3	12.1	Delaminated at 2" and 9". Moisture present between 2" and 9".
RW7R-25L				
8	20.3	12.8		Delaminated at 3" and 6". Moisture retention at the bottom
9	15.3	12.0		Delaminated at 7". Moisture present throughout core.
10	13.3	13.0	8.8	Delaminated at 8".

3.3.2 NON-DESTRUCTIVE TESTING

Non-destructive testing (NDT) was performed by Roy D. McQueen and Associates (RDM) on December 6 and 7, 2008.

Nondestructive testing (NDT) is used to measure the structural properties of pavement systems. NDT equipment, test procedures, and data reduction methods used in this study conformed to the requirements of FAA Advisory Circular 150/5370-11A, "*Use of NDT Equipment in the Evaluation of Airport Pavements*".

Approximately 110 Falling Weight Deflectometer (FWD) tests were conducted in the intersection of Runway 1L-19R and Runway 7R-25L. The FWD testing was performed on a 50-foot grid dividing both runways into four (4) lanes each. All testing was conducted under an impulse forcing function at a nominal amplitude of 30,000 lbs. FWD field data are included in Appendix B.

When analyzing the FWD testing, deflections at the center of the machine loading plate and at fixed distances from center are measured. After pavement thickness and composition was established from the core information (Table 3.2), layered elastic back-calculation procedures were used to reduce the NDT data for structural evaluation purposes. Layered elastic back-calculation methods were used to process the deflection basis data to compute the elastic moduli (E-value) of pavement layers and subgrade. For the back-calculation, the aggregate base and the subgrade were combined to a composite layer.

The data was analyzed and design inputs were developed to understand and verify the structural adequacy of the existing pavement structure, using the subgrade in-situ modulus and the expected traffic listed in section 4.0 below. For the layered elastic design procedures used for the pavement analysis, the primary strength characterization is the elastic modulus (E) for the pavement layers and CBR and/or modulus of reaction, K, of the subgrade.

Table 3.3 "Back-calculation Summary" shows the results. In general the asphalt concrete modulus is very high, above 1,000,000 psi. Given the low temperatures that were experienced during testing, the values indicated for the asphalt concrete are expected. The oxidation and aging of the materials may also have contributed to the high results. However, when analyzing the subgrade data, the modulus should not have been affected by the surface temperature during testing. As such, the average composite subgrade modulus of the intersection is 29,107 psi with a standard deviation of 2,663 and a coefficient of variability of 9%.

The subgrade CBR is related to the subgrade E as E=1500*CBR in pounds per square inch (psi) as referenced in FAA Advisory Circular 150/5320-6D, *"Airport Pavement Design and Evaluation"*. The modulus of subgrade reaction K is related to the subgrade E as $E=26K^{1.284}$ in pounds per cubic inch (pci) as referenced in the same Advisory Circular. The composite CBR and K for the intersection are assigned as 17% and 220 pci respectively. These values are the result of the average elastic moduli value minus one standard deviation based on FAA procedures.

Table 3.3

BACK-CALCULATION SUMMARY

Station ft	Offset ft	E, psi Asphalt Surface	E, psi Asphalt Base	E, psi Concrete	Composite Subgrade E, psi	Composite Subgrade CBR, %
RW1-19 Sides						
0-360	47L/47R	2,500,000	1,952,162	801,958	30,931	20.6
360-900	47L/47R	1,635,303		3,239,614	28,778	19.2
RW1-19 Keel						
0-330	10L/10R	2,500,000	1,952,162	801,958	30,931	20.6
360-730	10L/10R	2,682,073	1,127,154	3,133,353	28,781	19.2
RW7-25 Sides						
0-710	47L/47R	2,147,216	796,363	4,192,478	24,139	16.1
RW7-25Keel						
0-680	10L/10R	2,449,014	1,806,599	2,016,390	31,082	20.7
				Average	**29,107**	**19**
				Std. Deviation	**2,663**	**2**
				COV	**9%**	**9%**

3.3.3 MATERIALS TESTING

SES performed the coring and laboratory testing program for the existing HMA material. Test results are compiled in the geotechnical report in Appendix A. HMA was placed in several lifts on top of the PCC at varying lift depths from 1 to 4-inches. Moisture is evident in different paving layers throughout the cores. Disintegration of various cores at differing layers was identified in cores No. 2, 3, 4 and 8. Core numbers 1, 2, 4, 5, 7 and 9 delaminated between paving layers at an approximate depth of 7 to 9-inches.

Six (6) cores were further tested at various layers for the following characteristics:

- Volumetric Properties;
- Tensile Strength Ratio;
- Asphalt Content.

The PCC material was not investigated given its overall depth within the pavement structure. Visual inspection of the PCC considered it in good condition. Pictures of the cores are located in Appendix A of this report.

3.3.3.1 VOLUMETRIC PROPERTIES TESTING – SPECIFIC GRAVITIES

Volumetric properties of HMA materials play an important role in all prescribed mix design procedures. Volumetric properties are typically represented as air void content (Va), voids in mineral aggregates (VMA), and voids filled with asphalt (VFA) and provide an indication of how an HMA will perform.

Air void content and density are the most important measurements specified in the P-401 specification. The dense graded HMA should provide a certain level of impermeability to both air and water to reduce aging and stripping related problems. The FAA considers HMA materials with an air void content greater than 8.0% as permeable. The P-401 specification was developed to provide in-place air void contents for HMA mixes below the 8.0% threshold. This has been accomplished by specifying the laboratory air void contents to be less than 5% with a prescribed average of 3.5% and a minimum in-place density of 96.3% with a prescribed average of 98%.

Table 3.5, "Asphaltic Material Characteristics," shows the results of air-voids of the samples obtained from the drilled cores by SES. Air void contents varied from 5.4% to 11.7% with an average of 8.6% and a standard deviation of 2.2%. It should be noted that five of the nine tests (or HMA layers) reported in the table are greater than the prescribed 8.0%

threshold for permeability and will allow for moisture induced damage such as stripping to occur. Stripping is related to the loss of bond between the asphalt and aggregate materials due to the presence of moisture.

3.3.3.2 TENSILE STRENGTH RATIO (TSR)

Moisture susceptibility in HMA is evaluated using the TSR. The test standard followed is *"AASHTO T283, Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage"*. This test basically measures the tensile strength in a dry sample and compares it to the tensile strength of a partially saturated sample. The percent air voids (Va) for both the dry and saturated samples should be between 7 +/-1 percent for all new mixes. When testing existing pavements, air void contents for comparison samples should also be similar. The ratio developed between the saturated and dry samples should be above 0.8 for new mixes and above 0.7 for the existing materials. Table 3.4 "Tensile Strength Results" show the results obtained from MTE Services, Inc. When reviewing the results, it should be noted that the air void contents for the dry and saturated samples for each core have wide variations. This variation may be due to testing different HMA layers and or mix types within the same core or the lack of compaction between the same layers. Core 7 was the closest to the prescribed air void content of +/-1 percent with a variation of 2.5 percent. Given the TSR result of 0.67, the material found within the core may be susceptible to moisture damage. In either case, cores 1 and 3 have an air void content variation greater than 5 percent and the TSR results do not provide conclusive evidence. As such, only the very low dry tensile strength results could be reviewed. Low tensile strength results are typical in HMA mixtures that have low asphalt and or high air void contents. As stated above, these types of results are indicative of HMA mixes that are considered permeable and will allow for moisture induced damage, such as stripping to occur.

Table 3.4

TENSILE STRENGTH RESULTS

CORE	Dry		Saturated		TSR
	Va (%)	TS (psi)	Va (%)	TS (psi)	
1	10.5	52	5.4	58	1.12
3	11.7	41	6.5	38	0.93
7	9.2	61	6.7	41	0.67

3.3.3.3 EXTRACTION TEST

The extraction test measures the asphalt content of a mixture. Either of the following test methods may be utilized to obtain the asphalt content; *ASTM D2172- "Quantitative Extraction of Bitumen from Bituminous Paving Mixtures"* or *ASTM D4125 – "Asphalt Content of Bituminous Mixtures by the Nuclear Method"*. HMA properties are affected directly by asphalt content (Vb). HMA materials with low Vb values typically develop durability related problems such as moisture induced damage and / or low temperature cracking. HMA materials with high Vb values are typically considered unstable given the loss of interlock within the aggregate matrix. They typically rut or deform under the traffic loading. The asphalt content was measured in three core locations as shown in Table 3.5. The low asphalt content appears to be located in the layers where high air void contents have been identified.

Table 3.5

ASPHALTIC MATERIAL CHARACTERISTICS

CORE #	Sample #	Va (%)	Gmm*	Gmb**	Vb (%)
1	1a	5.4		2.462	
	1b	10.5		2.329	
	1c	8.9	2.599	2.368	3.4
2	2a	7.3	2.606	2.416	
3	3a	6.5		2.434	
	3b	11.7		2.297	
4	4a				4.9
6	6a	11.1	2.597	2.308	4.5
7	7a	6.7		2.43	
	7b	9.2		2.363	
	Average	8.6	2.6	2.4	4.3
	St.Dev	2.2	0.0	0.1	0.8
	COV	26.0%	0.2%	2.5%	18.2%

*Maximum Specific Gravity (Gmm)
**Bulk Specific Gravity (Gmb)

3.3.4 TOPOGRAPHICAL SURVEYS

Topographical surveys were performed by Bloom Companies, LLC (Bloom) on December 7 2008, and February 1, 2009. The surveyors were unable to survey features off-pavement due to the presence of snow and ice approximately 10 inches deep. Features in the shoulders were also not located unless they protruded above the ice and snow.

The survey found that the profiles of the pavement are generally in good condition with some aberrations due to patching. One location indicated a sharp bend in the one-tenth foot contour and was later found to be an area that was ponding water at or near a patch. With the exceptions of these small areas, no drainage problems were indicated. The existing grading plan is provided in Appendix C.

4.0 AIRCRAFT FORECASTS

When performing a structural evaluation of the existing pavement, the proposed traffic is critical to the design process. The gear configuration and the aircraft take off weights directly affect the pavement thickness calculations. For GMIA, the aviation forecast information was estimated using the 2003 Master Plan Update.

All operations outlined in the Master Plan for Runway 1L-19R and Runway 7R-25L were analyzed. The intersection traffic used for our analysis included the forecasted traffic on Runway 1L-19R and Runway 25L. The traffic on Runway 7R was not utilized in this study since the number of aircraft that use this runway have minimal impact on the intersection pavement.

The information for the forecasted aircraft types and operations is summarized in Table 4.1 "Aircraft Fleet Mix".

Table 4.1
AIRCRAFT FLEET MIX

Aircraft		Weight (lbs)	Gear	Departures
BE1	Beechcraft 1900D	16,950	D	3,399
FRJ	Fairchild Dornier 728	79,343	D	9,079
SF3	Saab SF340A	28,000	D	502
ER3	Embraer ERJ 135	44,092	D	6,538
ERD	Embraer ERJ 140	46,517	D	5,499
ERJ	Embraer ERJ 145	42,328	D	4,722
CRJ	Canadair Reg. Jet CL 600	51,000	D	9,378
ER4	Embraer ERJ 145	42,328	D	6,420
DC9	DC-9-32	108,000	D	0
D9S	DC-9-15	90,700	D	736
146	BAE 146	93,000	D	44
319	Airbus 319	141,000	D	1,946
D95	DC-9-50	121,000	D	982
733	Boeing 737-300	138,500	D	1,412
72S	ATR 72	44,070	D	372
M80	MD-83	160,000	D	5,399
734	B-737-400	138,500	D	430
320	Airbus 320-100	145,505	D	491
757	B757-300	270,000	D	982
717	B717-200	121,000	D	16,787
73G	B737-700	153,000	D	1,636
Single Engine Piston		5,000	S	2,517
Twin Engine Piston		6,850	S	2,829
Single Engine Turboprop		5,000	S	78
Twin Engine Turboprop		28,500	D	1,537
Twin Engine Jet	B757	255,000	D	9,965
Three Engine Jet	Dassault Falcon 900B	45,500	D	349
A300	Airbus 300-600R	375,890	2D	1,819
B-757	Boeing 757-300	270,000	2D	1,189
B-727-200	Boeing 727-200	209,500	D	21
DC-8	DC-8-71	325,000	2D	0
B-727-100	Boeing	169,000	D	0
DC-9	DC-9-32	108,000	D	7
330-200	Airbus	458,559	2D	401
SA-227-AT	Fairchild Metro III	16,000	D	451
C-208	Cessna 208B	8,750	S	2,618
C-402	Cessna 402	6,850	S	435
PA-31	Piper PA-31 Navajo	6,500	S	472
CE-310R	Cessna 310R	5,500	S	694
BE-58	Beach 60 Duke	6,775	S	651
C-130	C-130	155,000	2S	840
KC-135	Boeing	322,500	2D	665
Total				***104,291***
Variable annual Growth Rate Considered				

5.0 PAVEMENT STRUCTURAL EVALUATION

Layered elastic analyses were employed to evaluate the estimated remaining structural life for the intersecting pavement structures of Runway 1L-19R and Runway 7R-25L based on the anticipated aircraft forecast discussed in Section 4.0. Design procedures contained in FAA Advisory Circular 150/5320-6D were used for the pavement evaluation.

The computed values are compared to limiting stresses and strains that are based on requirements to limit pavement rutting and cracking. The pavement characteristics inputs used for a mechanistic analysis are subgrade strength, represented by the CBR; the materials stiffness represented by E; the estimated traffic, as described in 4.0 and the pavement thickness summarized from the coring results of the geotechnical investigation.

Based on the prescribed FAA procedures, the structural evaluation concluded that the runway intersection pavement has an estimated structural life that is greater than 10 years based on the forecasted traffic. Therefore, structural rehabilitation such as a strengthening overlay or reconstruction is not required. It should be noted that the structural life computations address potential load-induced damage to the pavement. Environmental, materials or construction related distresses categorized by the Pavement Condition Index (PCI) do not have any effect on this value. As such, it can be concluded that the distresses recorded for the PCI are not structurally related and can be attributed to the poor condition of the existing HMA materials. Therefore, increasing the amount of maintenance and repair initiatives performed on a yearly basis could be effective in maintaining the current service level of this pavement. As noted above the high air void and low asphalt contents reported in different layers of the various cores has contributed to the HMA stripping. This could have been caused from the production of the HMA materials, the placement of the HMA materials or a combination thereof.

6.0 ALTERNATIVES DEVELOPMENT & ANALYSIS

Five preliminary alternatives were developed for this study. Alternative 1 consisted of a complete reconstruction of the intersection with PCC pavement. This alternative entailed a shutdown of the intersection for a period long enough to reconstruct the pavement with conventional methods, schedules and curing periods and was assumed to take approximately 30 days. This alternative may be viable if the runway 1R-19L extension, shown in the Airport Master Plan is built thus relieving traffic on this intersection. This alternative was discussed with the GMIA staff and discarded due to severe operational impact on the airport and the unknown schedule for the runway extension.

Alternate 2 was the complete reconstruction of the intersection with PCC pavement, but done over a period of multiple weekends. This alternate was carried forward and is discussed in more detail below.

Alternate 3 consisted of a complete reconstruction with Precast PCC slabs. This alternate presented unnecessary risks and was discarded. Risks associated with this option include critical grades when laying the base course to avoid rocking slabs, difficulty with leveling of slabs, smaller slab sizes creating more linear footage of joints requiring maintenance and difficulty in installing load transfer devices between the slabs.

Alternate 4 was the complete reconstruction of the intersection with Rapid Set concrete, a very fast curing (3 hours) hydraulic based concrete mix. This concrete is proprietary and is four to five times the cost of normal concrete and is intended for small repair areas such as panel replacement. This alternate was discarded for those reasons.

Alternate 5 was to mill and overlay the intersection with asphalt. This alternate consisted of 3 options, 3-inch mill and overlay, 8-inch mill and overlay and full depth mill and overlay. The first option, a 3-inch mill and overlay was increased to a 4-inch mill and overlay at the request of the airport. The third option was discarded due to the extensive cure time associated with the depth of the HMA necessary for construction. The extensive depth would require many lifts and each lift must cool prior to placing subsequent lifts. The 4-inch and 8-inch mill and overlays are discussed in more detail below.

Regardless of which alternative is selected, it is recommended that the areas of existing bituminous pavement outside of the 200-foot runway safety area should be replaced with 16-inches of PCC on top of a 2–inch HMA leveling course which will be constructed on top of the existing PCC (the only exception to this will be some areas that require complete removal and replacement of the pavement section). This will provide a longer life pavement, which will require less maintenance (and thereby lessen the impact to operations over a longer period of time).

Listed below are the four alternatives that have been carried forward as possible solutions to rehabilitate the Runway 1L-19R / 7R-25L intersection.

6.1 LONG TERM SOLUTION USING PCC

Long Term solutions are defined by the FAA as pavements designed for a 20 year life. The design will remove the HMA materials to a depth of 18 inches including the areas found to have been deteriorated and replace them with new Portland cement concrete pavement that conforms to current FAA quality standards.

6.1.1 RIGID PAVEMENT

The PCC alternative was designed using a composite k value of 213 pci. The existing PCC and HMA below the proposed section will be left in place. Given the variable thickness of HMA above, removal of portions of the existing PCC will be required. As such, the existing PCC has been evaluated as a high quality aggregate material for the pavement design. After removal of the existing pavement structure has been made to the prescribed depth an HMA leveling course with a minimum thickness of 2-inches is recommended prior to the placement of the new PCC. It is further recommended that the new PCC thickness be 16-inches. A typical section of this alternative can be found in Appendix C.

The closures could be phased into an estimated seven (7) weekend closures with at least 36 hours of closure time per weekend beginning at midnight on Friday night and concluding by noon on Sunday. It is anticipated that two separate lanes inside of the safety area would be constructed each weekend. Every other lane would be removed four inches wider than the proposed lane width while placement is made in the existing HMA. A double layer of expansion board would be installed (2 inch width on each side) against the existing HMA pavement structure as a side form. This expansion board should further act as protection for the new PCC when the removal of the interior fill lane is performed. At this time the expansion board material would be removed and the fill lane would be placed at the proposed width between the new PCC lanes that were previously placed. Any leveling required for runway grade profile correction between the PCC pilot lanes could be accomplished on a temporary basis until the fill lanes have been placed.

The electrical work to replace the lighting may be performed during nightly closures during the week, the proposed weekend closure times or an additional weekend closure may be required.

The areas outside of the safety area would require additional closures of each runway (independent of each other) to a time frame of approximately 5 days.

For the potential thin section on Runway 25L located to the East of the intersection, an unknown area with a thin HMA overlay on top of the old 12-inch PCC section may need to be fully reconstructed. In accordance with Advisory Circular 150/5320-6D *"Airport Pavement Design and Evaluation"*, the recommended depth of 16-inches of PCC is to be constructed on 6-inches of bituminous stabilized base P-401 or P-403 on 12-inches of aggregate subbase P-209. Additional coring of this area will be required during the design phase of the project. Further, additional frost protection may also be necessary. The proposed typical section can be found in Appendix C.

6.2 MEDIUM TERM SOLUTION USING 8-INCH MILL AND OVERLAY

Medium term solutions for this project were evaluated to provide an anticipated design life of 7 to 10 years. The pavement design reviewed the removal of the deteriorated HMA layer noted in the cores at approximately 8 inches below the surface. Upon completion of this removal the area would be reviewed for potential patching. The entire depth would then be replaced with new HMA that conforms to the current FAA quality standards.

6.2.1 MILL AND OVERLAY 8-INCHES

As noted above, the cores taken during the geotechnical investigation defined a layer between 7 and 9 inches from the surface that was delaminated. As such, this design alternative reviewed the removal and replacement of the existing HMA to approximately 8 inches (understanding that patches below may be required). In general, this removal depth does not take off all of the underlying HMA from the existing PCC but appears to eliminate the layer with the highest severity of stripping. This option will delay potential reflective cracking from the remaining materials below and provide a high quality HMA. A typical section of this alternative can be found in Appendix C.

The closures could be phased into an estimated three (3) weekend closures with at least 36 hours of closure time per weekend beginning at midnight on Friday night and concluding by noon on Sunday. It is anticipated that the center 120 feet of Runway 1L-19R safety area could be completed on the first weekend. The next two weekends would require the two separate areas on each side of this pilot area be completed. This would allow for any grade corrections required in the runway profile for drainage to be made. Patching below the 8-inch depth should be anticipated and corrected as necessary. As noted above, the electrical work to replace the lighting may be performed during nightly closures during the week, the proposed weekend closure times or an additional weekend closure may be required. The proposed PCC to be placed in the areas outside of the safety area would require additional closures of each runway (independent of each other) to a time frame of approximately 5 days.

6.3 SHORT TERM SOLUTION USING 4-INCH MILL AND OVERLAY

A short term solution alternative was further reviewed for a 3 to 5 year life. The design process would be to provide a functional repair of the existing wearing course. Taking into account minimal disruption through closure limitations, the replacement of the wearing course would provide the airport with a viable operating surface for the proposed design life. Given the remaining HMA materials below, proper maintenance would need to be coordinated to obtain the overall design life. A typical section of this alternative can be found in Appendix C.

The closure for this option could be phased into one (1) weekend. However it is recommended that two (2) weekends should be scheduled with at least 36 hours of closure time per weekend beginning at midnight on Friday night and concluding by noon on Sunday. When reviewing the 6 hour night time closure, an estimated time of seven (7) nights would be required to complete the safety area. As noted above, the electrical work to replace the lighting may be performed during nightly closures during the week, the proposed weekend closure times or an additional weekend closure may be required. The proposed PCC to be placed in the areas outside of the safety area would require additional closures of each runway (independent of each other) to a time frame of approximately 5 days.

6.4 COMBINATION MEASURES

When reviewing the three (3) main alternatives that have been developed herein, additional options could be derived through integration during the design phase of the project. These integrated options could provide the airport with the ability to have a higher quality repair such as the long or medium term solution placed in the keel section while utilizing the short term solution in the side sections on the runways. One of these options is discussed below.

6.4.1 PCC KEEL SECTION WITH 4-INCH MILL AND OVERLAY

One option of the rigid pavement alternative is to use 16 inch PCC in the keel section only and to mill and overlay the area outside this keel to a depth of four inches. The "keel" section is considered to be 80 feet in width which is where the overwhelming majority of aircraft traffic track on the pavement.

This option provides several advantages. First is that the duration of construction is shortened. Second is that the initial cost is lower than the full width PCC alternate. Third is that the shoulders do not have to be disturbed, thus further reducing the costs.

The closures could be phased into an estimated five (5) weekend closures of at least 36 hour duration per weekend beginning at midnight on Friday night and continuing to noon on Sunday. On each weekend, two lanes of PCC could be placed. Aspahlt paving can be accomplished on the sides when the edge lanes of PCC are cured. A fifth weekend then is necessary to finish out the asphalt work abutting the PCC placed the previous weekend. As with all of the alternatives, this option assumes that the areas outside the runway safety area will be reconstructed with PCC in separate 5 day closures.

One disadvantage of this option is that the outside asphalt areas do not have the same life expectancy as the PCC keel. Since the traffic in those areas is limited however, the life expectancy is greater than the full width asphalt option. It is estimated that the life of that area will be approximately 5-7 years and possibly longer with diligent maintenance.

There are some considerations to this option that must be examined. The first is that permission to do this type of construction should be approved by the FAA to ensure eligibility of funding. The second consideration is that the pavement will be two different colors, especially in the early years. That color difference may be misleading or alarming to pilots and should be vetted with the FAA- both the Airports Division and the Air Traffic Division.

7.0 ON-SITE PRE-CONSTRUCTION TESTING

All of the alternates presented herein have some risk associated with them. Any risk related to opening the runway or impacting the operations of the airport must be minimized or eliminated. To that end, it is recommended that on-site test sections be built outside the intersection to demonstrate the contractor's means and methods, test mixes etc. There is no room for error when the intersection is closed, therefore the test section will find areas for improvement or change and give the contractor and the airport confidence that the work can be safely accomplished. The cost of not opening the runway on time due to construction issues, far out-weighs the cost of the on-site pre-construction testing.

The FAA requires a test section for asphalt pavements, but not for PCC. The PCC test section is critical to coordinate and schedule the operations necessary to achieve the construction activities necessary to open the runway on time. This test section will entail all work required to remove and replace the pavement to the necessary depth in the specified time that is allotted during construction. The work shall include milling, patching, overlay (for grade correction), PCC placement, PCC drilling and dowel placement for filler lanes and any other work that may be anticipated. A PCC test section is not necessary for the asphalt alternatives since the PCC construction that will be done outside the RSA for all options, is typical construction with fewer constraints depending upon the closure time frames set by GMIA.

8.0 OPERATIONAL CONSIDERATIONS

As previously mentioned, normal construction windows for the intersection area are one weekend night per week for six hours. After analysis of the amount of work needed for each of these alternatives including cure time, cool time for pavements, etc, it was determined that the work cannot be done efficiently in six hour time periods. An extensive analysis was done to determine the optimum amount of time needed per weekend to accomplish a reasonable amount of work for each alternate. The minimum amount of time needed was 36 hours and was assumed to last from midnight on Friday night to noon on Sunday. These calculations were used to determine the number of weekends used in the discussion of the alternates above.

Other operational considerations include construction activities that could potentially be performed at times other than the weekend closures such as preliminary work on sawing, grooving or electrical work.

When the centerline lights are removed for construction, the airport may lose use of the CAT II/III capability of runway 1L-19R. This may increase the minimums for the runway and must be coordinated with the FAA.

Closures must be coordinated with the cargo carriers both for the weekend work and any preliminary work. The Wisconsin Air National Guard may have to relocate its aircraft for the duration of the work, and airlines may have to downsize aircraft in order to use the other, shorter runways.

Since operations (including nighttime) will change from the predominant runways in use now, during the construction, it may be advisable for the airport to inform the community regarding the temporary change in noise patterns.

9.0 ELECTRICAL CONSIDERATIONS

There are 15 in-pavement centerline lights, four in-pavement high speed exit lights from 1L-19R to taxiway M, and two in-pavement runway 1L-19R edge lights within the intersection area.

The centerline lights were installed with the original pavement in 1947 and later modified as the overlays were constructed. Most of those lights are mounted in light cans that have differing height extension cans or rings to bring them up to grade. Reconstruction of the pavement can be accomplished by removing the lights and cable, coring around the cans, removing the extension can or rings, installing a steel cover plate, and then milling the pavement. At the conclusion of the milling and overlay, the lights would be cored out, extension rings, fixtures and cable would be re-installed and the fixture edges would be sealed. It should be noted that this method may not work on all of the lights since the first few have very little adjustment due to the short (or absence of) extensions. This issue can be further investigated during the design of the project.

The high speed exit lights and the edge lights were installed by coring and sawing a kerf to install the wiring. The construction should remove fixtures, cable and cans and re-install these in a similar manner.

During construction (between weekends), the runway edge electrical circuit must be maintained. In order to do this the design must develop a method of "jumpering" the circuit around the construction area. In the case of the high speed exit lights, the circuit may be either "jumpered" or even locked/tagged out of service. Centerline lights will have to be locked/tagged out of service. In addition, lights, cables and transformers must be disconnected and pulled out of the construction area.

The design should take into consideration signage that may be tied to the circuits that are being taken out of service or "jumpered". Signage power must be maintained through the course of the project.

Underground power, control, and other utilities that cross the construction area must be clearly identified and noted in the design.

10.0 COST ESTIMATES

The estimates included in Appendix D represent the best estimates available, at this level of investigation. There are items that when designed, could change the unit prices or total costs. The numbers herein are encompassing and any detail design should yield a project within these numbers. It should be noted that with the depressed economy, some pricing may be different at the time of bidding. Additionally, the variability of pricing on some items like oil, remain volatile.

Work in the intersection is extremely important and to guarantee that the work is accomplished with success, test strips should be mandatory in the bid documents. The estimates for the test strips were developed by using the following assumptions:

- Construction area of 200 feet long by 20 feet wide for each of 3 lanes (two pilot lanes and a filler lane) for concrete, and two lanes for asphalt.
- The time limitation will be set at 36 hours from Friday midnight to Sunday noon and include premium times for employees, additional mobilization of equipment on a weekly basis and various items to accommodate overnight construction activities such as light plants, generators, back up equipment, full time mechanics, etc.
- The test area will be somewhere on the airport, in asphalt pavement.

- The contractor must mobilize for this small quantity, starting up the concrete and or asphalt plant for the particular mixes, thereby increasing their costs.
- The means and methods will be determined by the contractor and evaluated jointly by the airport and consultant. It is believed that the means and methods will be revised during this 'test' operation and that the contractor will plan for any potential inefficiencies in his bid.
- The proposed pavement materials will be produced, and tested both in the plant and in the field. The placement procedures will further be monitored and tested to ensure that the runway will open on time.

The test strip pavement materials will ultimately be incorporated into other runway or taxiway pavement structures at the airport that will provide a beneficial section going forward.

All four estimates assume PCC pavement outside the safety areas.

Actual removal and replacement of lights will depend on final design since each existing light is slightly different.

Given the complexity of the project, further allowances were made to provide additional quality control / quality assurance testing with a full time onsite quality control supervisor (which is not the superintendent).

11.0 LIFE-CYCLE COST ANALYSIS

The four alternates studied each have different initial costs, maintenance costs, replacement costs and life-spans. The following is an analysis of the four alternates, comparing them in current dollars over a span of 20 years. As mentioned earlier, the PCC pavement will be analyzed assuming a 20-year lifetime and the asphalt pavements will be analyzed using 10 years for the 8-inch mill and overlay and 5 years for the 4-inch mill and overlay. These lifetime estimates assume the pavement is appropriately maintained and no outside factors change (traffic levels or size/weight of aircraft). The initial construction cost estimates are included in Appendix D.

In order to calculate the 20-year life cycle cost for reconstructing with PCC the estimated initial construction cost was added to a maintenance cost consisting of resealing 25% of the joints every 5 years as well as crack repair in years 10 and 15. The life-cycle cost for the 8-inch mill and overlay consists of the estimated initial construction cost plus a replacement cost in year 10 added to maintenance costs consisting of patching and crack sealing beginning 4 years after construction and continuing every year until reconstructed again. Similarly, the life-cycle cost for the 4-inch mill and overlay consists of the initial estimated construction costs plus a replacement cost in years 5, 10 and 15 added to maintenance costs consisting of patching and crack sealing the pavement every year. The two asphalt options also include joint and crack sealing maintenance costs for the PCC outside of the safety area in years 5, 10 and 15.

The PCC Keel option mentioned in section 6.4.1 includes a combination of maintenance and life expectancies as would be surmised from its makeup. The PCC life expectancy is 20 years and the asphalt life expectancy is 7-10 years. The asphalt is expected to require patching and crack sealing after 4 years.

A summary of the life-cycle costs for each alternative and the option is provided in Table 11.1. An escalation of 3% per year was assumed. As a comparison only, the current practice costs are also shown.

In addition to the construction costs associated with replacement of the bituminous alternatives, additional design fees will also add to the cost when a replacement is necessary. The design fee for the initial construction is estimated to be approximately $410,000.00.

12.0 CONCLUSIONS

The four alternatives analyzed each have advantages and disadvantages that will need to be considered by the airport. Operational considerations, both current and future, must be weighed against costs. All stakeholders involved must be in agreement, not only for the operational impacts, but for the airfield cost center impacts as well. This intersection is arguably the most important piece of real estate the airport owns, so the decision as to how to rehabilitate it must be carefully considered.

This pavement should be maintained by mill and overlay (patching) and other maintenance measures until a more permanent restorative project can be accomplished. Since the deterioration is not structurally related, this method of maintenance can continue, but at an increasing cost both in construction and operational impacts. In addition, the increasing amounts of money used to continuously rehabilitate this failing pavement would be more efficiently spent on a more permanent repair. In addition, as time passes and the traffic mix at the airport increases in size and number, closing the intersection for repair will become increasingly difficult and costly.

Table 11.1
LIFE-CYCLE COST ANALYSIS SUMMARY

OPTION	Time to Construct***	Lifetime (years)	Initial Construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
PCC	7	20	$7,400,781.00					$12,000.00					$24,000.00
								Joint Seal PCC					Joint & Crack Seal PCC
8" Mill & Overlay	3	10	$5,020,101.00					$22,500.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,903,453.00
								Crack Seal Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC
4" Mill & Overlay	2	5	$4,170,501.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,013,419.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,013,419.00
				Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC
PCC in Keel, 4" Mill & Overlay	5	20 - PCC 7 - Asphalt	$5,758,614.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$512,210.00	$8,500.00	$8,500.00	$8,500.00
				Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.
Current Practice**		1	$0.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00
				Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal

OPTION		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL COSTS*
PCC						$24,000.00						$7,484,337.50
						Joint & Crack Seal PCC						
8" Mill & Overlay						$22,500.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$7,869,076.85
						Crack Seal Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
4" Mill & Overlay		$17,000.00	$17,000.00	$17,000.00	$17,000.00	$512,210.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$7,906,748.83
		Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
PCC in Keel, 4" Mill & Overlay		$8,500.00	$8,500.00	$8,500.00	$515,000.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$7,379,490.59
		Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
Current Practice**		$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$8,302,945.72
		Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	

*Inflation assumed to be 3% per year

**This option is included for comparison only. It is not recommended as a method for rehabilitating the intersection.

***Number of weekends required to construct with at least 36 hours of closure time per weekend

Baker

Michael Baker Jr., Inc.

Appendix A

Geotechnical Investigation

Geotechnical Exploration and Report

Runway 1L-19R & 7R-25L Intersection Pavement Study
General Mitchell International Airport

Milwaukee County, Wisconsin

February 27, 2009

Prepared for:
Michael Baker Jr., Inc.

Prepared by:
SOILS & ENGINEERING SERVICES, INC.
1102 Stewart Street
Madison, WI 53713-4648

TABLE OF CONTENTS

PROJECT INFORMATION

The Runway 1L-19R & 7R-25L Intersection Pavement Study project at General Mitchell International Airport (GMIA) is intended to provide alternatives for the existing intersection of the two runways. The alternatives include replacement of the entire pavement thickness or removal and replacement of a portion of the existing pavement. Repairs to the existing intersection have been limited in scope due the requirement to limit the closure of the two runways to a short period of time at night on weekends. We understand that annual repairs typically consist of milling and replacing sections of the pavement to a depth of 2 to 3 inches.

FIELD EXPLORATION

The geotechnical exploration was performed on February 1, 2009 and February 8, 2009. The work performed the on February 1 consisted of drilling and sampling three soil borings (Borings 1, 3, and 10) and coring the existing pavement at seven locations (Borings 1, 2, 3, 6, 7, 8, and 10). At six of the seven core locations, we used the drilling rig with hollow-stem augers to determine the thickness of the base course material directly below the pavement. Boring 8 was performed last on February 1, 2009. The drilling crew had to patch the core hole immediately after the coring was completed in order for GMIA Air Operations to open the runways. The thickness of base course, therefore, was not determined at this location. The amount of time available for the field work the first weekend was limited due to a delay in accessing the intersection as determined by Air Operations. Based on discussions with Roy D. McQueen & Associates, Ltd. and with Michael Baker Jr., Inc. personnel, the work performed on February 8, 2009 consisted of coring the pavement at Borings 4, 5, and 9. Sampling of base course or the subsoils was not desired.

The soil boring and core locations and the numbering sequence was established by Michael Baker Jr., Inc. personnel. The relative locations of the soil borings and cores are shown on the Boring Location Sketch, enclosed as Drawing 12801-1.

The three soil borings were each performed to a depth of 13 feet below grade. The soil sampling started at a depth of 3 feet 6 inches below grade, with the sampler driven 18 inches at depth intervals of 3½ to 5 feet, 6 to 7½ feet, 8½ to 10 feet, and 11½ to 13 feet below grade.

Soil drilling was accomplished using 2¼-inch-inside-diameter, continuous-flight, hollow-stem auger sections. The hollow-stem auger sections serve as temporary casing to maintain an open borehole in most soil and groundwater conditions. The soil samples were obtained using a 2-inch-outside-diameter, split-barrel sampler. In addition, bag samples of the auger cuttings of the subgrade soils were collected from the auger cuttings that came to the ground surface at the soil borings. The soil sampling was performed in accordance with American Association of State Highway and Transportation Officials (AASHTO) Designation T 206.

Core samples of the pavement were obtained using a diamond-tipped core barrel. Water with a food-grade antifreeze additive was used to cool the core barrel and to remove the cuttings from the kerf created by the diamond-tipped barrel.

PAVEMENT CORING

The pavement encountered at each of the ten core holes consisted of hot-mix asphalt over concrete. The overall pavement thicknesses varied from 26¼ to 38-⅝-inches. The thickness of the asphalt portion varied from 13¼ inches to 26-⅝ inches. The thickness of the concrete portion varied from 11-⅛ inches to 13 inches. We observed the core samples in our laboratory and measured the number and thicknesses of the various asphalt layers in each of the core samples. The pavement thicknesses are summarized in Table 1. Digital photographs of the core samples were taken before any laboratory testing was performed. The photographs are presented in Appendix A.

Visual observation of the core samples indicates that, in general, the hot-mix asphalt portions and the concrete portions of the pavement are in good condition. The concrete at Boring 6 encountered a vertical fracture for the entire depth of the concrete pavement. The upper 3½ inches of the fracture was observed to contain an asphaltic material that filled the crack. The bottom 4½ inches of the hot-mix asphalt portion of the core from Boring 2 appears to be missing some asphalt binder. The coring operation reportedly encountered some gravely material between the hot-mix asphalt and the concrete, which we presume was the unbonded portion of the hot-mix asphalt.

SOIL STRATIGRAPHY

At the soil boring locations, the soil stratigraphy can be characterized as pavement over fill material overlying naturally deposited (native) soil strata. Bedrock was not encountered for the maximum depth of the borings performed.

The fill material encountered below the pavement at Borings 1, 3, and 10 extended to depths of 12 feet 6 inches, 7 feet, and 9 feet, respectively. The fill material consisted of a silty sand and gravel base course over clay. The fill material at Boring 10 also consisted of clay with sand and gravel to a depth of 5 feet and clay below a depth of 5 feet. The base course thickness varied from 8-⅜ inches to 15-⅜ inches at Borings 1, 2, 3, 6, 7, and 10.

Below the fill material, native soil strata were encountered consisting of topsoil at Boring 1; topsoil over lean clay over silty fine to medium sand, some gravel at Boring 3; and topsoil over lean clay with fine sand partings at Boring 10.

For additional information regarding the fill material and native soil strata encountered at Borings 1, 2, 3, 6, 7, and 10, please refer to the Soil Boring Records, Drawings 12801-3 through 12801-8.

GROUNDWATER

Groundwater was not encountered at the soil borings or core locations. It is our opinion that groundwater should not hinder the design or the construction of the subject project.

Surface water from precipitation, surface water runoff, snowmelt, or other sources should be properly diverted away from all runway construction areas to minimize infiltration of water into excavations and into the subgrade soils. If not managed properly, surface water may be as troublesome as groundwater.

LABORATORY AND FIELD TESTS

Laboratory tests were performed on selected split-barrel samples obtained from the soil borings and on sections of the hot-mix asphalt pavement cores. The scope of the asphalt testing was determined by Roy D. McQueen & Associates, Ltd. In addition, we performed laboratory tests on a composite sample of the base course material collected from Borings 1, 2, 3, 6, 7, and 10. Tests were also performed on a composite sample of the clay fill material encountered at Borings 1, 3, and 10.

For the split-barrel soil samples, the laboratory tests consisted of natural moisture content (NM), Atterberg limits (Liquid Limit, LL, and Plastic Limit, PL), percent of organic matter by loss on ignition (LI), and approximate unconfined compressive strength (q_p) using a calibrated-spring penetrometer. These laboratory test results are shown on the Soil Boring Records.

For the composite sample of the base course material, the laboratory tests consisted of a particle size distribution analysis (gradation). For the composite sample of the clay fill material, the laboratory tests consisted of NM, Atterberg limits, particle size distribution including hydrometer analysis, maximum density and optimum moisture content based on the modified Proctor method, and California Bearing Ratio (CBR). The laboratory test results for the base course and clay fill samples are presented in the following sections of this report and are provided in Appendix B.

The field test consisted of the Standard Penetration Test (SPT), performed during the sampling procedures for Borings 1, 3, and 10. The test result of the SPT is provided in terms of blows per foot based on driving the split-barrel sampler using a 140-pound hammer free-falling for 30 inches. The blows per foot are referred to as the "N" value, and the "N" values are shown on the Soil Boring Records, Drawings 12801-3, 12801-5, and 12801-8.

SPLIT-BARREL SOIL SAMPLES

Based on the field and laboratory test results, our evaluations of the fill material and native soil encountered at the boring locations are summarized below:

Fill Material: At the locations of Borings 1, 3, and 10, the clay fill material was determined to be of medium to hard consistency, with a moderate to high strength.

Topsoil: At Boring 1, the topsoil was tested for the amount of organic matter, with a result of 8.2 percent. The topsoil was of medium to stiff consistency with a very high moisture content and very high plasticity.

Lean Clay: At Borings 3 and 10, this stratum was determined to be of soft to stiff consistency, with moderate strength.

Silty Fine to Medium Sand, Some Gravel: This soil stratum was encountered at Boring 3, below the native lean clay. Based on the N value at this boring, the relative density of this stratum is in a loose to medium dense state of relative density.

BULK SOIL SAMPLES

Bulk samples of the soils recovered from the auger cuttings were composited for testing. The laboratory test results are summarized below:

Particle Size Distribution:

A particle size distribution test was performed on a composite of the bag samples obtained of the base course and the clay fill material. The particle size distribution test for the base course material consisted of a sieve analysis for the particles down through the No. 200-mesh sieve. The test for the lean clay fill material consisted of a sieve analysis for the particles larger than the No. 200-mesh sieve and hydrometer analysis for the particles passing the No. 200-mesh sieve. A summary of the particle size distribution test results are shown, as follow:

Test Sample	Sieve Analysis		Hydrometer Analysis	
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
bag samples from Borings 1, 2, 3, 6, 7, and 10, consisting of the existing base course (silty fine to coarse sand, some gravel)	26.6	46.1	27.3	
bag samples from Borings 1, 3, and 10, consisting of fill material (lean clay, some sand and little gravel)	5.2	20.0	28.2	46.6

Graphical presentation of the particle size distribution test result is shown on the enclosed Figure 12801-A and 12801-B in Appendix A.

Atterberg Limits and Soil Classification:

The Atterberg limits test was performed on the bag samples of clay fill material from Borings 1, 3, and 10. The results of the Atterberg limits test on the bag samples, and classification of the soil based on the Unified Soil Classification System (USCS) and the U.S. Department of Transportation Federal Aviation Agency (FAA) soil classification system are shown as follows:

Test Sample	Atterberg limits			Soil Classification	
	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	USCS	FAA
bag sample from Borings 1, 3, and 10 (lean clay with little sand and occasional gravel	37	17	20	CL	E-7

Modified Proctor:
A composite sample of the clay fill obtained from Borings 1, 3, and 10 was tested for maximum dry density and optimum moisture content based on the procedure in ASTM Designation D 1557, which is referred to as the modified Proctor method. The modified Proctor test results are as follow:

Test Sample	Modified Proctor Test Result	
	Optimum Moisture Content (%)	Maximum Dry Density (lb/ft^3)
bag samples from Borings 1, 3, and 10 (lean clay, some sand and gravel)	11.6	125.8

Graphical presentation of the modified Proctor test result is shown on the enclosed Figure 12801-C in Appendix B.

California Bearing Ratio:
Laboratory CBR tests were performed on a composite of the bag samples of the clay fill material. The CBR test samples were prepared in accordance with ASTM Designation D 1883. The CBR test samples were compacted to differing densities. This provides a determination of a range of CBR values based on the level of compaction for the soil. The test samples were compacted using 10 blows per layer, 25 blows per layer, and 56 blows per layer which correspond to percent compaction values of approximately 86 percent, 95 percent, and 100 percent, respectively.

For each level of compaction, after compacting the test samples, the test samples were placed in a water bath and allowed to soak between 101 to 104 hours. The test samples were soaked to simulate a saturated subgrade condition which should provide the lower boundary of soil strength and CBR value to use for the design of the new taxiway pavement and other pavement areas. A surcharge weight of 105 pounds was placed on the test samples during the soaking periods and during the CBR tests. The surcharge weight is intended to simulate the surcharge pressure applied to the subgrade soil by the weight of the existing pavement and base course materials. After soaking, the test samples were tested using the CBR test procedure described in ASTM Designation D 1883. The test results are summarized as follows:

Sample	Moisture Content		Applied Piston Pressure		CBR Values	
	Before Soaking (%)	After Test (%)	0.1" Penetration (lb/in^2)	0.2" Penetration (lb/in^2)	CBR Bearing Ratio at 0.1" Penetration	CBR Bearing Ratio at 0.2" Penetration
test sample compacted using 10 blows per layer, 86 percent compaction	11.2	18.6	13.7	22.8	1	2

Sample	Moisture Content		Applied Piston Pressure		CBR Values	
	Before Soaking (%)	After Test (%)	0.1" Penetration (lb/in²)	0.2" Penetration (lb/in²)	CBR Bearing Ratio at 0.1" Penetration	CBR Bearing Ratio at 0.2" Penetration
test sample compacted using 25 blows per layer, 95 percent compaction	12.3	15.7	41.0	68.6	4	5
test sample compacted using 56 blows per layer, 100 percent compaction	11.6	12.6	148	261	15	17

The CBR values for the test samples varied depending on the level of compaction imparted to the test samples. The CBR test results are shown graphically on Figures 12801-D through 12801-F which are enclosed in Appendix B. In addition, we are providing Figure 12801-G which shows the relationship between molded dry density and the CBR value corresponding to 0.1-inch penetration of the CBR piston.

ASPHALT PAVEMENT CORES

Roy D. McQueen & Associates, Ltd. requested laboratory tests on various sections of the asphalt cores. The tests requested are summarized as follows:

Core Number	Depth of Test	Requested Tests
1	8¼" to 16-3/8"	Tensile Strength Ratio (TSR)
1	20-5/8" to 22-5/8"	Air Voids Gmm Gmb Asphalt Content Aggregate Gradation
2	9-1/8" to 12-1/8"	Air Voids Gmm Gmb
3	11½" to 19-3/4"	TSR
4	9-1/8" to 13-3/8"	Asphalt Content Aggregate Gradation

Core Number	Depth of Test	Requested Tests
6	9" to 12¼"	Air Voids Gmm Gmb Extraction Gradation
7	11-7/8" to 19-5/8"	TSR

The TSR test sections from Borings 1, 3, and 7, were sent to MTE Services, Inc. The TSR test method was modified for this project due to the limited quantity of material available. This test is typically performed with a total of six sections per sample to allow three tests performed in a dry state and three tests performed after saturating in water. The testing for this project consisted of testing two samples from Cores 1, 3, and 7, one each in a dry state and one each after saturation. The test report from MTE Services, Inc. is included in Appendix C, and a portion of the test results are summarized as follows:

Sample	Wet Strength (kPa)	Dry Strength (kPa)	TSR
1	399.6	361.6	110.5
3	261.7	279.7	93.5
7	281.7	419.5	67.1
Averages	314.3	353.6	

Based on the average of the wet and dry strengths for the 3 samples tested, the TSR value is 88.9.

The asphalt content, gradation analyses of the extracted aggregate, air voids, theoretical maximum specific gravity (Gmm), and bulk specific gravity (Gmb) tests were performed in our laboratory. The test results, with the exception of the gradation analyses results, are summarized as follows:

Sample	Air Voids	Gmm	Gmb	Asphalt Content
1	8.9%	2.599	2.368	3.4%
2	7.3%	2.606	2.416	----
4	----	----	----	4.9%
6	11.1%	2.597	2.308	4.5%

Visual observations of the extracted aggregate from Cores 1, 4, and 6 indicate a relatively high proportion of rounded particles.

The gradation analyses results are provided on Figure 12801-H through 12801-J. The test results were compared to the specifications for State of Wisconsin Department of Transportation Bureau of Aeronautics *Standard Specifications for Airport Construction*. None of the samples meet Specification P-401 Plant Mix Bituminous Pavements. The samples do meet the gradation control points for 3/4-inch (19 mm) nominal size aggregate as presented in Table 2 of Standard Special Provision P401-015 Modified Specification P-401 Plant Mix Bituminous Pavements (Superpave™). Comparing the test results to Table 460-1 in Section 460 Hot Mix Asphalt Pavement, *2008 Standard Specifications* from Wisconsin Department of Transportation, all three samples meet the specifications for 19.0 mm material.

PAVEMENT DESIGN PARAMETERS

In the design of airport runway and taxiway pavement, the pavement design parameters of interest to the design engineer consist of the CBR value of the subgrade soil for flexible pavement (hot-mix asphalt (HMA) pavement) and the Modulus of Subgrade Reaction of the subgrade soil for rigid pavement (concrete pavement). Also, the design of airport runway or taxiway pavement should consider the climatic conditions which will act on the pavement and the underlying subgrade soil during the lifetime of the pavement. The supporting subgrade soil is assigned a Frost Group (FG) value which is an indicator of the frost susceptibility of the subgrade soil.

The CBR value of a composite sample of the clay fill material encountered at Borings 1, 3, and 10 was determined in our laboratory. We estimated the Modulus of Subgrade Reaction value and the Frost Group value of the bag sample based on the available information. The soil classifications for the USCS and the FAA systems were based on the laboratory test results. The pavement design parameters assigned to the clay fill material encountered at Borings 1, 3, and 10 are as follows:

SUBGRADE SOIL	PAVEMENT DESIGN PARAMETERS	
FILL MATERIAL:	USCS Soil Classification	CL
Lean Clay, some sand and little gravel	FAA Soil Classification	E-7
	CBR	1
	Modulus of Subgrade Reaction	100 lb/in^3
	Frost Group	FG-3

The above recommended design CBR of 1 is based on a density of the existing clay fill soil of approximately 90 percent of the maximum dry density determined for the subgrade soil in accordance with ASTM Designation D 1557. A higher CBR value is possible to use for design purposes but the subgrade soil will need to be compacted to a value greater than 90 percent. A CBR of 2 would require compaction of the clay to at least 93 percent. Proper compaction of soils is dependent upon its moisture content. The moisture content should be near the optimum, as determined by the modified Proctor test. This is more critical for a cohesive soil, such as was encountered on this project. The natural moisture content of the lean clay, as determined from split-barrel samples from Borings 1, 3, and 10, ranged from 17.9 to 21.8 percent. The optimum moisture content from the modified Proctor test is 11.6 percent. This indicates that the clay soils would need to be disced and aerated to reduce their moisture content prior to compaction.

INITIAL SITE PREPARATION

If reconstruction of the runway intersection is proposed, the initial site preparations will consist of removing the existing hot-mix asphalt and concrete pavement. The removal of the pavement will expose the underlying base course material as indicated by our soil borings. This base course material is described as a silty fine to coarse sand, some gravel. It contains a very high percentage of material finer than the No. 200 mesh sieve (P200) and is not suitable for proper support of a pavement. Review of WisDOT specifications for base course material for highways and for airports have maximum P200 values of 15.0 percent. As the P200 value of a soil increases, the material is typically less permeable and has a higher moisture content, and is more frost susceptible.

The depth of frost encountered by the soil borings was up to 5 feet below grade. At this depth, the clay fill material is present. Based on the frost depth and the presence of the silty base course material, preparations for reconstruction should include removal of the base course material and the upper portion of the clay fill material to a depth of 5 feet below grade.

PLACEMENT OF FILL MATERIAL

For the new pavement area, after removing the base course and clay fill to a depth of 5 feet below grade and prior to placement of fill material, we recommend that the subgrade soil to receive the fill material be proof-rolled with heavy rubber tire equipment such as a fully loaded tri-axle or quad-axle dump truck to identify any areas of soft unstable soils.

If any soft or unstable soils are encountered by the proof-rolling, we recommend that excavation below subgrade (EBS) elevation be performed for the total area of the new pavement area. We recommend that EBS consist of the excavation and removal of at least 12 inches of soil. The EBS should be accomplished using a backhoe equipped with a cleaning bucket which is intended to reduce disturbance of the remaining fill material at the bottom of the EBS area. We recommend that the excavation surface be sloped to provide positive drainage of water away from the center of the runway intersection toward the outer edges of the pavement area. If practical, side drains should be installed to transport water from the project area.

Following the removal of the clay fill material to a depth of 5 feet below grade and EBS, if needed, we recommend that the bottom of the excavation area be covered using a woven geotextile similar to Mirafi 600X or Contech C300. The geotextile is intended to provide tensile strength and separation between the remaining fill material at the bottom of the excavation area and new fill material be placed to meet subgrade elevation. The geotextile should be applied in accordance with the geotextile manufacturer's specifications. The geotextile should be pulled taut to remove slack and wrinkles in the fabric spread out at the bottom of the EBS area. Overlaps of adjacent sheets of the geotextile should be at least 2 feet, and the overlapped sheets should be connected using metal pins.

After placement of the geotextile, to replace the excavated EBS material, we recommend to place compacted crushed stone or gravel similar to No. 2 stone as defined in ASTM Designation C 33. The No. 2 stone consists primarily of 1½-inch- to 2-inch-size stone or gravel particles without "fines". The No. 2 stone should be thoroughly compacted using a self-propelled steel-drum vibratory compactor.

In lieu of EBS, installation of a geotextile, and placement of compacted No. 2 stone, the fill material at the stripped subgrade surface could be improved by the application of either fly ash or cement which should be properly placed, spread, blended, and compacted as a means to stabilize and strengthen the existing fill material prior to the placement of additional fill material.

After placement of 12 inches of No. 2 stone for the EBS option, or after the application of fly ash or cement, if the grade is low with respect to the design subgrade elevation for the proposed pavement area, we recommend that additional fill material be placed. It should consist of compacted crushed aggregate base course material placed in maximum 6-inch-thick layers with each layer compacted to a density of at least 95 percent of the maximum dry density determined for the crushed aggregate base course material in accordance with ASTM Designation D 1557. The compacted fill material should be observed and tested by Soils & Engineering Services, Inc.

CLOSING COMMENTS

This geotechnical engineering report was prepared for the exclusive use of Michael Baker Jr., Inc., General Mitchell International Airport, and the Milwaukee County Department of Transportation and Public Works to aid in the evaluation of the subject project area, and for the intended uses described herein. Changes in the design of the proposed reconstruction of the intersection of Runways 1L-19R and 7R-25L may warrant changes to the information and recommendations provided in this report. Likewise, the nature and extent of soil and/or groundwater variations between the locations of the soil borings may not become evident until the time of excavation and construction of the subject project. If soil or groundwater variations are evident at that time, it will be necessary to re-evaluate the information and recommendations given herein.

Soils & Engineering Services, Inc. should review the final design and specification documents for the subject project to verify that our recommendations are interpreted correctly, and implemented in the design of the subject project as they are intended. It is further recommended that Soils & Engineering Services, Inc. be present at the time of site earthwork/construction activities to observe compliance with the design concepts and specifications, and to provide recommendations to modify the design if soil or groundwater conditions differ from those anticipated prior to construction. It is important that soil composition, soil density, soil strength, soil uniformity, pavement design parameters, other soil parameters, and degree of compaction required be confirmed and/or determined at the time of construction.

Safety precautions, such as those required by OSHA and the Wisconsin Department of Commerce, should be followed throughout the entire construction of the subject project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls, and proper support of existing runways and taxiways in the area of the subject project.

This report has been prepared for the subject project in accordance with generally accepted soil and engineering practices at this time. No other warranty, expressed or implied, is made.

Soils & Engineering Services, Inc. will store the soil samples obtained from the borings performed for this project for a period of 60 calendar days after the date of this report. Please advise us if this period should be extended.

The information and recommendations in this report are based on our interpretation and classification of the soils and information given on the Field Boring Logs, and may not be based solely on the contents of the driller's field logs.

If you have any questions concerning this report, or if we can be of any further assistance to you, please contact us.

Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

WISCONSIN
DUANE E.
REICHEL
E-28408
MADISON,
WI
PROFESSIONAL ENGINEER

Duane E. Reichel, P.E.

DER:DMH:wsr

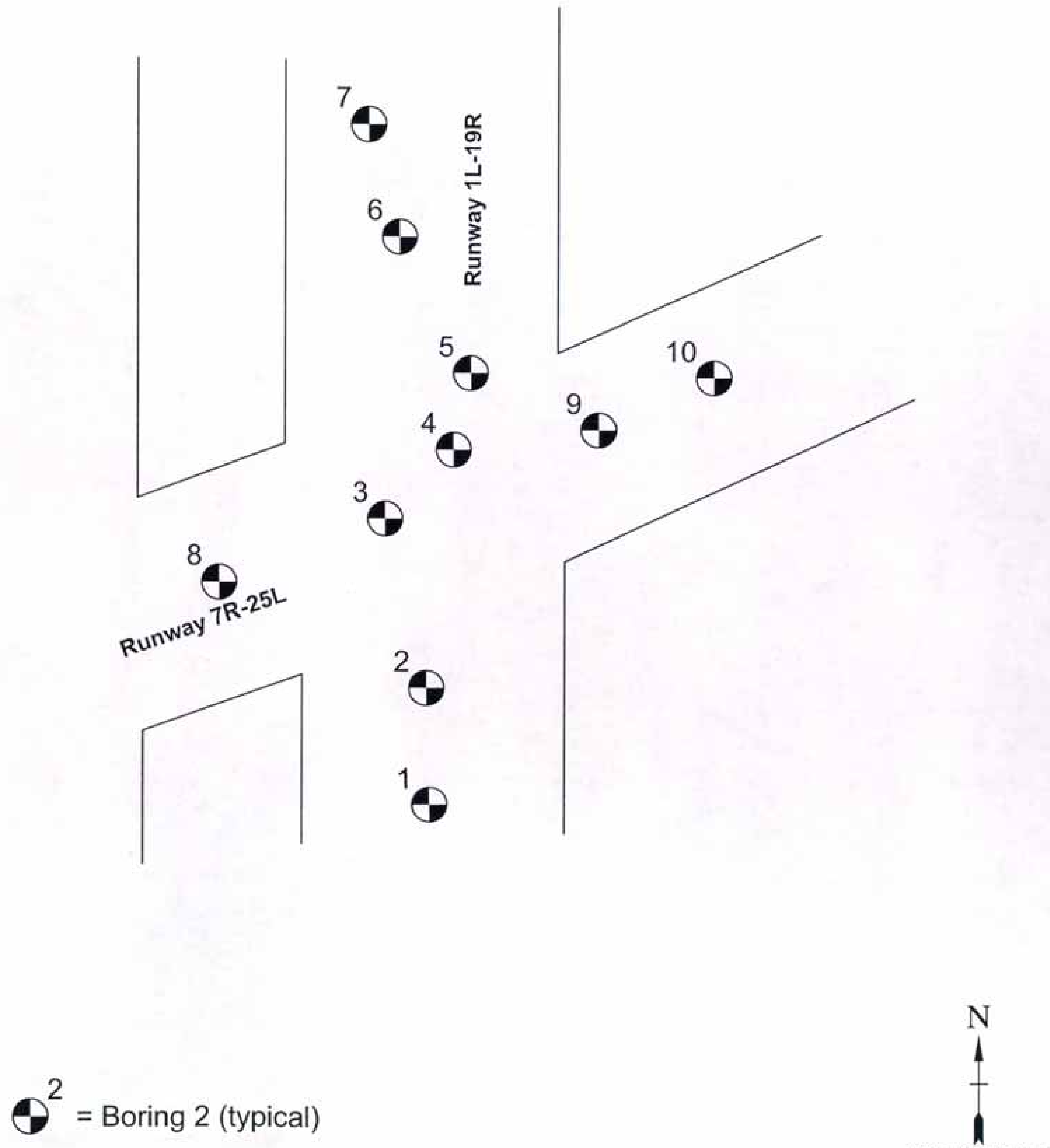
Enclosures (14): Drawing 12801-1, Boring Location Sketch
Drawing 12801-2, Notes and Legend for Soil Boring Records
Drawings 12801.2-3 through 12801-8, Soil Boring Records

Table 1: Pavement Core Summary

Appendix A: Pavement Core Photographs

Appendix B: Figure 12801-A, Particle Size Distribution Test Report (Base Course)
Figure 12801-B, Particle Size Distribution Test Report (Fill Material - Lean Clay)
Figure 12801-C, Modified Proctor Test Report
Figures 12801-D through 12801-F, CBR Test Reports
Figure 12801-G, Dry Density versus CBR Test Report

Appendix C: Figure 12801-H through 12801-J; Particle Size Distribution Test Report
TSR Test Results
TSR Test Sample Photographs



Soils & Engineering Services, Inc.

1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws

CONSULTING CIVIL ENGINEERS SINCE 1966

LOCATION SKETCH

Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING
12801-1

Printed on 2/16/2009

NOTES

1. The drilling for the soil borings was performed using 2¼-inch-inside-diameter, continuous flight, hollow-stem augers.

2. The soil sampling for the borings was performed in accordance with ASTM Designation D 1586. The number of blows required to drive a 2-inch-outside-diameter, split-barrel sampler 12 inches, or fraction thereof when so noted, with a 140-pound hammer falling 30 inches is recorded in the "N-Value" column at the approximate middle elevation of the sample. This number of blows is the "standard penetration resistance."

3. The boreholes that were greater than 10 feet in depth, that intersected the groundwater table, or that intersected possible contaminated soils were backfilled with bentonite after determining the depth to water. The boreholes that were less than or equal to 10 feet in depth were backfilled with auger cuttings after determining the depth to water.

4. The boundary lines between different soil strata, as shown on the Soil Boring Records, are approximate and may be gradual. The recovered soils were visually identified in accordance with the Unified Soil Classification System (USCS) as defined in ASTM Designation D 2487. The drillers' field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Soil Boring Records contain the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the drillers' field logs and soil samples and/or laboratory test results.

5. The Soil Boring Records are a part of the geotechnical report. The geotechnical report should be included in the bidding or reference documents.

TEST RESULTS LEGEND

q_p = Penetrometer reading, $^{ton}/_{ft^2}$

NM = Natural moisture, % moisture by weight

LI = Loss on ignition, % organic content by weight

LL = Liquid limit, % moisture by weight

PL = Plastic limit, % moisture by weight

REMARKS LEGEND

D = Damp relative moisture condition
M = Moist relative moisture condition
W = Wet relative moisture condition

SAMPLER TYPE LEGEND

2-inch-outside-diameter, split-barrel sampler

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

NOTES AND LEGEND
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING
12801-2

Boring **1**
Completed **February 1, 2009**
Total Depth = **13'-0"** (Page 1/1)

Depth (feet)	Material Description	N-Value	Test Results	Remarks
0	*HOT MIX ASPHALT (HMA)* 22 5/8 inches thick			
2	*CONCRETE* 13 inches thick			
	BASE COURSE Brown silty sand and gravel, 8 3/8 inches thick		NM=18.1; LL=32 PL=16	
4	*FILL MATERIAL* Lean clay	10		
		7	q_p=1.8; NM=21.8	M
		4	q_p=3.5, 4.0	M
		5	q_p=1.0, 1.5 NM=64.7; LL=97 PL=40; LI=8.2	M
	TOPSOIL 6 inches thick			

WATER LEVEL LEGEND
D Dry 13'-0" at completion

OTHER LEVEL LEGEND
Frozen, 0'-0" to 5'-0"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

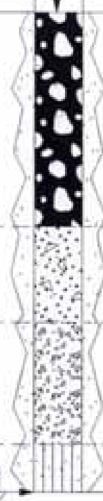
SOIL BORING RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING 12801-3

Boring **2**
Completed **February 1, 2009**
Total Depth = **5'-0"** (Page 1/1)

Material Symbol

DEPTH (feet)	Material Description	Remarks	DEPTH (feet)
0	***HOT MIX ASPHALT (HMA)*** $26^{5}/_{8}$ inches thick		0
2	***CONCRETE*** 12 inches thick		2
4	***BASE COURSE*** Brown silty sand and gravel, $15^{3}/_{8}$ inches thick		4
	FILL MATERIAL Clay D		
6			6
8			8
10			10
12			12
14			14



WATER LEVEL LEGEND
D Dry 5'-0" at completion

OTHER LEVEL LEGEND
Frozen, 0'-0" to 5'-0"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

SOIL BORING RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING
12801-4

Boring **3**
Completed **February 1, 2009**
Total Depth = **13'-0"** (Page 1/1)

DEPTH (feet)	Material Description	N-Value	Test Results	Sampler Type / Recovery / Remarks
0	***HOT MIX ASPHALT (HMA)*** 23 inches thick			
2	***CONCRETE*** 12 inches thick			
	BASE COURSE Brown silty sand and gravel, 9 inches thick			
4	***FILL MATERIAL*** Lean clay with gravel	11	q_p=3.5, 5.5; NM=17.9	M
6		13	q_p=6.5+, 1.0; NM=19.1; LL=41; PL=19	D
	TOPSOIL 2 inches thick			
8	***LEAN CLAY (CL)*** Brown			
		6	q_p=1.5, 1.8	M
10				
12		10	q_p=2.0, 3.5	M
	SILTY FINE TO MEDIUM SAND, SOME GRAVEL (SM) Grayish-Brown			
14				

WATER LEVEL LEGEND
D Dry 13'-0" at completion

OTHER LEVEL LEGEND
Frozen, 0'-0" to 4'-6"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

SOIL BORING RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING
12801-5

Printed on 2/19/2009

Boring **6**

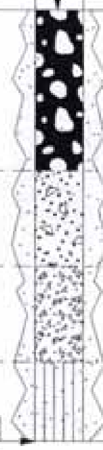
Completed **February 1, 2009**

Total Depth = **4'-6"** (Page 1/1)

Material Symbol

Material Description

Depth (feet)	Material Description	Remarks
0	***HOT MIX ASPHALT (HMA)*** 20 inches thick	
2	***CONCRETE*** 12 inches thick	
	BASE COURSE Brown with sand and gravel, 12 inches thick	
4	***FILL MATERIAL*** Brown lean clay	



D

DEPTH (feet) 0, 2, 4, 6, 8, 10, 12, 14

WATER LEVEL LEGEND

D Dry 4'-6" at completion

OTHER LEVEL LEGEND

Frozen, 0'-0" to 4'-6"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.

1102 STEWART STREET • MADISON, WISCONSIN 53713-4648

Phone: 608-274-7600 • 888-866-SOIL (7645)

Fax: 608-274-7511 • Email: soils@soils.ws

CONSULTING CIVIL ENGINEERS SINCE 1966

SOIL BORING RECORD

Runways 1L - 19R & 7R - 25L

Intersection Pavement Study

General Mitchell International Airport

Milwaukee County, Wisconsin

DRAWING 12801-6

Printed on 2/19/2009

Material Symbol

DEPTH (feet)	Material Description	Remarks
0	***HOT MIX ASPHALT (HMA)*** $19\frac{5}{8}$ inches thick	
2	***CONCRETE*** $12\frac{1}{4}$ inches thick	
	BASE COURSE Gray silty sand and gravel, $12\frac{1}{8}$ inches thick	
4	***FILL MATERIAL*** Brown mottled lean clay D	

Depth scale (feet): 0, 2, 4, 6, 8, 10, 12, 14

WATER LEVEL LEGEND
D Dry 4'-4" at completion

OTHER LEVEL LEGEND
Frozen, 0'-0" to 4'-4"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

SOIL BORING RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

SES

DRAWING
12801-7

Boring **10**

Completed **February 1, 2009**

Total Depth = **13'-0"** (Page 1/1)

Depth (feet)	Material Description	N-Value	Test Results	Remarks
0	***HOT MIX ASPHALT (HMA)*** 13 1/4 inches thick			
	CONCRETE 13 inches thick			
2	***BASE COURSE*** Brown sand and gravel, 8 3/4 inches thick			
	FILL MATERIAL Lean clay with sand and gravel, 2'-11" to 5'-0"	11	q_p=4.9; NM=18.5 LL=35; PL=17	M
5	Lean clay, 5'-0" to 9'-0"	13	q_p=2.2, 3.0 NM=21.7	M
9	***TOPSOIL*** 12 inches thick	5	q_p=0.8, 1.6	M
10	***LEAN CLAY (CL)*** Grayish-Brown with fine sand partings	5	q_p=0.3, 0.6	W
13	D			

WATER LEVEL LEGEND

D Dry 13'-0" at completion

OTHER LEVEL LEGEND

Frozen, 0'-0" to 4'-6"

NOTE: Pavement cored with 6 1/2-inch diameter core barrel

For Notes and Legend, see Drawing 12801-2.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

SOIL BORING RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

DRAWING
12801-8

TABLE 1

Pavement Core Summary

Core 1

Section Thickness	Layer Thickness	Pavement Type
3-1/4 inches	3-1/4 inches	HOT-MIX ASPHALT
5 inches	2-1/2 inches	
	2-1/2 inches	
14-3/8 inches	2 inches	
	1-5/8 inches	
	1-1/2 inches	
	3 inches	
	2-1/4 inches	
	2 inches	
	2 inches	
Total Asphalt	22-5/8 inches	
13 inches	13 inches	CONCRETE
Total Pavement	**36-5/8 inches**	

TABLE 1

Pavement Core Summary

Core 2

Section Thickness	Layer Thickness	Pavement Type
4-3/8 inches	1-5/8 inches	HOT-MIX ASPHALT
	2 inches	
	3/4 inches	
2-3/4 inches	2-3/4 inches	
13 inches	2 inches	
	3 inches	
	2 inches	
	1-1/2 inches	
	2-1/2 inches	
	2 inches	
6-1/2 inches (bottom 4½ inches is porous)	2 inches	
	1 inches	
	3-1/2 inches	
Total Asphalt	26-5/8 inches	
12 inches	12 inches	CONCRETE
Total Pavement	**38-5/8 inches**	

TABLE 1

Pavement Core Summary

Core 3

Section Thickness	Layer Thickness	Pavement Type
6-1/4 inches	2-1/4 inches	HOT-MIX ASPHALT
	2 inches	
	2 inches	
6-1/2 inches	3-1/4 inches	
	3-1/4 inches	
10-1/4 inches	2 inches	
	2 inches	
	2 inches	
	2-1/4 inches	
	2 inches	
Total Asphalt	23 inches	
12 inches	12 inches	CONCRETE
Total Pavement	**35 inches**	

TABLE 1

Pavement Core Summary

Core 4

Section Thickness	Layer Thickness	Pavement Type
4 inches	4 inches	HOT-MIX ASPHALT
3 inches	3 inches	
5-1/2 inches	2-1/8 inches	
	2-3/8 inches	
8-1/4 inches	1-7/8 inches	
	2-1/8 inches	
	2-1/4 inches	
	2 inches	
Total Asphalt	19-3/4 inches	
11-1/8 inches	11-1/8 inches	CONCRETE
Total Pavement	**30-7/8 inches**	

TABLE 1

Pavement Core Summary

Core 5

Section Thickness	Layer Thickness	Pavement Type
5 inches	1-7/8 inches	HOT-MIX ASPHALT
	3-1/8 inches	
10-1/8 inches	2 inches	
	1-3/4 inches	
	2-1/2 inches	
	1-7/8 inches	
	2 inches	
4-3/8 inches	2-1/2 inches	
	2-1/4 inches	
Total Asphalt	19-7/8 inches	
11-1/4 inches	11-1/4 inches	CONCRETE
Total Pavement	**31-1/8 inches**	

TABLE 1

Pavement Core Summary

Core 6

Section Thickness	Layer Thickness	Pavement Type
15-3/8 inches	4 inches	HOT-MIX ASPHALT
	2-1/2 inches	
	2-1/2 inches	
	3-1/4 inches	
	3-1/8 inches	
4-5/8 inches	2-1/8 inches	
	2-1/2 inches	
Total Asphalt	20 inches	
12-1/2 inches	12 -1/2 inches	CONCRETE
Total Pavement	**32-1/2 inches**	

TABLE 1

Pavement Core Summary

Core 7

Section Thickness	Layer Thickness	Pavement Type
2-1/8 inches	2-1/8 inches	HOT-MIX ASPHALT
5-5/8 inches	2-3/4 inches	
	2-7/8 inches	
11-7/8 inches	4-1/8 inches	
	2-3/4 inches	
	2-1/2 inches	
	2-1/2 inches	
Total Asphalt	19-5/8 inches	
12-1/4 inches	12-1/4 inches	CONCRETE
Total Pavement	**31-7/8 inches**	

TABLE 1

Pavement Core Summary

Core 8

Section Thickness	Layer Thickness	Pavement Type
2-1/2 inches	2-1/2 inches	HOT-MIX ASPHALT
17-5/8 inches	2-5/8 inches	
	1-3/4 inches	
	2-1/2 inches	
	2 inches	
	2-3/8 inches	
	2-1/2 inches	
	2-1/2 inches	
	1-3/8 inches	
Total Asphalt	20-1/4 inches	
12-3/4 inches	12-3/4 inches	CONCRETE
Total Pavement	**32-7/8 inches**	

TABLE 1

Pavement Core Summary

Core 9

Section Thickness	Layer Thickness	Pavement Type
5-3/4 inches	2-3/4 inches	HOT-MIX ASPHALT
	3 inches	
9-1/2 inches	2-3/4 inches	
	2-1/2 inches	
	2 inches	
	2-1/4 inches	
Total Asphalt	15-1/4 inches	
12 inches	12 inches	CONCRETE
Total Pavement	**27-1/4 inches**	

TABLE 1

Pavement Core Summary

Core 10

Section Thickness	Layer Thickness	Pavement Type
2-3/4 inches	2-3/4 inches	HOT-MIX ASPHALT
10-1/2 inches	2-1/2 inches	
	1-3/4 inches	
	1-3/4 inches	
	2 inches	
	2-1/2 inches	
Total Asphalt	13-1/4 inches	
13 inches	13 inches	CONCRETE
Total Pavement	**26-1/4 inches**	

APPENDIX A

Pavement Core Photographs

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 1

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 2

BORING 2

(Detail of bottom of asphalt portion of core)

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 3

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 4

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 5

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 6

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 6

(Detail of Filled Fracture at Top of Concrete Pavement)

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 7

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 8

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 9

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

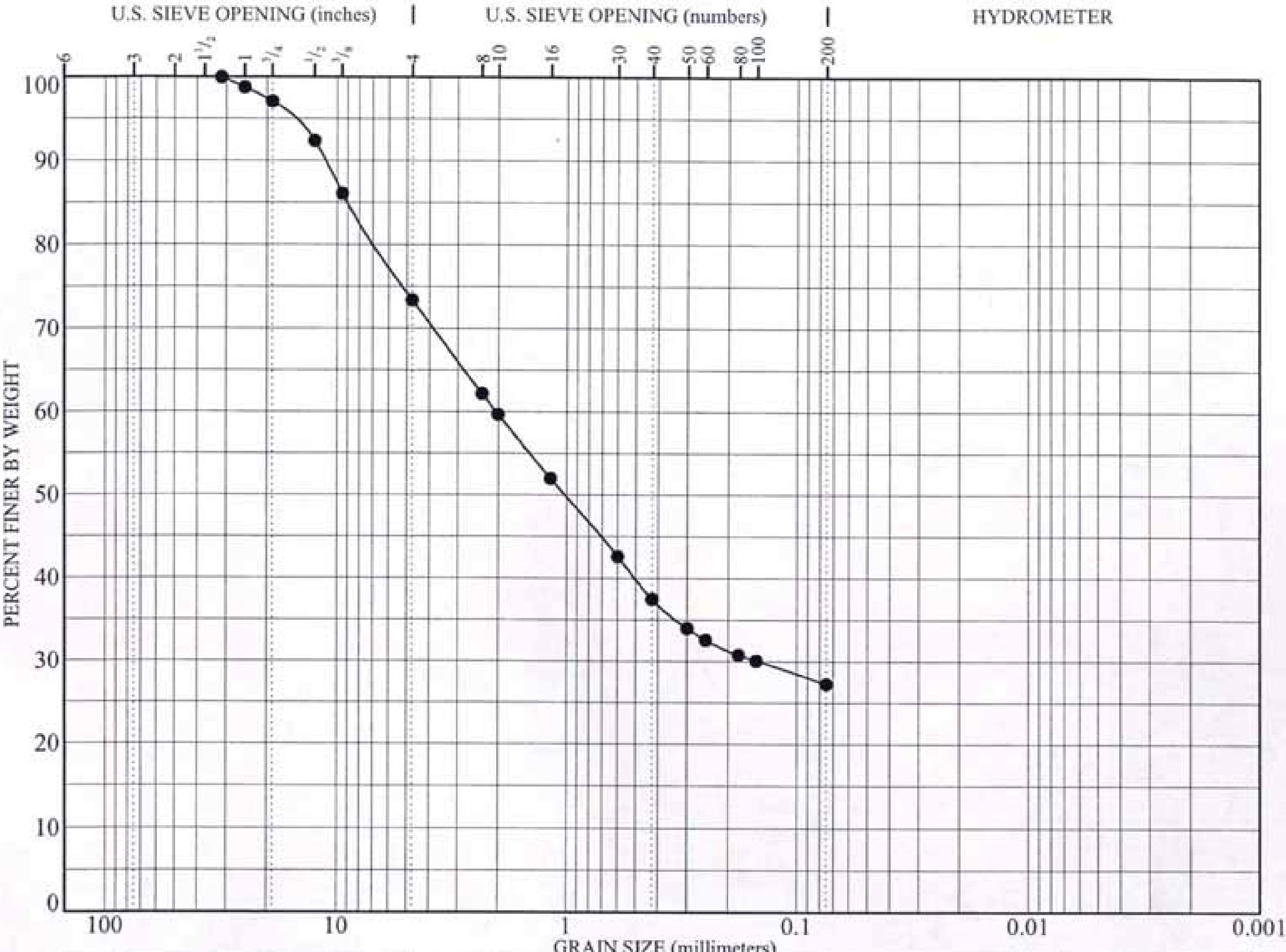
BORING 10

APPENDIX B

SOIL LABORATORY TEST REPORTS

Figure 12801-A, Particle Size Distribution Analysis Test Report
Figure 12801-B, Particle Size Distribution Analysis Test Report
Figure 12801-C, Modified Proctor Test Report
Figures 12801-D through 12801-F, CBR Test Reports
Figure 12801-G, Dry Density versus CBR

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%) coarse	GRAVEL (%) fine	SAND (%) coarse	SAND (%) medium	SAND (%) fine	SILT AND CLAY (%)
●	0.0	26.6		46.1			27.3

Sieve Size	Percent Finer ●		
1 1/4-inch	100		
1-inch	99		
3/4-inch	97		
1/2-inch	92		
3/8-inch	86		
#4	73		
#8	62		
#10	60		
#16	52		
#30	43		
#40	38		

Sieve Size	Percent Finer ●		
#50	34		
#60	33		
#80	31		
#100	30		
#200	27.3		

	Grain Size (mm) D_{60}	D_{30}	D_{10}	Coefficients C_c	C_u
●	2.04	0.146			

Sample Information

● **Composite of bag samples from Borings 1, 2, 3, 6, 7, and 10 (Existing base course): Silty Fine to Coarse Sand, some gravel (SM)**

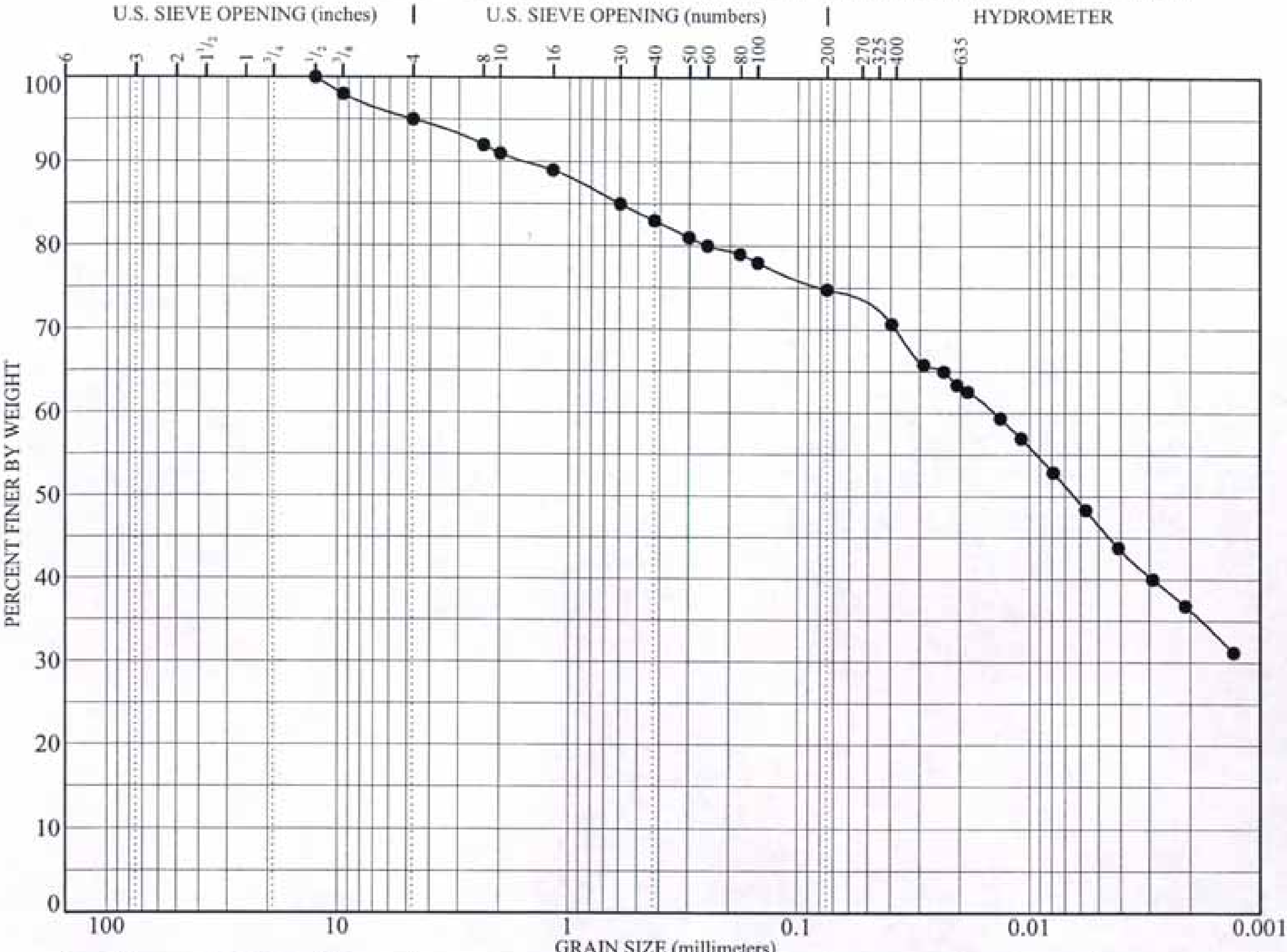
Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE 12801-A

Printed on 2/24/2009

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%)		SAND (%)			SILT (%)	CLAY (%)
		coarse	fine	coarse	medium	fine		
●	0.0	5.2		20.0			28.2	46.6

Sieve Size	Percent Finer ●		
1/2-inch	100		
3/8-inch	98		
#4	95		
#8	92		
#10	91		
#16	89		
#30	85		
#40	83		
#50	81		
#60	80		
#80	79		

Sieve Size	Percent Finer ●		
#100	78		
#200	74.8		

	Grain Size (mm) D_{60}	D_{30}	D_{10}	Coefficients C_c	C_u
●	0.0142				

	Sample Information
●	**Composite of bag samples from Borings 1, 3, and 10: Brown Lean Clay, some sand and little gravel (CL)**

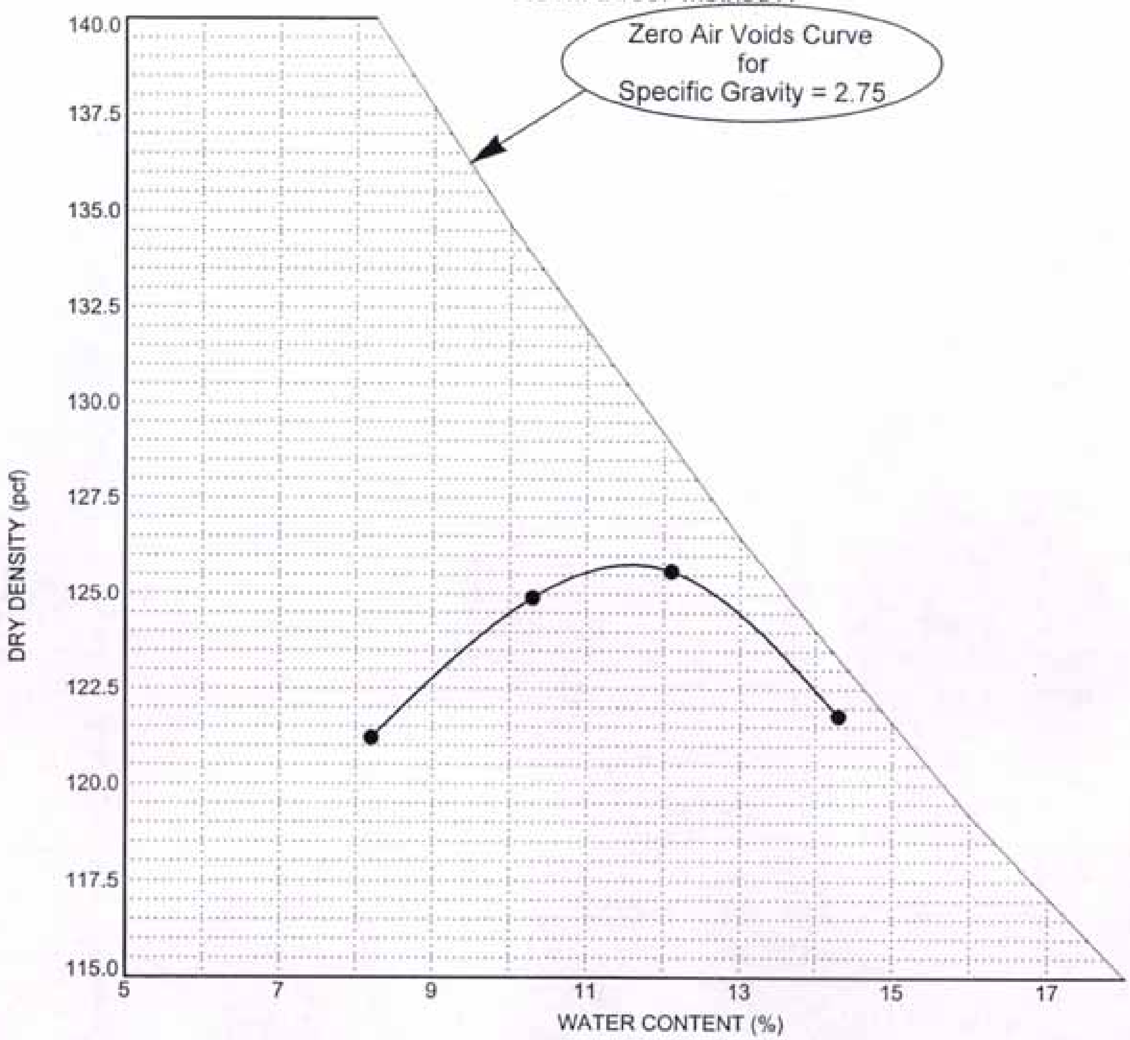
Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE
12801-B

OPTIMUM MOISTURE / MAXIMUM DENSITY TEST REPORT

ASTM D1557 Method A



Laboratory Maximum Dry Density* = **125.8** pcf at Optimum Moisture = **11.6** %

*Laboratory Maximum Dry Density determined for material passing the #4 sieve.

Soil Classification	Natural Moisture	Liquid Limit	Plastic Limit	Plasticity Index	Percent Material Retained			Percent Material Passing
					3/4"	3/8"	#4	#200
Brown Lean Clay, some sand and little gravel (CL)	**15.7**	**37**	**17**	**20**	**0**	**2**	**5**	**74.8**

Sample Name and Description	Remarks
Composite of bag samples from Borings 1, 3, and 10	

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

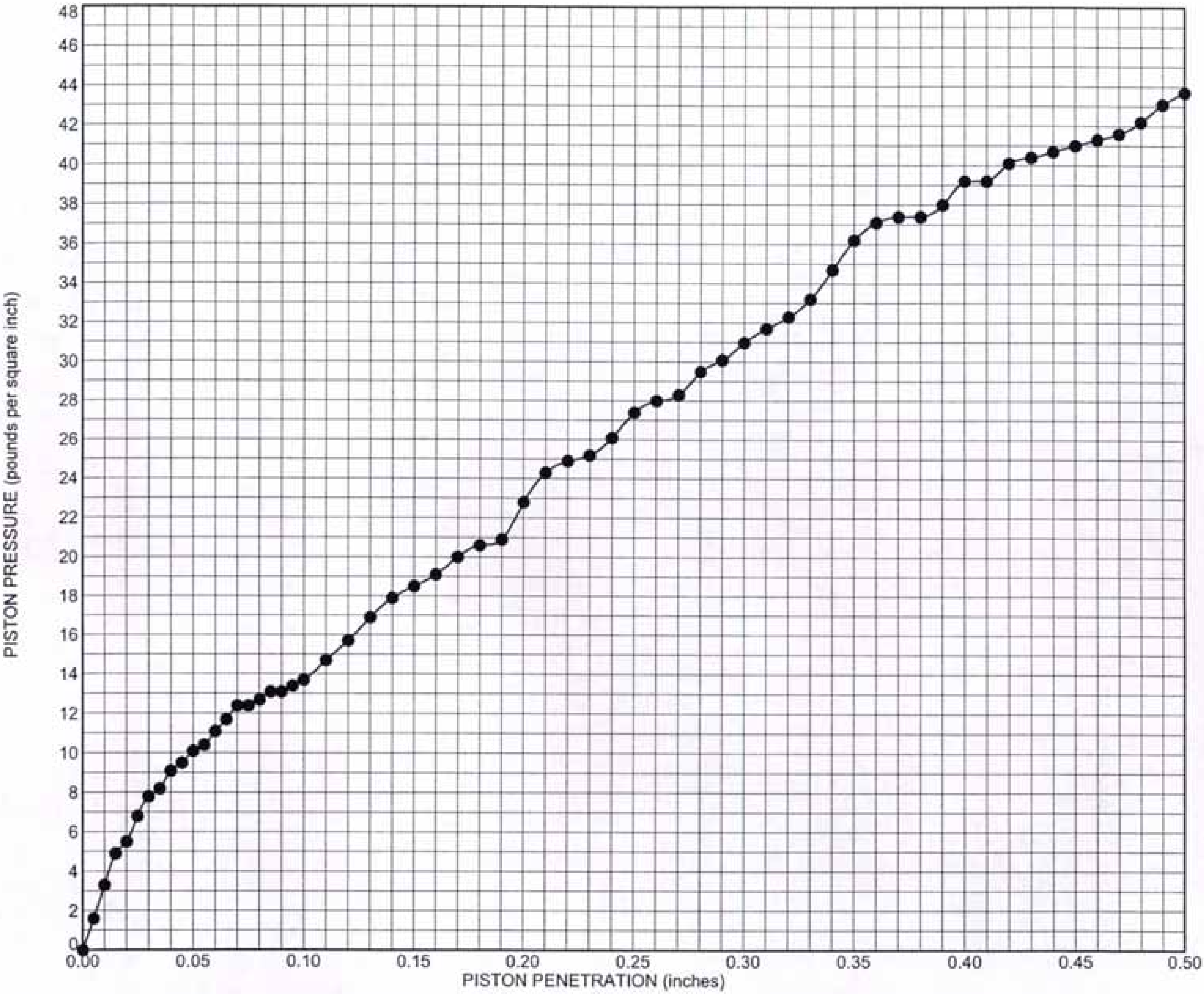
LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE
12801-C

Printed on 2/24/2009

CALIFORNIA BEARING RATIO TEST REPORT

ASTM Test Designation D1883
Piston Pressure Versus Piston Penetration



Penetration (inches)	Piston Pressure (psi)	Conversion Pressure (psi)	CBR Value (%)
0.100	**13.7**	1000	**1**
0.200	**22.8**	1500	**2**
0.300	**31.0**	1900	**2**
0.400	**39.2**	2300	**2**
0.500	**43.7**	2600	**2**

Miscellaneous Information
Method Of Compaction: **ASTM D1557 Method A**
Surcharge Weight: **105** lb Blows per layer: **10**
Sample **was** soaked for **101** hours which yielded a **0.7% swell** from the initial sample height.

Sample Condition	Before Soaking	After Soaking
Dry Density (lb/ft³)	**108.8**	**108.0**
Compaction (%)	**86**	**86**

Moisture Contents (%)	
Before Compaction	**13.0**
After Compaction	**11.2**
Top 1-inch After Test	**21.2**
Average After Test	**18.6**

Sample Identification
Composite of bag samples from Borings 1, 3, and 10

Material Classification
Brown Lean Clay, some sand and little gravel (CL)

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

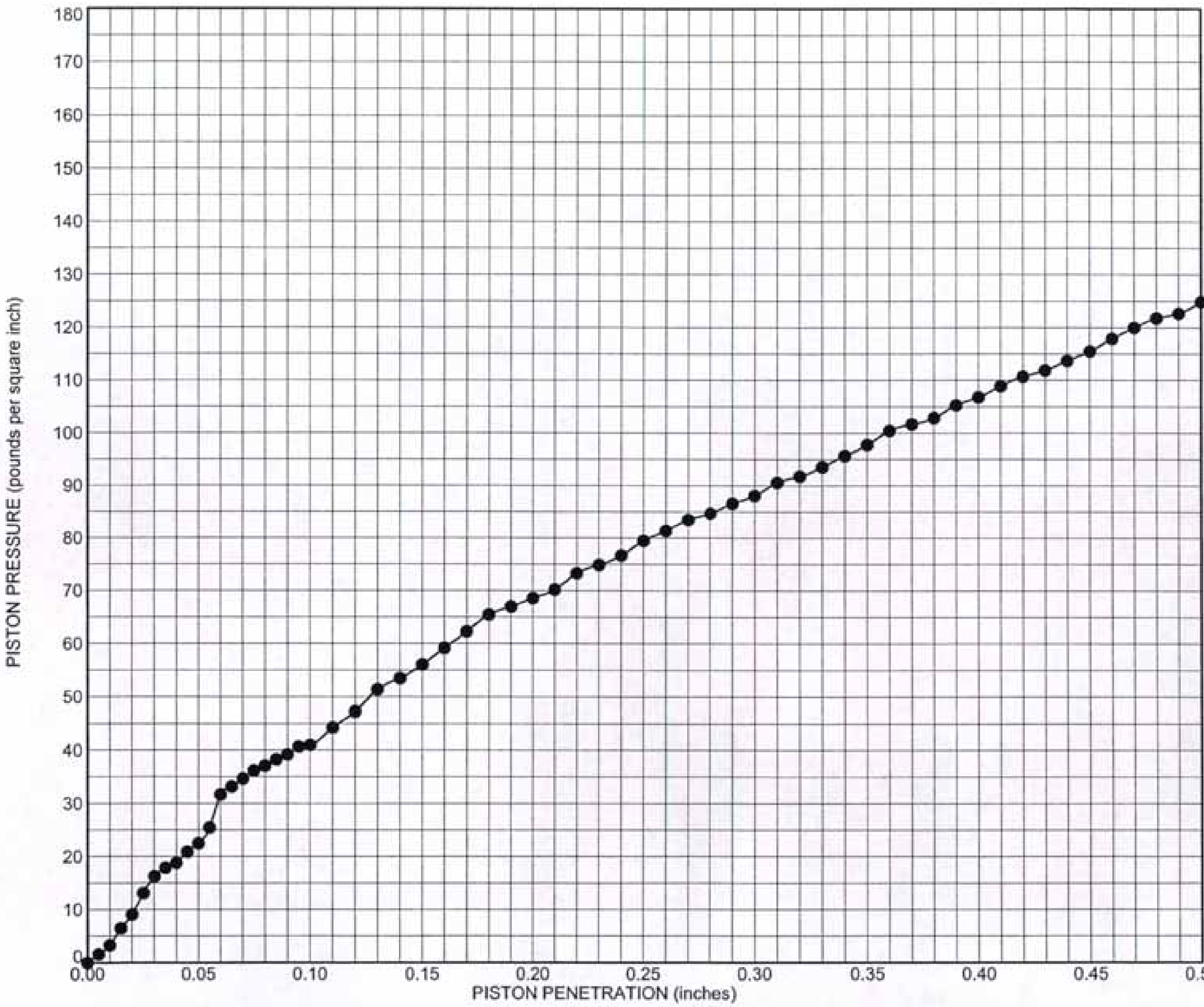
FIGURE 12801-D

Printed on 2/24/2009

CALIFORNIA BEARING RATIO TEST REPORT

ASTM Test Designation D1883

Piston Pressure Versus Piston Penetration



Penetration (inches)	Piston Pressure (psi)	Conversion Pressure (psi)	CBR Value (%)
0.100	**41.0**	1000	**4**
0.200	**68.6**	1500	**5**
0.300	**88.1**	1900	**5**
0.400	**107**	2300	**5**
0.500	**125**	2600	**5**

Miscellaneous Information
Method Of Compaction: **ASTM D1557 Method A**
Surcharge Weight: **105** lb Blows per layer: **25**
Sample **was** soaked for **102** hours which yielded a **1.6% swell** from the initial sample height.

Sample Condition	Before Soaking	After Soaking
Dry Density (lb/ft³)	**119.7**	**117.8**
Compaction (%)	**95**	**94**

Moisture Contents (%)	
Before Compaction	12.4
After Compaction	12.3
Top 1-inch After Test	18.0
Average After Test	15.7

Sample Identification
Composite of bag samples from Borings 1, 3, and 10

Material Classification
Brown Lean Clay, some sand and little gravel (CL)

Soils & Engineering Services, Inc.

1102 STEWART STREET • MADISON, WISCONSIN 53713-4648

Phone: 608-274-7600 • 888-866-SOIL (7645)

Fax: 608-274-7511 • Email: soils@soils.ws

CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD

Runways 1L - 19R & 7R - 25L

Intersection Pavement Study

General Mitchell International Airport

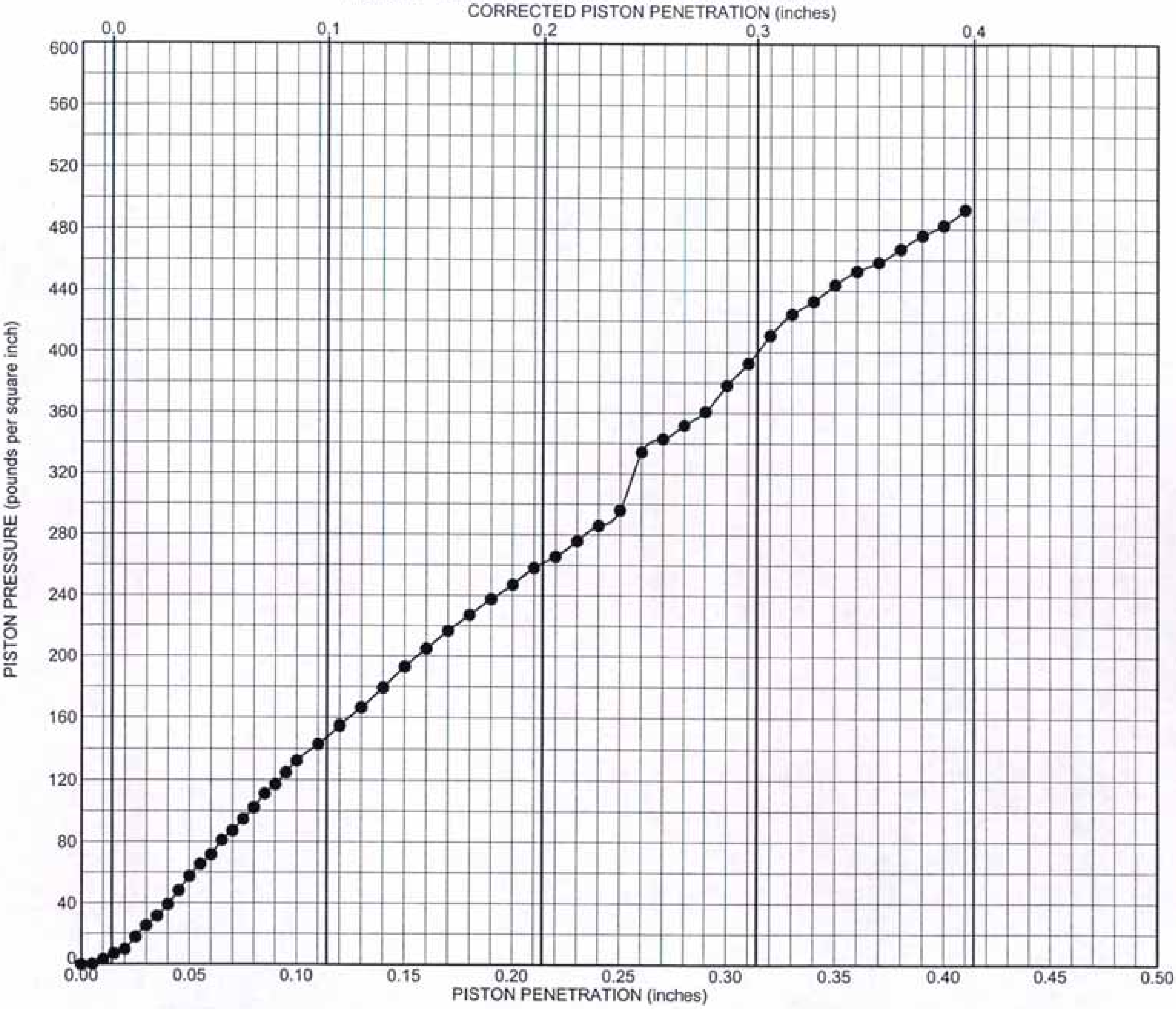
Milwaukee County, Wisconsin

FIGURE 12801-E

CALIFORNIA BEARING RATIO TEST REPORT

ASTM Test Designation D1883

Piston Pressure Versus Piston Penetration



Penetration (inches)	Corrected Piston Pressure (psi)	Conversion Pressure (psi)	CBR Value (%)
0.100	**148**	1000	**15**
0.200	**261**	1500	**17**
0.300	**400**	1900	**21**
0.400	---	2300	---
0.500	---	2600	---

Miscellaneous Information

Method Of Compaction: **ASTM D1557 Method A**
Surcharge Weight: **105** lb Blows per layer: **56**
Sample **was** soaked for **104** hours which yielded a **0.5% swell** from the initial sample height.

Sample Condition	Before Soaking	After Soaking
Dry Density ($^{lb}/_{ft^3}$)	**126.4**	**125.9**
Compaction (%)	**100**	**100**

Moisture Contents (%)	
Before Compaction	**12.7**
After Compaction	**11.6**
Top 1-inch After Test	**13.1**
Average After Test	**12.6**

Sample Identification

Composite of bag samples from Borings 1, 3, and 10

Material Classification

Brown Lean Clay, some sand and little gravel (CL)

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

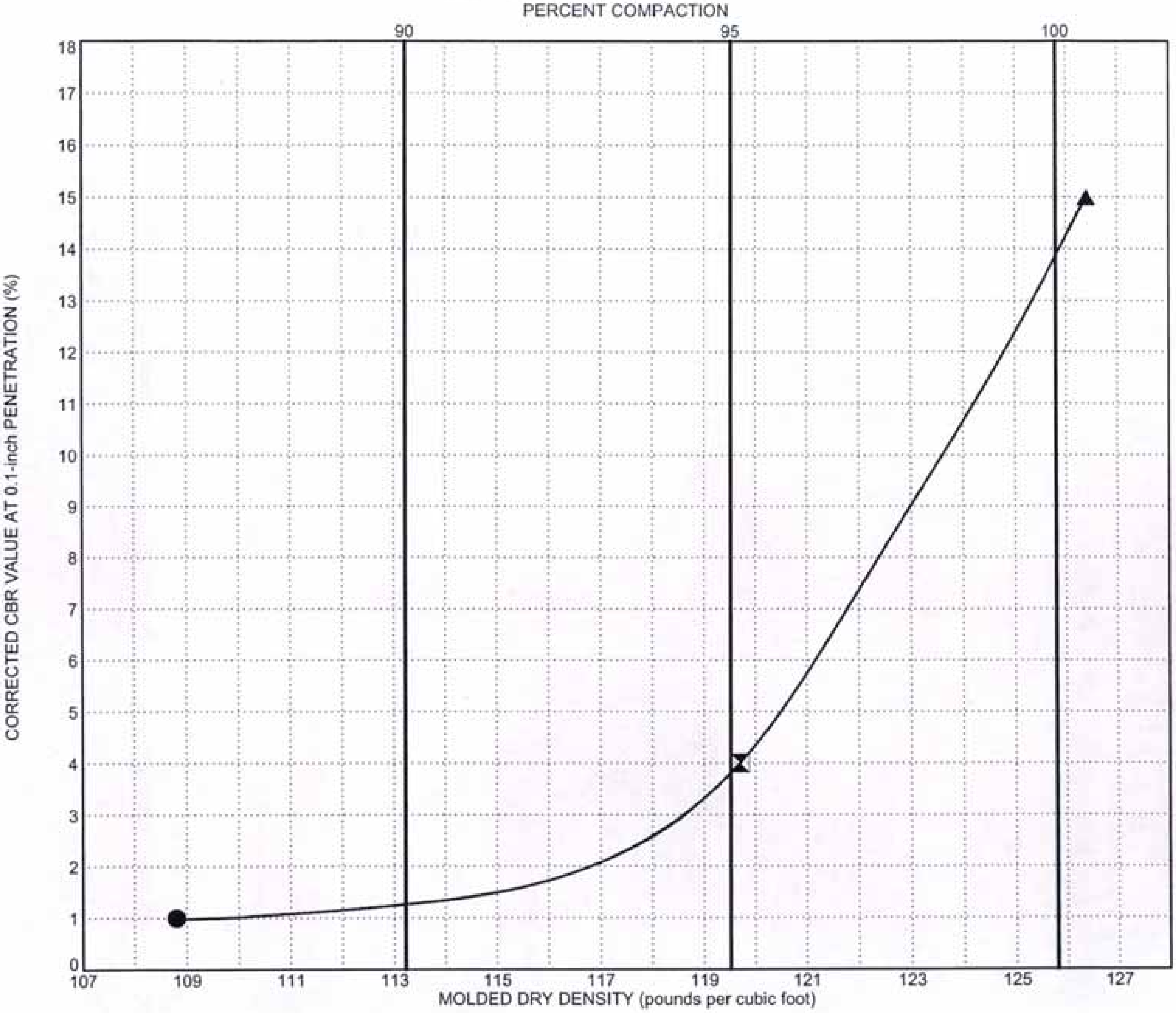
LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE 12801-F

Printed on 2/24/2009

CALIFORNIA BEARING RATIO TEST REPORT

ASTM Test Designation D1883



The Method Of Compaction was **ASTM D1557 Method A**. The maximum dry density was **125.8** pcf.
The surcharge weight was **105** lb. The samples **were** soaked.

Blows per Layer	Before Soaking			After Soaking			
	Dry Density (lb/ft³)	Moisture Content (%)	Compaction (%)	Dry Density (lb/ft³)	Moisture Content (%)	Compaction (%)	CBR Value (%)
● 10	**108.8**	**11.2**	**86**	**108.0**	**18.6**	**86**	**1**
⧗ 25	**119.7**	**12.3**	**95**	**117.8**	**15.7**	**94**	**4**
▲ 56	**126.4**	**11.6**	**100**	**125.9**	**12.6**	**100**	**15**

Sample Identification: **Composite of bag samples from Borings 1, 3, and 10**

Material Classification: **Brown Lean Clay, some sand and little gravel (CL)**

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE
12801-G

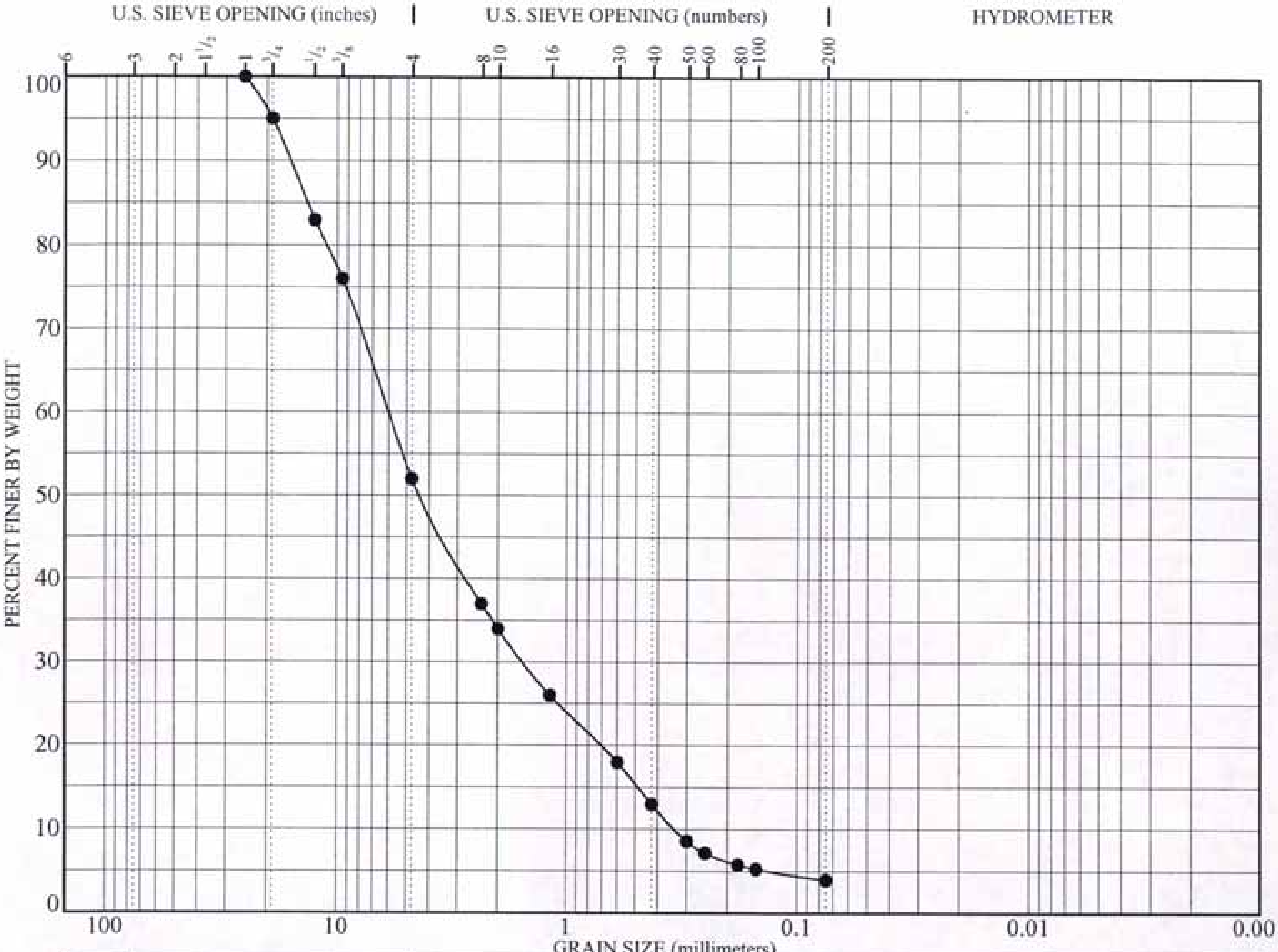
Printed on 2/24/2009

APPENDIX C

ASPHALT LABORATORY TEST REPORTS

Figure 12661.2-H, Particle Size Distribution Analysis Test Report
Figure 12661.2-I, Particle Size Distribution Analysis Test Report
Figure 12661.2-J, Particle Size Distribution Analysis Test Report
TSR Test Results
TSR Test Sample Photographs

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%) coarse	GRAVEL (%) fine	SAND (%) coarse	SAND (%) medium	SAND (%) fine	SILT AND CLAY (%)
●	0.0	48.3		47.7			4.0

Sieve Size	Percent Finer ●		
1-inch	100		
3/4-inch	95		
1/2-inch	83		
3/8-inch	76		
#4	52		
#8	37		
#10	34		
#16	26		
#30	18		
#40	13		
#50	8.6		

Sieve Size	Percent Finer ●		
#60	7.2		
#80	5.8		
#100	5.3		
#200	4.0		

	Grain Size (mm) D_{60}	Grain Size (mm) D_{30}	Grain Size (mm) D_{10}	Coefficients C_c	Coefficients C_u
●	6.00	1.55	0.334	1.19	17.9

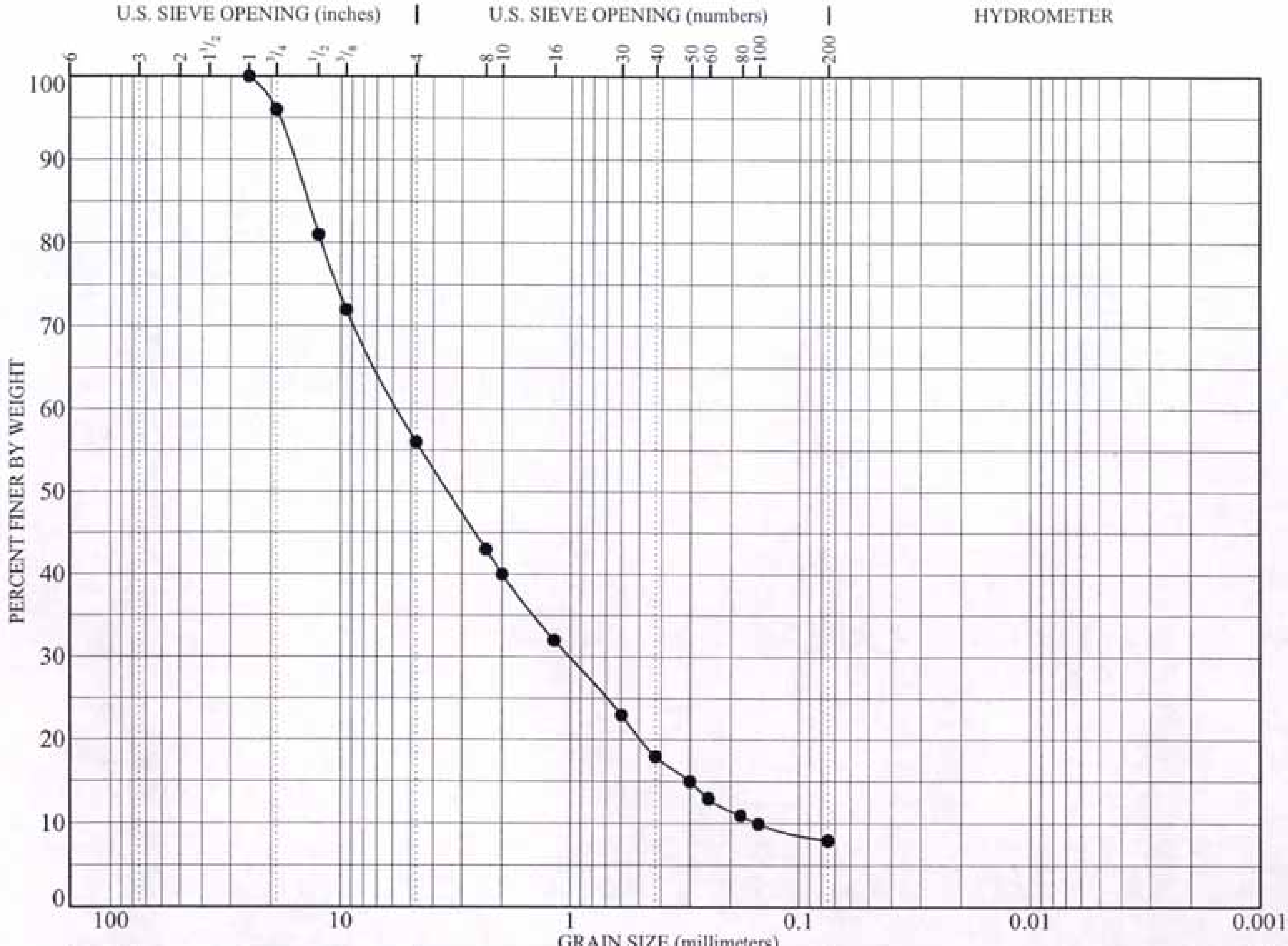
	Sample Information
●	**Asphalt Core Boring 1: Fine Gravel, much sand and trace silt (GW)**

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE 12801-H

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%) coarse	GRAVEL (%) fine	SAND (%) coarse	SAND (%) medium	SAND (%) fine	SILT AND CLAY (%)
●	0.0	44.1		47.9			8.0

Sieve Size	Percent Finer ●		
1-inch	100		
3/4-inch	96		
1/2-inch	81		
3/8-inch	72		
#4	56		
#8	43		
#10	40		
#16	32		
#30	23		
#40	18		
#50	15		

Sieve Size	Percent Finer ●		
#60	13		
#80	11		
#100	10		
#200	8.0		

	Grain Size (mm) D_{60}	D_{30}	D_{10}	Coefficients C_c	C_u
●	5.67	1.03	0.131	1.43	43.4

	Sample Information
●	**Asphalt Core Boring 4: Fine to Coarse Sand With Silt, much gravel (SW-SM)**

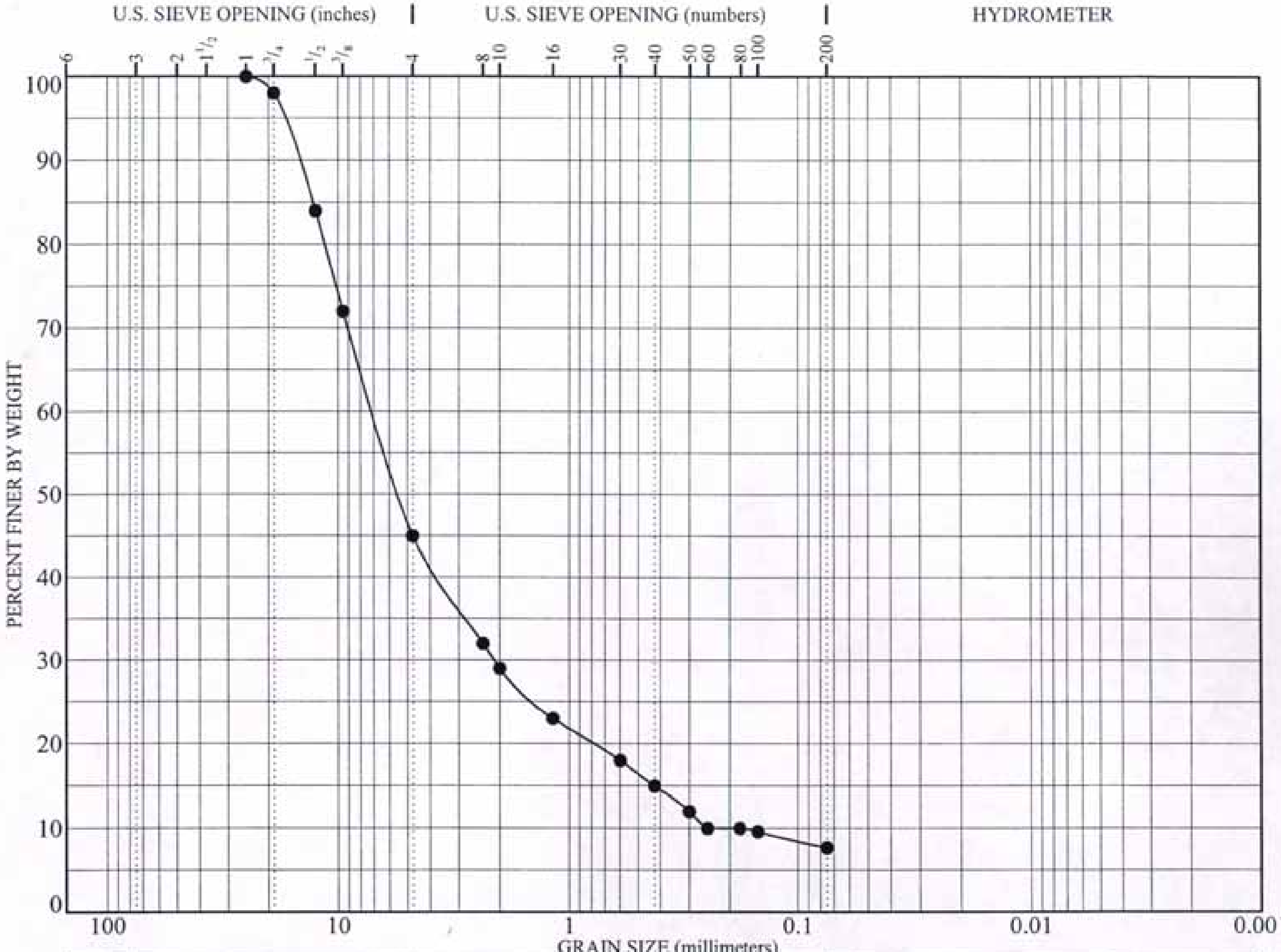
Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE
12801-I

Printed on 2/24/2009

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%)		SAND (%)			SILT AND CLAY (%)
		coarse	fine	coarse	medium	fine	
●	0.0	54.5		37.8			7.7

Sieve Size	Percent Finer ●		
1-inch	100		
3/4-inch	98		
1/2-inch	84		
3/8-inch	72		
#4	45		
#8	32		
#10	29		
#16	23		
#30	18		
#40	15		
#50	12		

Sieve Size	Percent Finer ●		
#60	10		
#80	10		
#100	9.6		
#200	7.7		

	Grain Size (mm)			Coefficients	
	D_{60}	D_{30}	D_{10}	C_c	C_u
●	6.98	2.11	0.177	3.60	39.5

	Sample Information
●	Asphalt Core Boring 6: Fine Gravel With Silt, much sand (GP-GM)

Soils & Engineering Services, Inc.

1102 STEWART STREET • MADISON, WISCONSIN 53713-4648
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws

CONSULTING CIVIL ENGINEERS SINCE 1966

LABORATORY TEST RESULT RECORD
Runways 1L - 19R & 7R - 25L
Intersection Pavement Study
General Mitchell International Airport
Milwaukee County, Wisconsin

FIGURE
12801-J

Printed on 2/24/2009

Tensile Strength Ratio Calculation and Input Page

Project Information	
Project Name	mitchell airport
Design AC (%)	
AC Type	
Gyratory Ht. (mm)	95
Antistrip	No

Rice Specific Gravity	
Wt. Flask and Mix	
Wt. Flask	
Wt. Flask and Water	
Wt. Flask, Water, & Mix	

G_{mm}
2.603

TSR Data	Wet				Dry			
Specimen #	1-a	3-a	7-a		1-b	3-b	7-b	
Diameter (mm)	150	150	150	150	150	150	150	150
Height (mm)	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
Air Wt. (g)	4501.1	4504.1	4280.9		4255.8	4123.4	4451.3	
Submerged Wt. (g)	2672.9	2653.7	2518.8		2428	2328.2	2567.1	
SSD Wt. (g)	4501	4504	4280.8		4255.6	4123.2	4451.1	
Bulk Specific Gravity (G_{mb})								
G_{mb}	2.462	2.434	2.430		2.329	2.297	2.363	
V_a	5.4	6.5	6.7		10.5	11.7	9.2	

Initial Conditioning				
Time (sec)	15	15	15	15
Pressure (mmHg)	500	500	500	500
Submerged Wt. (g)	2697.8	2742	2586	
SSD Wt. (g)	4520.4	4575.6	4337.4	
Initial Degree of Saturation				
G_{mb}	2.470	2.456	2.444	
Abs. Water Vol.	19.3	71.5	56.5	
Saturation (%)	**19.5**	**59.6**	**48.1**	
Swell (%)	-0.301	-0.903	-0.602	

Final Conditioning								
Submerged Wt. (g)	2711.4	2744.5	2593.7					
SSD Wt. (g)	4526	4587.2	4348.8					
Load (lbs)	2000	1310	1410		1810	1400	2100	
TSR Results								
G_{mb}	2.480	2.444	2.439					
Abs. Water Vol.	24.9	83.1	67.9					
Saturation (%)	25.2	69.3	57.8					
Swell (%)	-0.738	-0.411	-0.392					
Strength (kPa)	399.6	261.7	281.7		361.6	279.7	419.5	
Avg Strength	314.3				353.6			

TSR
88.9

Specimen Inspection								
Moisture Damage								
Broken Aggregate								

Tensile Strength Ratio Calculation and Input Page

Project Information	
Project Name	mitchell airport
Design AC (%)	
AC Type	
Gyratory Ht. (mm)	95
Antistrip	No

Rice Specific Gravity	
Wt. Flask and Mix	
Wt. Flask	
Wt. Flask and Water	
Wt. Flask, Water, & Mix	

G_{mm}

TSR Data								
	Wet				Dry			
Specimen #								
Diameter (mm)	150	150	150	150	150	150	150	150
Height (mm)	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
Air Wt. (g)								
Submerged Wt. (g)								
SSD Wt. (g)								
Bulk Specific Gravity (G_{mb})								
G_{mb}								
V_a								

Initial Conditioning				
Time (sec)	15	15	15	15
Pressure (mmHg)	500	500	500	500
Submerged Wt. (g)				
SSD Wt. (g)				
Initial Degree of Saturation				
G_{mb}				
Abs. Water Vol.				
Saturation (%)				
Swell (%)				

Final Conditioning								
Submerged Wt. (g)								
SSD Wt. (g)								
Load (lbs)								
TSR Results								
G_{mb}								
Abs. Water Vol.								
Saturation (%)								
Swell (%)								
Strength (kPa)								
Avg Strength								

TSR

Specimen Inspection								
Moisture Damage								
Broken Aggregate								

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 1 TSR Sample

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 3 TSR Sample

General Mitchell International Airport
Runway Intersection Pavement Study
Milwaukee, Wisconsin
SES Project No. 12801

BORING 7 TSR Sample

Appendix B

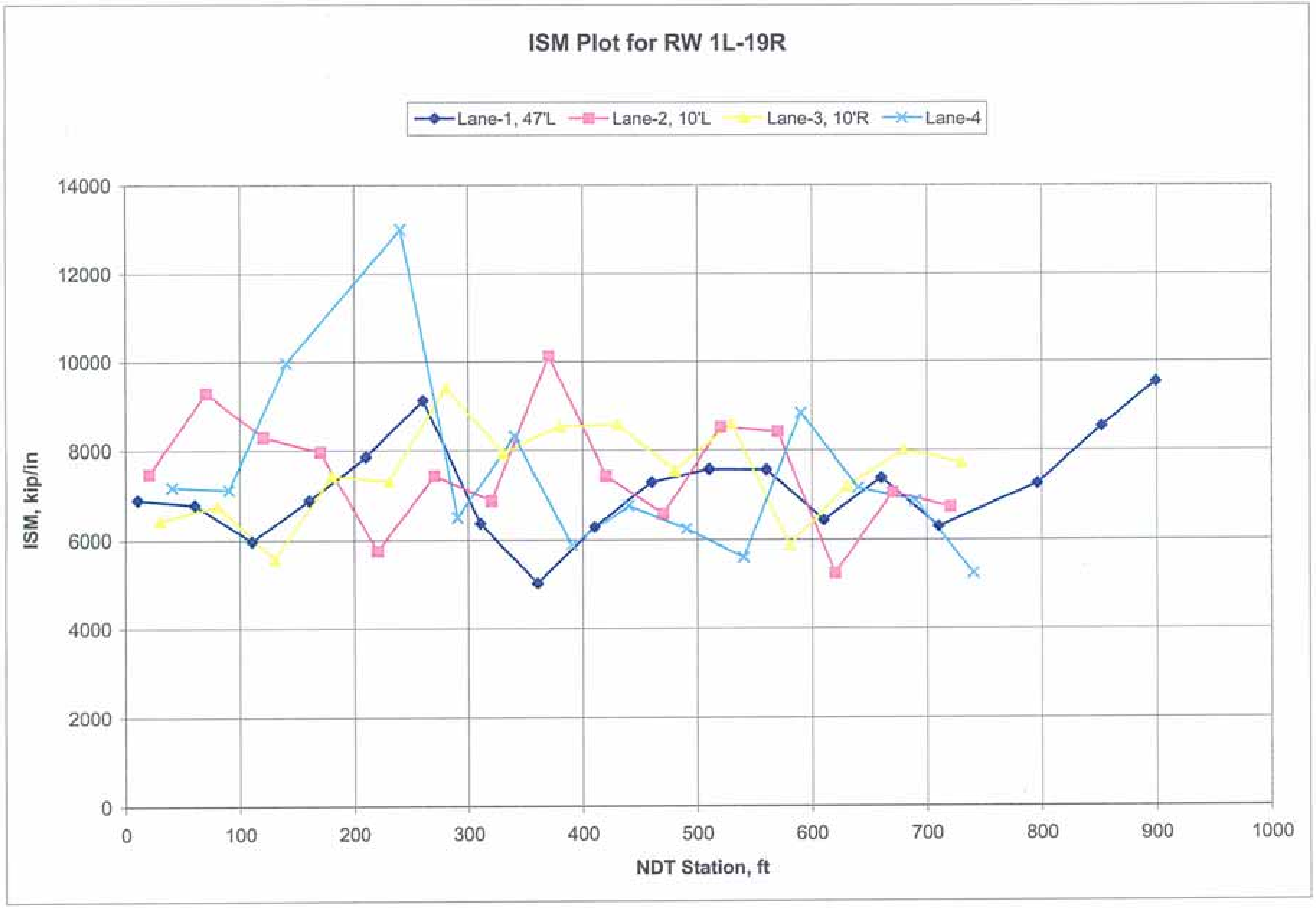
Non-Destructive Test Data

Milawukee, Wi
NDT Field Data

Runway 1-19

Air Temp 8F

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	Displacement Sensors (mils) d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (kip/in	Remarks
5	1	10	47	30	4.35	3.67	3.48	3.27	3.01	2.75	2.62	-6	6904	acc
6	1	60	47	30	4.42	3.86	3.62	3.18	2.82	2.36	2.29	-6	6789	acc
7	1	110	47	30	5.02	4.60	4.39	3.42	2.93	2.60	2.55	-6	5974	ac
8	1	160	47	30	4.36	3.15	2.91	2.79	2.56	2.30	2.29	-6	6885	ac
9	1	210	47	30	3.82	3.27	3.05	2.75	2.49	2.19	2.00	-6	7859	ac
10	1	260	47	30	3.29	2.86	2.72	2.51	2.23	1.79	1.76	-6	9113	ac
11	1	310	47	30	4.71	2.88	2.77	2.36	2.09	1.86	1.43	-6	6368	ac
12	1	360	47	30	5.98	4.30	4.04	3.24	2.75	2.33	2.22	-6	5020	ac
13	1	410	47	30	4.77	4.21	3.86	3.41	2.86	2.41	2.40	-6	6283	ac
14	1	460	47	30	4.11	3.44	3.23	3.13	2.64	2.35	2.19	-6	7292	ac
15	1	510	47	30	3.96	3.16	2.94	2.64	2.23	2.11	2.02	-6	7580	ac
16	1	560	47	30	3.96	2.89	2.83	2.43	2.16	1.91	1.89	-6	7567	ac
17	1	610	47	30	4.66	2.86	2.55	2.37	2.09	1.96	1.77	-6	6433	ac
18	1	660	47	30	4.06	3.64	3.40	2.96	2.53	2.32	2.29	-6	7381	ac
19	1	710	47	30	4.77	2.78	2.75	2.41	2.18	2.00	1.98	-6	6291	ac
20	1	796	47	30	4.13	2.85	2.79	2.51	2.31	2.03	2.06	-6	7256	pcc
21	1	852	47	30	3.52	2.99	2.90	2.53	2.28	2.01	1.90	-6	8516	pcc
22	1	899	47	30	3.15	2.71	2.46	2.33	2.23	1.94	1.81	-6	9523	pcc
1	2		10	30	3.25	2.79	2.67	2.41	2.21	2.03	2.12	-9	9235	pcc
2	2	20	10	30	4.01	3.35	3.20	2.85	2.52	2.12	2.11	-9	7490	ac
3	2	70	10	30	3.23	2.65	2.84	2.43	2.31	2.11	1.93	-9	9282	ac
4	2	120	10	30	3.62	3.04	2.76	2.52	2.27	2.05	2.01	-9	8291	ac
5	2	170	10	30	3.77	3.34	3.12	2.69	2.42	2.31	2.20	-9	7968	ac
6	2	220	10	30	5.22	3.08	2.93	2.56	2.29	2.12	1.96	-9	5751	ac
7	2	270	10	30	4.03	4.00	3.50	3.08	2.54	2.15	1.93	-9	7447	ac
8	2	320	10	30	4.36	3.97	3.65	3.13	2.75	2.34	2.24	-9	6881	int
9	2	370	10	30	2.96	2.36	2.05	1.93	1.85	1.57	1.47	-9	10119	int
10	2	420	10	30	4.04	3.49	3.05	2.46	2.13	1.88	1.68	-9	7434	int
11	2	470	10	30	4.56	3.83	3.78	3.22	2.81	2.58	2.52	-9	6584	int
12	2	520	10	30	3.53	3.00	2.74	2.47	2.30	2.11	1.94	-9	8509	ac
13	2	570	10	30	3.57	3.15	2.71	2.65	2.46	2.21	2.09	-9	8401	ac
14	2	620	10	30	5.73	3.45	3.24	3.04	2.73	2.63	2.60	-9	5236	ac
15	2	670	10	30	4.25	3.81	3.49	2.99	2.66	2.37	1.43	-9	7055	ac
16	2	720	10	30	4.46	3.79	3.53	3.10	2.76	2.45	2.39	-9	6730	ac
1	3	30	10	30	4.67	3.92	3.58	3.29	3.03	2.42	2.77	-9	6423	ac
2	3	80	10	30	4.43	4.06	3.63	3.21	2.76	2.36	2.25	-9	6768	ac
3	3	130	10	30	5.39	3.95	3.50	3.02	2.66	2.44	2.33	-9	5564	ac
4	3	180	10	30	4.03	3.65	3.62	3.10	2.72	2.45	2.19	-9	7437	ac
5	3	230	10	30	4.10	3.49	3.37	2.85	2.47	2.17	1.94	-9	7311	ac
6	3	280	10	30	3.20	2.83	2.68	2.28	2.03	1.93	1.82	-9	9379	ac
7	3	330	10	30	3.78	3.18	2.93	2.84	2.47	2.17	1.92	-9	7935	int
8	3	380	10	30	3.52	2.78	2.56	2.43	2.24	1.95	1.82	-9	8519	int
9	3	430	10	30	3.51	2.86	2.69	2.55	2.42	2.09	2.03	-9	8558	int
10	3	480	10	30	3.98	3.22	3.10	2.58	2.44	2.16	2.10	-9	7547	ac
11	3	530	10	30	3.50	2.89	2.71	2.51	2.31	2.12	2.10	-9	8580	ac
12	3	580	10	30	5.11	3.32	2.99	2.65	2.34	2.06	2.00	-9	5869	ac
13	3	630	10	30	4.18	3.90	3.68	3.20	2.80	2.43	2.38	-9	7181	ac
14	3	680	10	30	3.76	3.32	3.24	2.75	2.41	2.11	2.05	-9	7987	ac
15	3	730	10	30	3.89	3.28	3.13	2.62	2.30	2.05	1.98	-9	7704	ac
1	4	40	47	30	4.17	3.74	3.48	3.22	2.65	2.47	2.36	-9	7186	ac
2	4	90	47	30	4.21	3.55	3.45	2.95	2.68	2.48	2.42	-9	7123	ac
3	4	140	47	30	3.01	2.37	1.95	1.82	1.52	1.40	1.22	-9	9961	ac
4	4	190	47	30	2.57	1.48	1.44	1.25	1.04	1.01	0.74	-9	11691	ac
5	4	240	47	30	2.31	1.99	1.91	1.64	1.59	1.26	1.18	-9	12996	ac
6	4	290	47	30	4.61	4.15	3.82	3.41	2.71	2.45	2.39	-9	6503	ac
7	4	340	47	30	3.61	2.97	2.81	2.66	2.44	2.32	2.11	-9	8302	int
8	4	390	47	30	5.10	3.97	3.81	3.37	2.93	2.60	2.52	-9	5883	int
9	4	440	47	30	4.44	3.92	3.68	3.23	2.95	2.67	2.60	-9	6752	int
10	4	490	47	30	4.81	3.93	3.64	3.23	2.73	2.69	2.58	-9	6236	int
11	4	540	47	30	5.36	3.64	3.16	2.74	2.50	2.33	2.31	-9	5593	ac
12	4	590	47	30	3.40	2.99	2.76	2.50	2.41	2.17	2.07	-9	8817	ac
13	4	640	47	30	4.20	3.56	3.36	2.93	2.57	2.50	2.39	-9	7151	ac
14	4	690	47	30	4.37	3.69	3.37	3.11	2.91	2.67	2.61	-9	6861	ac
15	4	740	47	30	5.74	3.71	3.62	3.33	2.97	2.62	2.60	-9	5228	ac

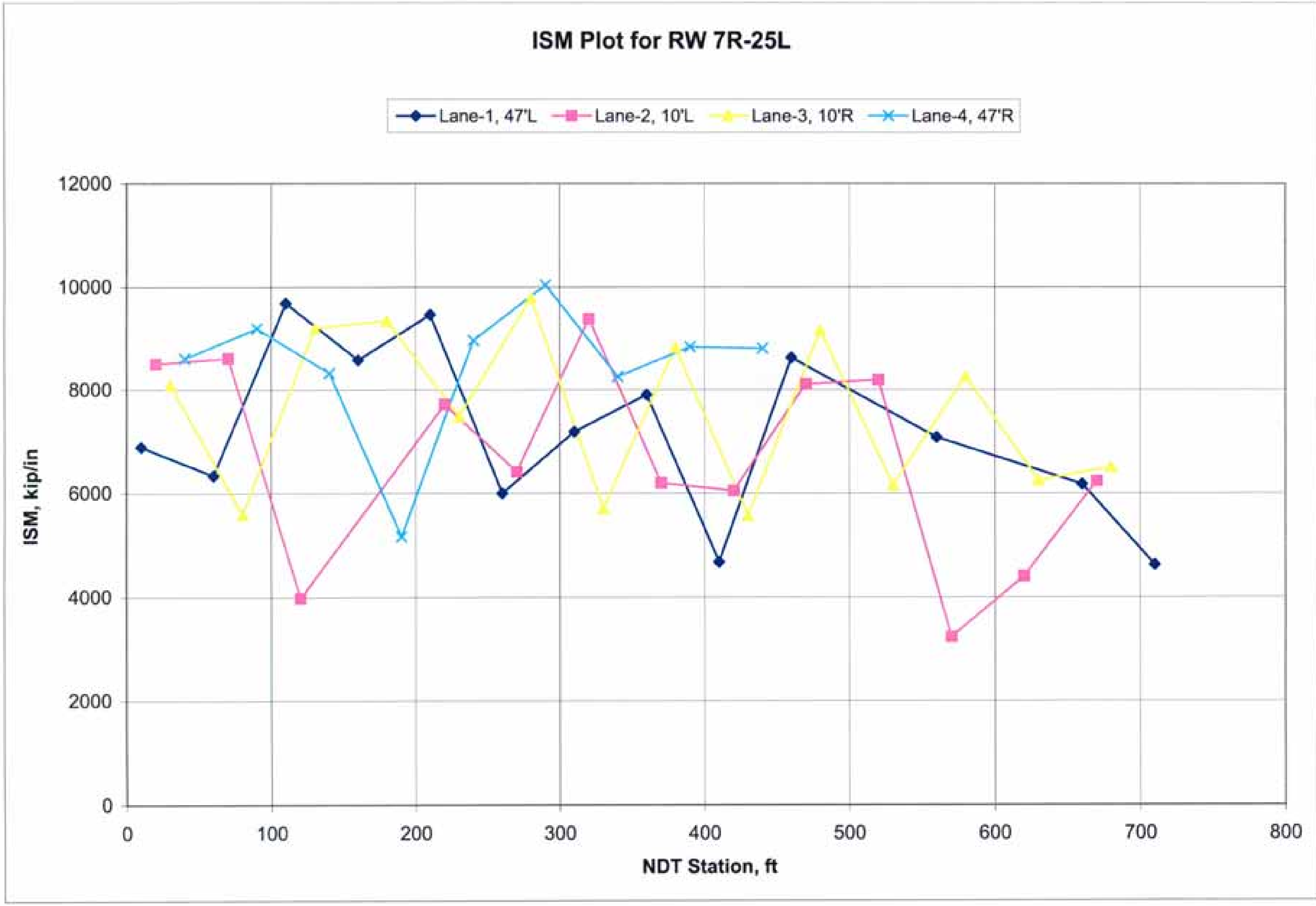

ISM Plot for RW 1L-19R
Lane-1, 47'L
Lane-2, 10'L
Lane-3, 10'R
Lane-4
14000
12000
10000
8000
6000
4000
2000
0
ISM, kip/in
0
100
200
300
400
500
600
700
800
900
1000
NDT Station, ft

Milwaukee, WI
NDT Field Data

Runway 7-25

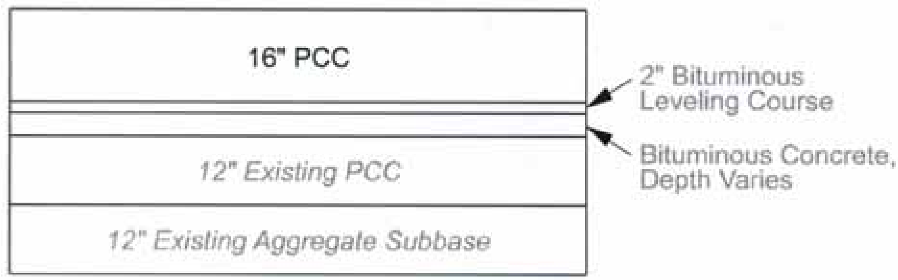
Air Temp 8F

NDT No.	Lane No.	Station (ft)	Offset (ft)	Force (kips)	d1 (0)	d2 (8")	d3 (12")	d4 (24")	d5 (36")	d6 (48")	d7 (60")	Pvmnt Temp (F)	ISM (kip/in)	Remarks
							Displacement Sensors (mils)							
1	1	10	47	30	4.35	3.56	3.21	2.97	2.66	2.36	2.21	-6	6891	ac
2	1	60	47	30	4.73	3.61	3.60	3.04	2.64	2.36	2.22	-6	6340	ac
3	1	110	47	30	3.10	2.68	2.60	2.33	2.13	1.97	1.64	-6	9683	ac
4	1	160	47	30	3.50	2.81	2.66	2.41	2.17	2.00	1.86	-6	8582	ac
5	1	210	47	30	3.17	3.12	2.79	2.57	2.34	2.19	2.09	-6	9464	ac
6	1	260	47	30	5.00	3.92	3.77	3.24	2.90	2.59	1.96	-6	6004	ac
7	1	310	47	30	4.17	3.27	3.00	2.58	2.23	1.94	1.85	-6	7190	int
8	1	360	47	30	3.79	3.45	2.90	2.67	2.35	2.11	1.97	-6	7906	int
9	1	410	47	30	6.41	3.71	3.40	3.07	2.68	2.41	2.24	-6	4681	int
10	1	460	47	30	3.48	2.69	2.55	2.19	2.07	1.84	1.72	-6	8628	int
12	1	560	47	30	4.24	3.75	3.66	3.26	2.87	2.54	2.52	-6	7083	ac
14	1	660	47	30	4.86	3.84	3.61	3.28	2.90	2.64	2.48	-6	6178	ac
15	1	710	47	30	6.49	5.90	4.97	4.12	3.38	2.72	2.65	-6	4622	ac
1	2	20	10	30	3.53	3.37	3.11	2.83	2.51	2.17	2.14	-6	8505	ac
2	2	70	10	30	3.48	2.98	2.87	2.50	2.26	2.05	1.88	-6	8609	ac
3	2	120	10	30	7.54	6.05	5.71	4.84	3.99	3.53	3.41	-6	3981	ac
5	2	220	10	30	3.89	3.75	3.46	3.10	2.78	2.51	2.36	-6	7716	ac
6	2	270	10	30	4.67	3.78	3.33	2.97	2.59	2.22	2.09	-6	6421	int
7	2	320	10	30	3.20	2.59	2.32	2.17	2.02	1.96	1.88	-6	9385	int
8	2	370	10	30	4.83	4.53	4.08	3.49	3.01	2.52	2.49	-6	6206	int
9	2	420	10	30	4.96	4.33	3.96	3.52	3.13	2.76	2.67	-6	6054	int
10	2	470	10	30	3.70	3.51	3.22	2.92	2.59	2.36	2.30	-6	8112	ac
11	2	520	10	30	3.66	3.28	3.13	2.92	2.68	2.54	2.49	-6	8197	ac
12	2	570	10	30	9.26	6.29	5.72	4.78	3.95	3.25	3.11	-6	3240	ac
13	2	620	10	30	6.81	4.74	4.57	4.31	4.00	3.88	3.81	-6	4405	ac
14	2	670	10	30	4.81	4.77	4.69	4.43	4.18	3.67	3.37	-6	6239	ac
1	3	30	10	30	3.71	3.50	3.27	3.00	2.65	2.39	2.32	-6	8095	ac
2	3	80	10	30	5.37	4.93	4.88	3.91	3.44	2.83	2.62	-6	5585	ac
3	3	130	10	30	3.26	2.93	2.72	2.46	2.28	2.08	1.83	-6	9196	ac
4	3	180	10	30	3.21	2.66	2.46	2.35	2.08	1.85	1.83	-6	9346	ac
5	3	230	10	30	4.00	2.69	2.39	2.32	2.10	1.94	1.60	-6	7491	ac
6	3	280	10	30	3.06	2.99	2.73	2.49	2.17	1.91	1.84	-6	9788	int
7	3	330	10	30	5.25	2.94	2.71	2.33	2.04	1.73	1.71	-6	5709	int
8	3	380	10	30	3.40	2.77	2.54	2.29	2.24	2.01	1.87	-6	8830	int
9	3	430	10	30	5.38	4.82	4.15	3.51	3.04	2.58	2.39	-6	5572	int
10	3	480	10	30	3.27	2.90	2.78	2.75	2.43	2.11	2.04	-6	9163	ac
11	3	530	10	30	4.87	3.10	2.91	2.60	2.33	2.11	1.88	-6	6166	ac
12	3	580	10	30	3.63	3.44	3.25	3.07	2.81	2.68	2.47	-6	8259	ac
13	3	630	10	30	4.80	4.15	3.47	3.53	3.13	2.91	2.81	-6	6254	ac
14	3	680	10	30	4.61	4.29	4.09	3.73	3.31	3.13	2.98	-6	6505	ac
1	4	40	47	30	3.48	3.00	3.07	2.54	2.25	2.03	1.98	-6	8610	ac
2	4	90	47	30	3.26	2.80	2.69	2.41	2.15	1.99	1.98	-6	9192	ac
3	4	140	47	30	3.60	2.84	2.76	2.76	2.33	2.13	2.07	-6	8325	ac
4	4	190	47	30	5.81	4.09	3.92	3.23	2.71	2.35	2.28	-6	5166	ac
5	4	240	47	30	3.35	2.39	2.26	2.11	1.96	1.74	1.72	-6	8966	int
6	4	290	47	30	2.99	2.26	2.03	1.95	1.77	1.66	1.54	-6	10040	int
7	4	340	47	30	3.63	3.31	3.00	2.79	2.49	2.17	2.07	-6	8261	int
8	4	390	47	30	3.39	2.75	2.58	2.34	2.13	1.92	1.81	-6	8839	int
9	4	440	47	30	3.41	2.75	2.56	2.43	2.12	1.93	1.87	-6	8810	int

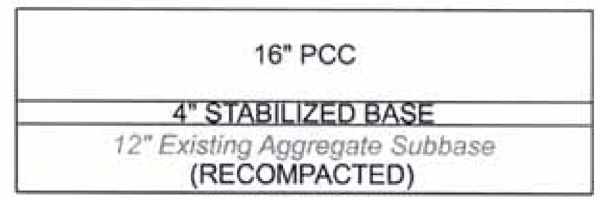

ISM Plot for RW 7R-25L
Lane-1, 47'L
Lane-2, 10'L
Lane-3, 10'R
Lane-4, 47'R
ISM, kip/in
NDT Station, ft
12000
10000
8000
6000
4000
2000
0
0
100
200
300
400
500
600
700
800

Appendix C

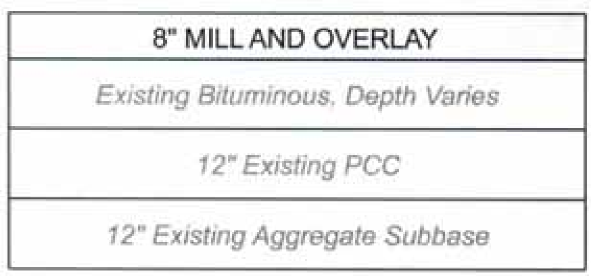
Typical Sections, Profiles & Existing Grading



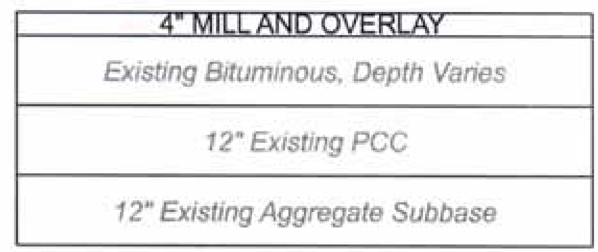
RIGID PAVEMENT



RIGID PAVEMENT, OUTSIDE RSA WHERE EXISTING ASPHALT IS LESS THEN 16"



8" MILL AND OVERLAY



4" MILL & OVERLAY

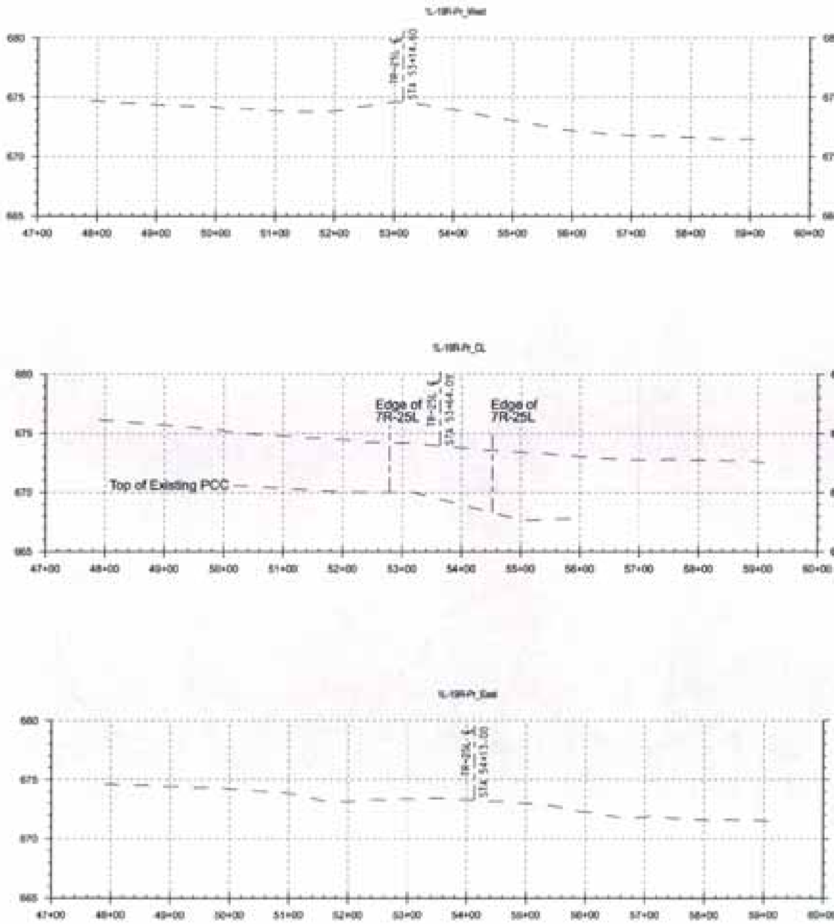
General Mitchell International Airport

APPENDIX C

Typical Sections

Baker

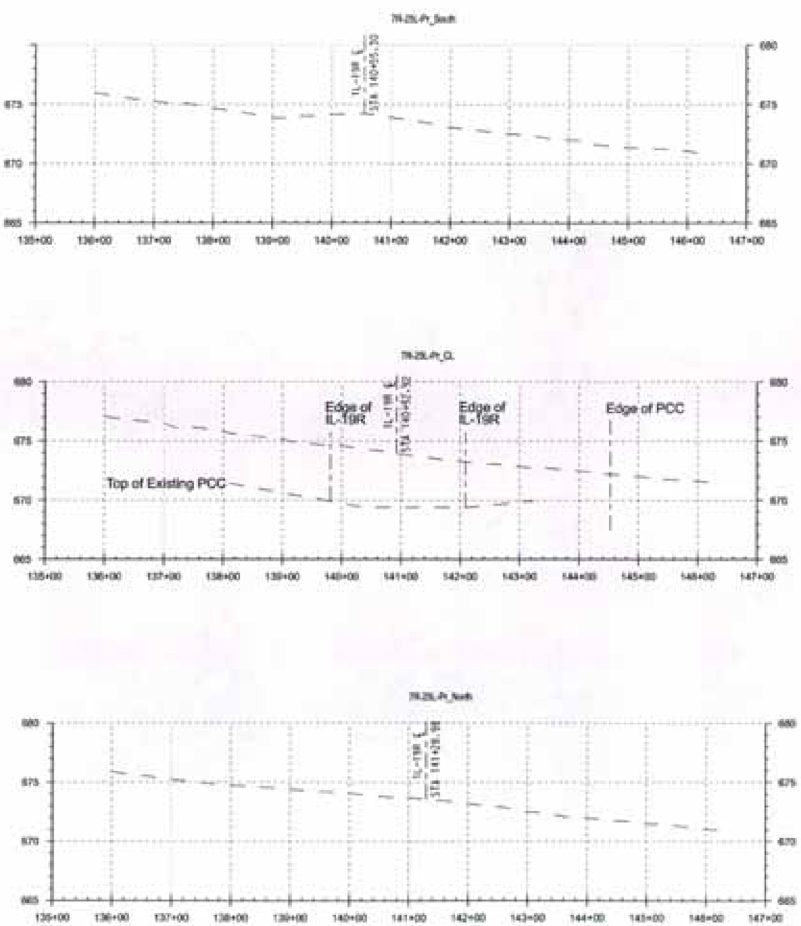
Not to Scale



General Mitchell International Airport

APPENDIX C

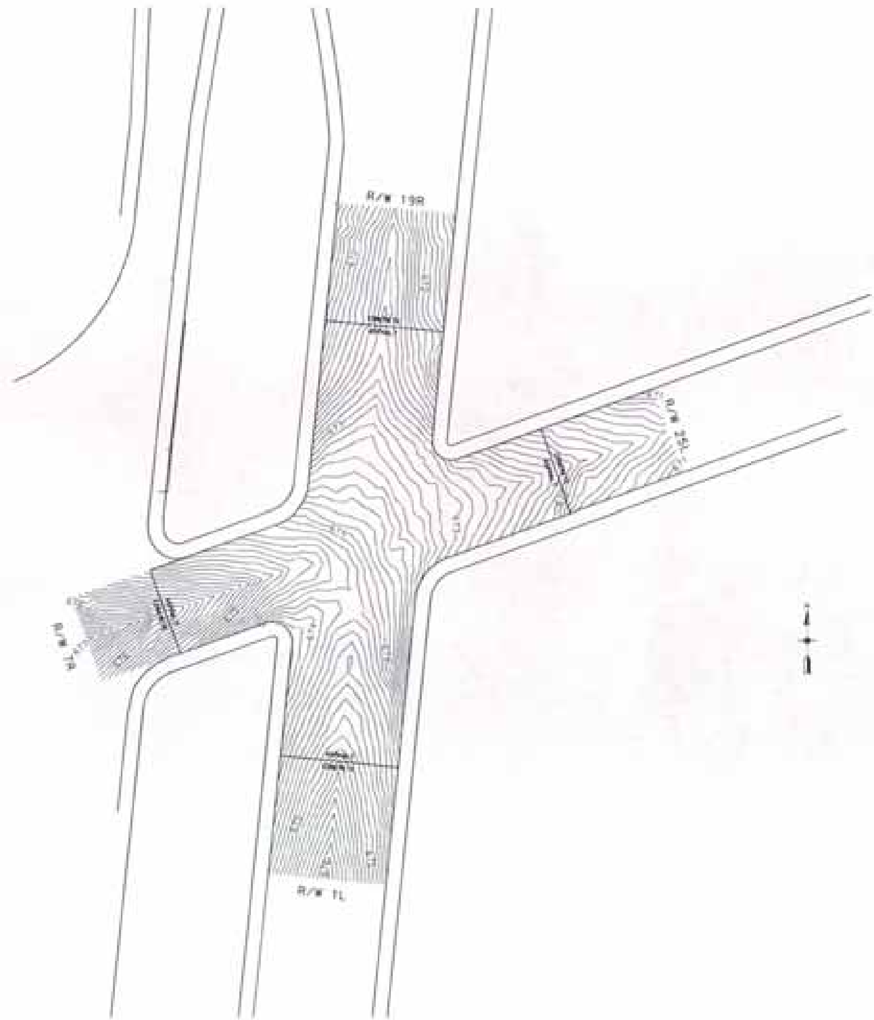
Runway 1L-19R Profiles



General Mitchell International Airport

APPENDIX C

Runway 7R-25L Profiles



General Mitchell International Airport

APPENDIX C

MKE Intersection Grading

0 50 100 150
Scale in Feet

Appendix D

Engineer's Opinion of Probable Construction Costs

Engineer's Opinion of Probable Construction Costs Summary

Runways 1L-19R and 7R-25L Intersection Pavement Study		
OPTION 1	Rehabilitation with PCC	$7,400,781.00
OPTION 2	Rehabilitation with 8-inch Mill and Overlay	$5,020,101.00
OPTION 3	Rehabilitation with 4-inch Mill and Overlay	$4,170,501.00
OPTION 4	Rehabilitation with PCC in Keel and 4-inch Mill and Overlay	$5,758,614.00

General Mitchell International Airport
Runways 1L-19R and 7R-25L Intersection Pavement Study
Engineer's Opinion of Probable Construction Costs
Concrete Option

INSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	12,250	$	150.00	$	1,837,500.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	1,500	$	120.00	$	180,000.00
Bituminous Concrete Wearing Course, 4-inch Depth	TON	160	$	160.00	$	25,600.00
Crushed Aggregate Base Course, 8-inch Depth	SY	700	$	13.00	$	9,100.00
Subbase Course, Variable Depth	CY	160	$	50.00	$	8,000.00
On-site Test Strips - Concrete	LS	1	$	500,000.00	$	500,000.00
Welded Wire Fabric Reinforcement	SY	750	$	9.00	$	6,750.00
Concrete Saw-cut Grooving	SY	12,250	$	5.25	$	64,312.50
Pavement Markings, White, With Glass Beads	SF	4,700	$	2.00	$	9,400.00
Pavement Markings, Black, Without Glass Beads	SF	1,600	$	1.50	$	2,400.00
Milling of Bituminous Pavement, 13 to 18-inch Depth	SY	12,250	$	32.00	$	392,000.00
Milling of Concrete Pavement, 5 inches or less	SY	6,125	$	10.00	$	61,250.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	1,400	$	2.00	$	2,800.00
Bare Counterpoise Cable with Duct	LF	1,400	$	2.00	$	2,800.00
Existing Cable Removal	LF	1,400	$	1.00	$	1,400.00
1-2" PVC Duct in Pavement (Encased)	LF	1,000	$	20.00	$	20,000.00
Remove and Salvage Inpavement Light	EA	12	$	150.00	$	1,800.00
Remove and Re-Install Light Base	EA	12	$	5,000.00	$	60,000.00
Re-Install Inpavement Light	EA	12	$	500.00	$	6,000.00
			SUBTOTAL INSIDE RSA		$	3,191,112.50

OUTSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	12,500	$	120.00	$	1,500,000.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	1,500	$	90.00	$	135,000.00
Bituminous Concrete Wearing Course, 4-inch Depth	TON	175	$	90.00	$	15,750.00
Crushed Aggregate Base Course, 8-inch Depth	SY	760	$	13.00	$	9,880.00
Subbase Course, Variable Depth	CY	170	$	50.00	$	8,500.00
Welded Wire Fabric Reinforcement	SY	750	$	9.00	$	6,750.00
Concrete Saw-cut Grooving	SY	12,500	$	4.75	$	59,375.00
Pavement Markings, Yellow, With Glass Beads	SF	2,100	$	2.00	$	4,200.00
Pavement Markings, White, With Glass Beads	SF	4,200	$	2.00	$	8,400.00
Pavement Markings, Black, Without Glass Beads	SF	5,000	$	1.50	$	7,500.00
Milling of Bituminous Pavement, 6 to 13-inch Depth	SY	12,500	$	22.00	$	275,000.00
Milling of Concrete Pavement, 6 inches or less	SY	6,250	$	12.00	$	75,000.00
Portland Cement Concrete Pavement Removal, 12-inch Depth	SY	6,250	$	20.00	$	125,000.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	600	$	2.00	$	1,200.00
Bare Counterpoise Cable with Duct	LF	600	$	2.00	$	1,200.00
Existing Cable Removal	LF	600	$	1.00	$	600.00
1-2" PVC Duct in Pavement (Encased)	LF	550	$	20.00	$	11,000.00
Remove and Salvage Inpavement Light	EA	9	$	150.00	$	1,350.00
Remove and Re-Install Light Base	EA	9	$	5,000.00	$	45,000.00
Re-Install Inpavement Light	EA	9	$	500.00	$	4,500.00
			SUBTOTAL OUTSIDE RSA		$	2,295,205.00

GENERAL

Description	Unit	Quantity	Unit Cost		Total Cost	
Mobilization	LS	1	$	404,000.00	$	404,000.00
Project Cleaning	LS	1	$	120,000.00	$	120,000.00
Quality Assurance Testing	LS	1	$	157,000.00	$	157,000.00
			SUBTOTAL		$	6,167,317.50
			Contingency 20%		$	1,233,463.50
			TOTAL		$	7,400,781.00

General Mitchell International Airport
Runways 1L-19R and 7R-25L Intersection Pavement Study
Engineer's Opinion of Probable Construction Costs
8-inch Mill and Overlay

INSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
Bituminous Wearing Course, 3-inch Depth	TON	2,250	$	160.00	$	360,000.00
Bituminous Concrete Base Course, 5-inch Depth	TON	3,700	$	120.00	$	444,000.00
Bituminous Tack Coat	GAL	1,850	$	3.00	$	5,550.00
On-site Test Strips - Bituminous	LS	1	$	250,000.00	$	250,000.00
Crushed Aggregate Base Course, 4-inch Depth	SY	200	$	8.00	$	1,600.00
Bituminous Saw-cut Grooving	SY	12,250	$	4.25	$	52,062.50
Pavement Markings, White, With Glass Beads	SF	4,700	$	2.00	$	9,400.00
Pavement Markings, Black, Without Glass Beads	SF	1,600	$	1.50	$	2,400.00
Milling of Bituminous Pavement, 8-inch Depth	SY	12,250	$	16.00	$	196,000.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	1,400	$	2.00	$	2,800.00
Bare Counterpoise Cable with Duct	LF	1,400	$	2.00	$	2,800.00
Existing Cable Removal	LF	1,400	$	1.00	$	1,400.00
1-2" PVC Duct in Pavement (Encased)	LF	1,000	$	20.00	$	20,000.00
Light Base Adjustment	EA	12	$	200.00	$	2,400.00
Remove and Salvage Inpavement Light	EA	12	$	150.00	$	1,800.00
Re-Install Inpavement Light	EA	12	$	500.00	$	6,000.00
			SUBTOTAL INSIDE RSA		$	1,358,212.50

OUTSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	12,500	$	120.00	$	1,500,000.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	1,500	$	90.00	$	135,000.00
Bituminous Concrete Wearing Course, 4-inch Depth	TON	175	$	90.00	$	15,750.00
Crushed Aggregate Base Course, 8-inch Depth	SY	760	$	13.00	$	9,880.00
Subbase Course, Variable Depth	CY	170	$	50.00	$	8,500.00
Welded Wire Fabric Reinforcement	SY	750	$	9.00	$	6,750.00
Concrete Saw-cut Grooving	SY	12,500	$	4.75	$	59,375.00
Pavement Markings, Yellow, With Glass Beads	SF	2,100	$	2.00	$	4,200.00
Pavement Markings, White, With Glass Beads	SF	4,200	$	2.00	$	8,400.00
Pavement Markings, Black, Without Glass Beads	SF	5,000	$	1.50	$	7,500.00
Milling of Bituminous Pavement, 6 to 13-inch Depth	SY	12,500	$	22.00	$	275,000.00
Milling of Concrete Pavement, 6 inches or less	SY	6,250	$	12.00	$	75,000.00
Portland Cement Concrete Pavement Removal, 12-inch Depth	SY	6,250	$	20.00	$	125,000.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	600	$	2.00	$	1,200.00
Bare Counterpoise Cable with Duct	LF	600	$	2.00	$	1,200.00
Existing Cable Removal	LF	600	$	1.00	$	600.00
1-2" PVC Duct in Pavement (Encased)	LF	550	$	20.00	$	11,000.00
Remove and Salvage Inpavement Light	EA	9	$	150.00	$	1,350.00
Remove and Re-Install Light Base	EA	9	$	5,000.00	$	45,000.00
Re-Install Inpavement Light	EA	9	$	500.00	$	4,500.00
			SUBTOTAL OUTSIDE RSA		$	2,295,205.00

GENERAL

Description	Unit	Quantity	Unit Cost		Total Cost	
Mobilization	LS	1	$	274,000.00	$	274,000.00
Project Cleaning	LS	1	$	60,000.00	$	60,000.00
Quality Assurance Testing	LS	1	$	196,000.00	$	196,000.00
			SUBTOTAL		$	4,183,417.50
			Contingency 20%		$	836,683.50
			TOTAL		$	**5,020,101.00**

General Mitchell International Airport
Runways 1L-19R and 7R-25L Intersection Pavement Study
Engineer's Opinion of Probable Construction Costs
4-inch Mill and Overlay

INSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
Bituminous Wearing Course, 4-inch Depth	TON	2,850	$	160.00	$	456,000.00
Bituminous Tack Coat	GAL	1,850	$	3.00	$	5,550.00
On-site Test Strips - Bituminous	LS	1	$	124,000.00	$	124,000.00
Bituminous Saw-cut Grooving	SY	12,250	$	4.25	$	52,062.50
Pavement Markings, White, With Glass Beads	SF	4,700	$	2.00	$	9,400.00
Pavement Markings, Black, Without Glass Beads	SF	1,600	$	1.50	$	2,400.00
Milling of Bituminous Pavement, 4-inch Depth	SY	12,250	$	8.00	$	98,000.00
Remove and Salvage Inpavement Light	EA	12	$	150.00	$	1,800.00
Re-Install Inpavement Light	EA	12	$	500.00	$	6,000.00
			SUBTOTAL INSIDE RSA		$	755,212.50

OUTSIDE RSA

Description	Unit	Quantity	Unit Cost		Total Cost	
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	12,500	$	120.00	$	1,500,000.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	1,500	$	90.00	$	135,000.00
Bituminous Concrete Wearing Course, 4-inch Depth	TON	175	$	90.00	$	15,750.00
Crushed Aggregate Base Course, 8-inch Depth	SY	760	$	13.00	$	9,880.00
Subbase Course, Variable Depth	CY	170	$	50.00	$	8,500.00
Welded Wire Fabric Reinforcement	SY	750	$	9.00	$	6,750.00
Concrete Saw-cut Grooving	SY	12,500	$	4.75	$	59,375.00
Pavement Markings, Yellow, With Glass Beads	SF	2,100	$	2.00	$	4,200.00
Pavement Markings, White, With Glass Beads	SF	4,200	$	2.00	$	8,400.00
Pavement Markings, Black, Without Glass Beads	SF	5,000	$	1.50	$	7,500.00
Milling of Bituminous Pavement, 6 to 13-inch Depth	SY	12,500	$	22.00	$	275,000.00
Milling of Concrete Pavement, 6 inches or less	SY	6,250	$	12.00	$	75,000.00
Portland Cement Concrete Pavement Removal, 12-inch Depth	SY	6,250	$	20.00	$	125,000.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	600	$	2.00	$	1,200.00
Bare Counterpoise Cable with Duct	LF	600	$	2.00	$	1,200.00
Existing Cable Removal	LF	600	$	1.00	$	600.00
1-2" PVC Duct in Pavement (Encased)	LF	550	$	20.00	$	11,000.00
Remove and Salvage Inpavement Light	EA	9	$	150.00	$	1,350.00
Remove and Re-Install Light Base	EA	9	$	5,000.00	$	45,000.00
Re-Install Inpavement Light	EA	9	$	500.00	$	4,500.00
			SUBTOTAL OUTSIDE RSA		$	2,295,205.00

GENERAL

Description	Unit	Quantity	Unit Cost		Total Cost	
Mobilization	LS	1	$	228,000.00	$	228,000.00
Project Cleaning	LS	1	$	30,000.00	$	30,000.00
Quality Assurance Testing	LS	1	$	167,000.00	$	167,000.00
			SUBTOTAL		$	3,475,417.50
			Contingency 20%		$	695,083.50
			TOTAL		**$**	**4,170,501.00**

General Mitchell International Airport
Runways 1L-19R and 7R-25L Intersection Pavement Study
Engineer's Opinion of Probable Construction Costs
PCC in Keel Option

INSIDE RSA

Description	Unit	Quantity	Unit Cost	Total Cost
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	6,225	$ 120.00	$ 747,000.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	720	$ 90.00	$ 64,800.00
Bituminous Wearing Course, 4-inch Depth	TON	1,400	$ 160.00	$ 224,000.00
Bituminous Tack Coat	GAL	905	$ 3.00	$ 2,715.00
On-site Test Strips - Bituminous	LS	1	$ 124,000.00	$ 124,000.00
On-site Test Strips - Concrete	LS	1	$ 500,000.00	$ 500,000.00
Bituminous Saw-cut Grooving	SY	6,025	$ 4.25	$ 25,606.25
Concrete Saw-cut Grooving	SY	6,225	$ 4.75	$ 29,568.75
Pavement Markings, White, With Glass Beads	SF	4,700	$ 2.00	$ 9,400.00
Pavement Markings, Black, Without Glass Beads	SF	1,600	$ 1.50	$ 2,400.00
Milling of Bituminous Pavement, 4-inch Depth	SY	6,025	$ 8.00	$ 48,200.00
Milling of Concrete Pavement, 5 inches or less	SY	3,115	$ 10.00	$ 31,150.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	1,000	$ 2.00	$ 2,000.00
Bare Counterpoise Cable with Duct	LF	1,000	$ 2.00	$ 2,000.00
Existing Cable Removal	LF	1,000	$ 1.00	$ 1,000.00
1-2" PVC Duct in Pavement (Encased)	LF	1,000	$ 20.00	$ 20,000.00
Remove and Salvage Inpavement Light	EA	12	$ 150.00	$ 1,800.00
Remove and Re-Install Light Base	EA	12	$ 5,000.00	$ 60,000.00
Re-Install Inpavement Light	EA	12	$ 500.00	$ 6,000.00
			SUBTOTAL INSIDE RSA	$ 1,901,640.00

OUTSIDE RSA

Description	Unit	Quantity	Unit Cost	Total Cost
HES Portland Cement Concrete Pavement, 16-inch Depth	SY	12,500	$ 120.00	$ 1,500,000.00
Bituminous Concrete Leveling Course, 2-inch Depth	TON	1,500	$ 90.00	$ 135,000.00
Bituminous Concrete Wearing Course, 4-inch Depth	TON	175	$ 90.00	$ 15,750.00
Crushed Aggregate Base Course, 8-inch Depth	SY	760	$ 13.00	$ 9,880.00
Subbase Course, Variable Depth	CY	170	$ 50.00	$ 8,500.00
Welded Wire Fabric Reinforcement	SY	750	$ 9.00	$ 6,750.00
Concrete Saw-cut Grooving	SY	12,500	$ 4.75	$ 59,375.00
Pavement Markings, Yellow, With Glass Beads	SF	2,100	$ 2.00	$ 4,200.00
Pavement Markings, White, With Glass Beads	SF	4,200	$ 2.00	$ 8,400.00
Pavement Markings, Black, Without Glass Beads	SF	5,000	$ 1.50	$ 7,500.00
Milling of Bituminous Pavement, 6 to 13-inch Depth	SY	12,500	$ 22.00	$ 275,000.00
Milling of Concrete Pavement, 6 inches or less	SY	6,250	$ 12.00	$ 75,000.00
Portland Cement Concrete Pavement Removal, 12-inch Depth	SY	6,250	$ 20.00	$ 125,000.00
# 6 AWG 5KV Cable Installed in Duct or Conduit	LF	600	$ 2.00	$ 1,200.00
Bare Counterpoise Cable with Duct	LF	600	$ 2.00	$ 1,200.00
Existing Cable Removal	LF	600	$ 1.00	$ 600.00
1-2" PVC Duct in Pavement (Encased)	LF	550	$ 20.00	$ 11,000.00
Remove and Salvage Inpavement Light	EA	9	$ 150.00	$ 1,350.00
Remove and Re-Install Light Base	EA	9	$ 5,000.00	$ 45,000.00
Re-Install Inpavement Light	EA	9	$ 500.00	$ 4,500.00
			SUBTOTAL OUTSIDE RSA	$ 2,295,205.00

GENERAL

Description	Unit	Quantity	Unit Cost	Total Cost
Mobilization	LS	1	$ 314,000.00	$ 314,000.00
Project Cleaning	LS	1	$ 60,000.00	$ 60,000.00
Quality Assurance Testing	LS	1	$ 228,000.00	$ 228,000.00
			SUBTOTAL	$ 4,798,845.00
			Contingency 20%	$ 959,769.00
			TOTAL	**$ 5,758,614.00**

Table 11.1
LIFE-CYCLE COST ANALYSIS SUMMARY

OPTION	Time to Construct***	Lifetime (years)	Initial Construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
PCC	7	20	$7,400,781.00					$12,000.00					$24,000.00
								Joint Seal PCC					Joint & Crack Seal PCC
8" Mill & Overlay	3	10	$5,020,101.00					$22,500.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,903,453.00
								Crack Seal Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC
4" Mill & Overlay	2	5	$4,170,501.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,013,419.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$1,013,419.00
				Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC
PCC in Keel, 4" Mill & Overlay	5	20 - PCC 7 - Asphalt	$5,758,614.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$512,210.00	$8,500.00	$8,500.00	$8,500.00
				Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.
Current Practice**		1	$0.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00
				Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal

OPTION		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	TOTAL COSTS*
PCC						$24,000.00						$7,484,337.50
						Joint & Crack Seal PCC						
8" Mill & Overlay						$22,500.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$7,869,076.85
						Crack Seal Bit. & Joint Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
4" Mill & Overlay		$17,000.00	$17,000.00	$17,000.00	$17,000.00	$512,210.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$17,000.00	$7,906,748.83
		Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
PCC in Keel, 4" Mill & Overlay		$8,500.00	$8,500.00	$8,500.00	$515,000.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$8,500.00	$7,379,490.59
		Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Replace Bit., Joint & Crack Seal PCC	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	Crack Seal Bit.	
Current Practice**		$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$8,302,945.72
		Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	Patch & Crack Seal	

*Inflation assumed to be 3% per year

**This option is included for comparison only. It is not recommended as a method for rehabilitating the intersection.

***Number of weekends required to construct with at least 36 hours of closure time per weekend