FHWA/LTPP Monitoring Program

Evaluation of Pavement Performance

Forensic Study - Specific Pavement Study (SPS) Sections 360801 and 360802, Lake Ontario State Parkway, Hamlin, NY

Report No. FHWA-TS-09-36-01

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

LONG TERM PAVMENT PERFORMANCE
FORENSIC EVALUATION AND PERFORMANCE
COMPARISONS OF LTPP SECTIONS 360801 AND 360802
LAKE ONTARIO STATE PARKWAY, HAMLIN, NEW YORK

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Executive Summary

A forensic study was conducted in May 2008 on two sections selected from the SPS-8 project on the eastbound lanes of the Lake Ontario State Parkway (LOSP) to evaluate pavement performance and what may have contributed to the differences in performance of these rural pavement sections. They were constructed by the same contractor during the same time period and have the same traffic & environmental conditions.

Based on meetings and a preliminary site review, sections 360801 and 360802 were selected. The primary differences between the selected sections are the thickness of the asphalt and aggregate base, and the subgrade. Section 360801 is a 'thin' pavement (127mm AC, 213mm aggregate base) over silty sand. Section 360802 is a 'thick' pavement section (193mm AC, 310mm aggregate base) over clayey sand. The constructed thickness for both sections was different than the design thickness and was highly variable. Both sections use a conventional AC-15 and AC-20 hot mix for the asphalt base/binder and surface friction layers, respectively. The aggregate base for both sections was a crushed stone with a maximum stone size of 38mm. The sections were constructed without a pavement drainage layer or external drains and relied on the slope of the pavement to drain the pavement to a turf shoulder.

This report primarily used information from the LTPP database including environmental, traffic, construction, materials and monitoring data throughout the life time of the pavement (construction through to forensic investigation).

Mechanistic Empirical Pavement Design Guide (MEPDG) performance characteristics were predicted for the two pavement types. The predicted performance indicated that both sections would not meet the 90% Reliability criteria for a 20-year design term with the exception of thermal cracking. These results varied when compared to an analysis performed using the procedures from the AASHTO Guide for Design of Pavement Structures, 1993. A design life expectancy was greater than 100-years for both sections.

The same pavement surface distress types appear on both sections but to a different magnitude and quantity. A longitudinal crack at the location of the centerline paving joint extends the length of both sections. This crack has expanded over time to include random, alligator and partial transverse cracks, many of which extend to the midlane. The extension and magnitude of cracking is much greater for 360801. Alligator and longitudinal cracks also appear in the wheelpath and midlane of both sections. Consistent with roads having low levels of traffic, the tendency of the cracking tends to be more random. The pavement surface for both sections looked weathered but did not have any significant aggregate loss with 360801 showing slightly more surface deterioration. The high points at the edge and midlane of 360801 had scrape marks from winter maintenance plowing. Pavement rutting occurred in both wheelpaths of each section, but the degree of severity was greater for 360801. The ride quality, based on IRI, had a similar trend where section 360801 would not require any intervention and 360802 is approaching a level that would need corrective action. The elevation survey indicated that

both sections had a pavement and shoulder slope that would be within tolerance, but the turf area that abutted the pavement shoulder was higher than the paved shoulder in many locations. This would impede the drainage of water from the pavement surface.

The examination of cores taken from both sections indicated that all cracking was top-down with some stripping and deterioration evident at the interface of the surface and AC base/binder layers. The cores taken at the longitudinal centerline joint crack for 360801 were full depth cracks whereas all the remaining cracks were partial depth. The AC base from both sections had visible voids in particular at the interface between layers but there were no lack of bonds identified. The interface of the AC bound layers with the aggregate base show minimal, if any, signs of stripping. The tack coat applied to the aggregate surface had bonded the surface stone to the AC base layer in most cases. The surface of 360801 was also substantially weathered.

The analysis of the historical FWD data indicated that there was minimal change in the structural capacity of the sections over time. The analysis also indicates that the thicker section 360802 is structurally more sufficient than 360801. A comparison of the trends in subgrade resilient moduli indicates that both sections have a slight decline in subgrade support. For pavement moduli, section 360802 has had greater pavement strength throughout the testing period. Overall, there is a fairly large scatter in the FWD data which is attributed to the variability within the section lengths and the seasonal effects of Lake Ontario.

The analysis of the materials data did not reveal any results that would significantly affect the performance of these pavements. The post construction laboratory tests showed some difference between the binder and asphalt tests for the AC-15 mix, as the tests were done on materials sourced from two asphalt plants. All asphalt paving materials for 360801 were sourced from one plant while asphalt for 360802 was supplied from two. The Specific Gravity test results from the forensic testing were very similar to the post construction results for the bitumen and asphalt mixes. There was minimal change in air void content for 360801 with a slight decrease identified in the air voids for the asphalt material at 360802. There was also a slight change in the stiffness properties for the surface and binder asphalt.

There was no discernable difference in the construction practice for the two sections evaluated. Delays in the delivery of asphalt could have impacted both sections (more so 360802 as asphalt was sourced from two different plants). For both sections, the aggregate base densities were highly variable. The asphalt surface layer thicknesses were also variable and outside the design specification.

After 13.75 years of service, the requirement for these two sections is similar but for different reasons. Section 360801 is in need of rehabilitative action to restore the surface condition while 360802 is in need of maintenance/rehabilitation to correct wheelpath rutting and ride quality. Improvement to the drainage at the edge of pavement should also be considered.

Long Term Pavement Performance
Forensic Evaluation
Test Sections 360801 and 360802, Hamlin, NY

1.0 Introduction

The FHWA-LTPP program was provided funding through the Focus Area Leadership and Coordination (FALCON) process toward forensic studies on pavement sections exhibiting failure due to construction, traffic and/or environmental circumstances or that is exhibiting unique performance characteristics. Section 360801 and 360802, of the Long Term Pavement Performance Program (LTPP) program Specific Pavement Study (SPS-8) project on the ‘Environmental Effects in the Absence of Heavy Traffic’, were selected to examine the types and causes for pavement failures, on a low volume highway with no commercial vehicles. The SPS-8 sections are located on eastbound Lake Ontario State Parkway (LOSP) approximately 2.9 kilometers West of S.R. 19, 8 kilometers north of Hamlin and 18 kilometers north of Brockport, NY as shown in Figure 1.

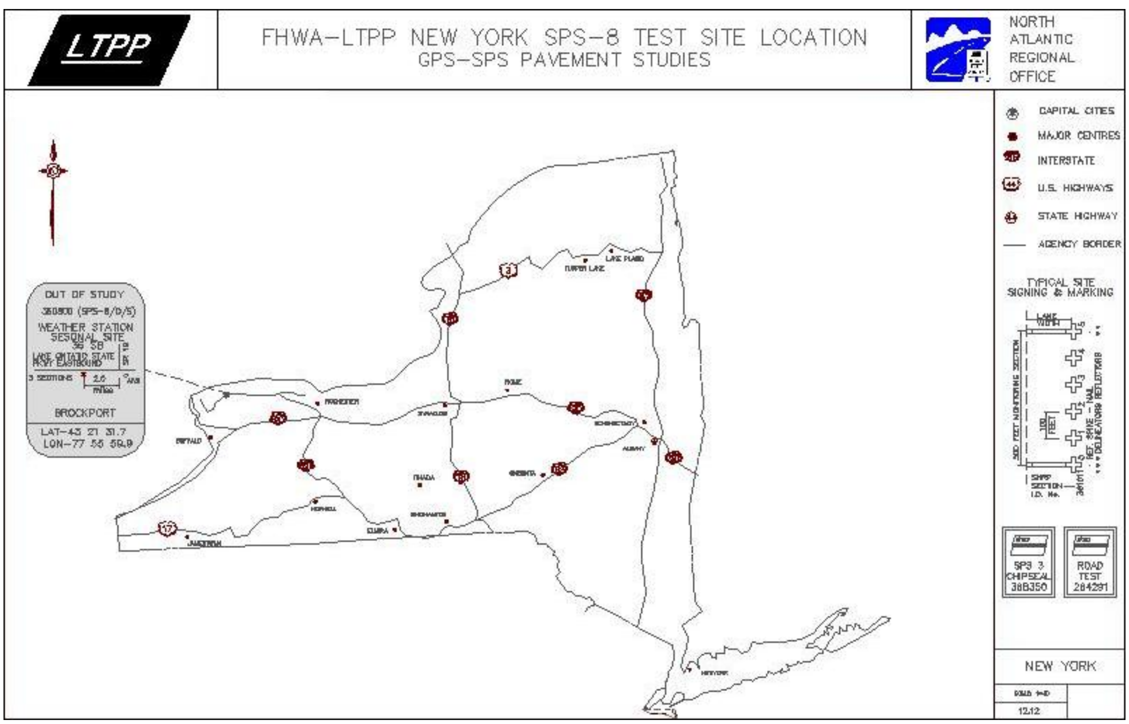

Figure 1: Site Location Map

The reconstruction on Lake Ontario State Parkway, Route 947A and LOSP 49-1, from Yanty Creek to route 260 near the town of Hamlin, NY was awarded under contract D254995 to Keeler Construction Co. Inc. on March 30, 1994. Work started on April 8, 1994 with the removal of the existing pavement structure and subgrade preparation. Construction of the pavement layers was completed in August 1994 after which the eastbound lanes containing the LTPP test sections were opened to traffic. A Weigh-in-

Motion (WIM) System was installed in the fall to monitor traffic weights and volumes. The LOSP is restricted to commercial traffic and its primary use is for recreation and local community access, as the parkway extension to the Buffalo area was not completed as originally planned. An Automated Weather Station (AWS) was installed on November 22, 1995 to monitor environmental conditions which are influenced by the 'lake effect' from Lake Ontario which is within site distance of the roadway. Section 360801 was included in the Seasonal Monitoring Program (SMP) in 1996 with instrumentation installed to monitor temperature, wind speed and direction, precipitation, pavement and soil temperature, freeze/thaw conditions and changes in the water table.

The pavement performance indicators for the two sections selected and evaluated as part of this forensic investigation show similar but different characteristics with more surface distress appearing on 360801 and 360802 having more rutting and roughness. Based on the low volumes and lack of commercial vehicular traffic it would be expected that there would be minimal difference in the performance of these sections although there could be some benefits attributed to the thicker aggregate base and AC surface for 360802.

This investigation is to examine the factors that may have contributed to the differences in performance between SPS-8 sections 360801 and 360802, which were constructed during the same time frame, utilizing the same contractors, exposed to the same environmental conditions and having the same traffic loadings.

Records available for sections 360801 and 360802 include construction, material sampling and laboratory analysis (done at time of construction), Ground Penetrating Radar (GPR), core samples, Falling Weight Deflectometer (FWD), Distress surveys (Manual and Photo), longitudinal and transverse profile, traffic from a continuous monitoring Weigh-in-Motion (WIM), and environmental data from 'at site' seasonal monitoring instrumentation and a weather station installed in the area of the intersection at LOSP and SR-19.

As part of the forensic investigation, 100mm core samples were extracted in areas exhibiting 'no distress' and 'various levels of distress', with 150mm core samples in the mid-lane and outer wheelpath at FWD, Dynamic Cone Penetration (DCP), split-spoon and moisture sample test locations. The 150mm cores were transferred to the state agency laboratory for testing to characterize material properties and effects of wear and aging. Notification was received on September 18, 2008 that a leak at the laboratory had covered the core samples with asbestos contaminated water and the cores had to be disposed of. Replacement 150mm cores were collected on October 7, 2008 and transferred to the state agency laboratory. Cutting of trenches across the width of the pavement was not deemed practical for this project, based on funding limitations and the lack of commercial traffic that would result in compressions and deformations in the surface and supporting soils.

This report documents the available historical information, forensic data collection and sampling, core sample examination, laboratory analysis and results, condition assessments, structural evaluation, findings and conclusions. The information provided far exceeds the needs of a forensic investigation involving pavement performance and failure mechanisms, as the report contains much of the information that is available from the LTPP database for these sections.

2.0 Preparation and Planning

2.1 Planning Meeting

The forensic study planning meeting took place at the Spencerport Residency, 2441 S. Union St., Spencerport, NY on May 13, 2008. This meeting was arranged to provide information on the selection process for the forensic sites, provide an overview of the historical information available for the potential sections, and discuss the roles and responsibilities of the parties involved. Follow-up instructions and arrangements were conducted over the remainder of the week, in particular the arrangement for utility clearances and in-place asphalt density tests, all of which fell in place for the field visit scheduled for May 20-22, 2008. Figures A-1 and A-2, Appendix A provide the minutes of the meeting and the roles and responsibilities respectively.

2.2 Site Investigation Group

The site investigation and forensic study of Section 360801 and 360802 was a cooperative effort between New York State Department of Transportation (NYSDOT), Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Division, and Stantec Consulting Services Inc., FHWA-LTPP North Atlantic Regional Support Contractor (NARSC). The personnel shown in Table 1 participated at the site inspection, materials sampling, data collection, observations and material handling:

Table 1: Site Investigation Group

Name	Agency	Task/Job Title
Rick Morgan	NYSDOT / TR&DB	LTPP Contact/Program Support
Residency Crew	NYSDOT/Spencerport Maintenance	Lane Close/Patching
Paul Peffers	NYSDOT/ Regional Materials	Drilling/Sampling
Don Briggs	NYSDOT/ Regional Materials	Drilling/Sampling
Freddy Gannat	NYSDOT/ Regional Materials	Coring/Sampling
Tom Schuttz	NYSDOT/ Regional Materials	Coring / Sampling
Tung Ngo	NYSDOT/ Materials Bureau	PQI Density Tests
Tony Wagner	Stantec Consulting Services Inc	FWD Operator
Brandt Henderson	Stantec Consulting Services Inc	Field Operations/Supervisor
Gabe Cimini	Stantec Consulting Services Inc	Data/ Data Base Manager
Alfred Lip	Stantec Consulting Services Inc	Data Collection/Engineer
Jesse Dickes	Stantec Consulting Services Inc	Data Collection/Engineer

2.3 Site Assessment and Work Plan

The SPS-8 project on the LOSP is an ideal candidate for the forensic investigation on the FALCON funding as it was close to the Stantec FHWA-LTPP RSC office, and was exhibiting signs of distress and need for maintenance or repair and access and support for the testing and sampling could be accomplished in the early spring of 2008. In conjunction with the manual distress survey, a review of the areas with cracks and no cracks would be conducted for the purpose of selecting those locations for 100mm core samples. The core samples would be used to determine the extent of damage to the asphalt surface layers, including location, width and depth of cracking, areas of visible voids, aggregate deterioration, binder adhesion or lack thereof and sufficiency of bonding between layers. At the completion of the FWD survey (conducted at 7.62-meter intervals), core locations would be selected, based on a review of the deflection results, from both the midlane and outer wheelpath. In the selected location, two 150mm cores (450mm apart station-wise) would be drilled to the bottom of the pavement surface, reducing the water to a trickle for the last 25mm of drilling so as not to contaminate the base material with excess moisture. The 150mm cores would be retained for measurements and laboratory testing. DCP testing was scheduled for the core hole at the FWD location with the split spoon and moisture sampling done in the nearby core hole located 450mm upstream. In addition to the Dipstick® transverse profile survey, rod and level measurements were planned to determine pavement, shoulder and grade cross-fall. Longitudinal profiles were to be collected with the ICC MDR4083 inertial profiler prior to the lane closures and sampling. Numerous photos were scheduled to document the data collection operation and site conditions. On completion of sampling, the 100mm cores would be retained by the NARSC and the 150mm cores would be delivered to the NYSDOT laboratory for testing and analysis.

3.0 Environment and Traffic Loading

The LTPP IMS database provides the following environmental data summarized as the annual average values:

Table 2: Environmental Data

Description	Annual Average
Freezing Index (C-Days)	292
Precipitation (mm)	672
July High Air Temperature (°C)	33.5
January Low Air Temperature (°C)	-15.6
Days Above 32°C	4.9
Days Below 0°C	105.6
Wet Days	123.2
No. of Freeze/Thaw Cycles	70.7
Annual Frost Depth (m)	0.61

The above statistics are based on 13 years of climatic data. Figures B-1 to B-8, Appendix B provides plots summarizing the historical annual and monthly humidity, precipitation, solar radiation and temperature. The summaries have excluded periods when the data was incomplete due to issues with the environmental instrumentation. The summary plots depict the seasonal changes that occur at the test sections located in a wet-freeze zone with a good portion of the year having wet or snowy conditions that include a number of freeze/thaw cycles with minimal frost penetration. The plots would also indicate that some years are much wetter than others although the annual humidity, solar radiation and temperatures are fairly constant.

Figure B-9, Appendix B provides and annual water table elevations from the piezometer installed at station 1+00 of section 360801. Water table data was collected at this location as part of the seasonal monitoring visits as there was no instrumentation installed for continuous monitoring. The results indicate a seasonal change in water table with the majority of samples showing a water table of less than 1-meter from the surface to periods when the water table fell to a depth greater than 2-meters from the surface. The depth to water table at the time of the forensic study was 1.08-meters. The median between the east and west lanes has a culvert that passes under the west bound lanes and drains towards Lake Ontario. The eastbound passing lane has a curb with catch basins draining to the median whereas the driving (slow lane) drains to the shoulder. There were no in-place drainage or permeable pavement layers included in the design or construction of the test sections.

A Weigh-in-Motion (WIM) System was installed in the eastbound driving lane 572m east of the end of the experiment section limits. Although the parkway was restricted to commercial vehicles, it was a requirement for the SPS-8 experiment to weigh and classify all individual single and tandem wheel loads. The majority of vehicles traveling this roadway would be motorcycles, cars and light trucks (Classes 1-3 of the FHWA 13-bin vehicle classification system) with the heavier vehicles being tour buses, motorhomes, towing of recreational equipment (boats and ATVs) and roadway maintenance vehicles (Classes 4, 5, 6, and 8). The WIM (in the driving lane) consists of bending plates placed in the pavement so as to cover the entire 3.66-meter lane width. The WIM equipment was manufactured by International Road Dynamics Inc., Saskatoon, SK. Figure E-1, Appendix E provides a photo of the WIM that was installed to monitor the traffic for the SPS-8 project. The WIM scale has been in operation since October 1995 with a number of down periods. The repair, maintenance and calibration of this WIM has not been a high priority as the early indications were that there was insufficient amounts of commercial traffic to warrant the cost and effort to keep the WIM fully operational. Although minimal weight information has been provided, the monitoring system has provided Average Vehicle Counts (AVC) for the test sections.

The traffic information available from the LTPP database provided the following traffic information for the monitoring lane based on 13 years of estimated (7 calculated by NARSC) and 3 years of monitoring data (only 1 year with a significant amount of data - 8 mo.):

- Annual Average Daily Traffic (AADT) of 1,104 vehicles/day
- Annual Average Daily Truck Volume of 10
- Annualized traffic loading 0 ESALs (Class 9)
- Annual (All Traffic) growth rate of 4.0%

Based on the traffic estimates, there were no Class 9 (18-wheel transport truck) vehicles in the SPS lane from the opening in November 1994 until the time of the forensic investigation in May 2008. This would be consistent with the expectations for this section within the SPS-8 study of the environmental effects of asphalt concrete pavements in the absence of heavy loads. However, WIM/AVC data indicates that a tiny fraction of the truck traffic were Class 9 vehicles.

4.0 Section 360801

4.1 Design and Life Expectancy

Using the design procedure from the 2007 Mechanistic Empirical Pavement Design Guide (MEPDG), the following would be the predicted levels of cracking, rutting and cumulative heavy traffic at 90% reliability for 13.75 years.

- Longitudinal Cracking – 288 meters for 152.4-meter section
- Alligator Cracking – 91.2% bottom up (100% at Reliability)
- AC Thermal Fracture (Transverse Cracking) – 0.02 meters for 152.4-meter section (0.03 meters at Reliability)
- Rut Depth – 25.55mm at Reliability (4.73mm AC, 3.38mm Base, 13.61mm Subgrade, Total 21.72mm)
- IRI – 6.65 m/km (7.94 m/km at Reliability)
- The cumulative heavy loads are 62,319

The 20-year analysis indicated this section would not meet the reliability criteria for the full design term with the exception of thermal cracking. In particular, significant amounts of longitudinal and alligator cracking were predicted in the early life of this thin pavement along with rapid deterioration in ride quality. Figure C-1, Appendix C provides the summary of the input variables for the MEPDG analysis for data extracted from the LTPP database. In instances when data inputs were not available from the LTPP database, default values provided in the MEPDG program were used. The predicted cumulative heavy loads, based on the default values, are higher than the monitored values, but would be typically considered when designing a rural commuter traffic roadway with low commercial content. Refinements to the traffic inputs, by modifying the default values, were considered but would have exceeded the time estimated for generating this report.

The results from the MEPDG analysis are significantly different than those using the procedures from the AASHTO Guide for Design of Pavement Structures, 1993. Based on the material types and thickness, the design Structural Number (SN) was 2.87 with an initial Present Serviceability Rating (PSR) of 3.86. Using the 1994 estimated Equivalent Single Axle Loads (ESAL's) of 1, 483 and a 4% growth rate it would be 256 years before this section would reach a terminal PSR of 2.5.

4.2 Pavement Structure

The Design and as-built thicknesses are provided in Table 3. The as-built layer thickness is outside the specified tolerance of +/- 7mm as required for this project. Some disruption of the aggregate base after final grading and tack coat, delays in delivery of asphalt and adjustments for thickness changes between the sections could have contributed to the thickness variations.

Table 3: Pavement Structure - 360801

Layer	Layer No.	Design Thickness (mm)	As-Built Thickness (mm)	Description
Surface Layer	3	25	30	Dense-Graded, Hot-Laid AC (Hot-Mixed, Hot-Laid Asphalt Concrete, Dense-Graded)
AC Layer Below Surface (AC Base/Binder Layer)	2	76	97	
Aggregate Base Layer	2	203	213	Crushed Gravel (Crushed Stone)
Subgrade	1	-	-	Coarse Grained Soil (Silty Sand)

4.3 Construction

The contract for the reconstruction of the LOSP was advertised on February 24, 1994 and was awarded to Keeler Construction Co. Inc., Albion, NY on March 30, 1994 under NYSDOT engineering contract D254995 with the first stages of work starting on April 8, 1994. The existing pavement was removed followed by preparation and grading of the subgrade. The final grading and compaction of the subgrade was started on July 12 and completed on July 15, 1994. A Cat 14E grader was used for the final grading with a 9-tonne Rascal 400-A single-drum vibrating roller used to compact the subgrade. The placement and compaction of the unbound aggregate base material started on July 28, 1994 and completed on August 9, 1994 using the same equipment previously used for the subgrade preparation. The aggregate base was placed and compacted in one lift based on a design thickness of 203mm. Photos of the prepared subgrade and aggregate base are provided in Figures D-1 to D-3, Appendix D. An RS-1 emulsion was placed on the aggregate base at the completion of fine grading. The construction traffic (trucks, paver and roller) were tracking the emulsion which lifted the aggregate which in turn resulted in disturbance and unevenness of the aggregate base prior to the placement of the asphalt base layer. Figure D-4, Appendix D provides a photo of the finished tack coat prior to access of construction traffic. The placement of the asphalt bound layers began August 10, 1994 with the placement of the asphalt base layer. The AC-15 dense graded hot mix asphalt was placed in one lift with a design thickness of 76mm. Problems at the plant resulted in delays in the delivery of the asphalt but the section limits were completed on August 10, 194 as scheduled. An AC-20 high friction type 7F asphalt surface layer was placed on August 12, 1994 in one lift with a design thickness of 25mm. All asphalt was sourced from the Genesee LeRoy Stone Corporation Batch Plant, Stafford, New York, and transported a distance of 53km (with haul times averaging 60 minutes) to the placement location. The asphalt layers were placed with a Blaw Knox CPF-200 paver at a width of 4.8 meters. Asphalt compaction was accomplished with a Tampo RS-188A model VC80 double-drum vibratory steel wheel roller, which was used for the breakdown, intermediate and finish compaction of all asphalt lifts. Figures D-5 to D-7, Appendix D, provides photos of the paving equipment, asphalt placement, compaction and material sampling. A photo of the batch plant from which the asphalt was sourced is provided in Figure D-8, Appendix D. A photo of the finished paving product is provided in Figure D-10, Appendix D. Table 4 provides the detailed information on the paving and compaction of the hot mix asphalt layers. There were no unusual circumstances identified with the exception of delays in receiving asphalt material from the plant. The weather was ideal for paving and there were no identified problems with the transportation or paving equipment.

As part of the construction, rod and level measurements were taken at the completion of the preparation of the subgrade, aggregate base and the asphalt base and surface layers by the contractor. Nuclear densities were also taken at the completion of the compaction of the subgrade, aggregate base and asphalt surface by Professional Services Industries (PSI), Tonawanda, NY who was also responsible for the material sampling and testing activities. FWD tests were taken on the subgrade and aggregate base layers at time of construction with the FHWA-LTPP FWD using testing protocol P059.

The eastbound portion of the Lake Ontario State Parkway containing the SPS-8 section 360801 was constructed as follows:

- The driving lanes are 3.66 meter wide with the outside (right) lane being monitored.
- The outside monitoring lane was constructed with a hot mix asphalt surface friction course over a hot mix asphalt base, with a crushed stone underlying base layer over a compacted silty sand subgrade with fragments of shale.
- The inside shoulder is comprised of curb with catch basins draining to a turf median. The outside lane drains to the turf shoulder.
- The outside shoulder (adjacent to the monitored lane) is 1.52 meters wide with a 203mm crushed stone base and 102mm hot mix asphalt surface.
- There is no subsurface drainage.
- The longitudinal surface joint was 3.65 meters from the outside shoulder lane edge joint or edge stripe.

Table 4: Plant Mixed Asphalt Bound Layers – Paving and Compaction

Layer	Lift No.	Placement Dates	Placement Thickness (mm)	Average Plant Mix Temp. (ºC)	Min/Max Placement Temp. (ºC)	Breakdown Roller (Metric Tonnes)	Breakdown Coverage	Finish Roller (Metric Tonnes)	Finish Coverage	Mean Air Temp. (ºC)	Compacted Thickness (mm)	Mean Density (kg/m^3)	Density Standard Deviation (kg/m^3	Min. Density (kg/m$^{3)}$	Max. Density (kg/m^3)	No. of Samples	Curing period (days)
AC Base	1	10-Aug-94	102	146	127-138	Double-Drum Vibr	2	Double-Drum Vibr	2	24	76	-	-	-	-	-	-
AC Surface	1	12-Aug-94	30	154	141-143	Double-Drum Vibr	1	Double-Drum Vibr	1	27	25	2265	19.2	2251	2292	3	-

4.4 Forensic Material Sampling and Observation

The profile, MDS and FWD surveys were completed on May 20, 2008 prior to selecting the locations for coring, DCP and split-spoon sampling. The locations for the surface material, DCP and split-spoon sampling, were based on a review of the FWD data to select representative areas of pavement response. The deflection results indicated varying pavement response over the length of the section that did not always conform to the distress and drainage observations. Three locations for sampling were selected based on variations in deflection readings, changes in drainage characteristics and localized distress. The 150mm cores that would be used for laboratory analysis and provide access for DCP and split-spoon sampling were located in the midlane and outer wheelpath at stations 1+00 (30.5m), 3+50 (106.7m) and 4+98 (152m). The DCP location was at the spot of the FWD test with the split spoon sampling offset by 450mm in the eastbound direction. The cores from the DCP location were selected for the laboratory analysis with the second set of cores retained as spares in the event additional materials were needed. As previously mentioned, the initial set of cores that were transferred to the NYSDOT laboratory had to be disposed of due to asbestos contamination from a leaky roof. Replacement cores were collected on October 7, 2008. A set of FWD test were collected at 7.62-meter intervals on October 6, 2008 to select the location of 150mm core samples for transfer to the NYSDOT laboratory. The location for these set of cores was at stations 2+50 (76.2m) and 4+00 (121.9m). DCP tests were also taken at the core locations; selectively from the core holes that had the least amount of water infiltration from the coring activities. Additional split-spoon sampling was not possible as the utility clearance had expired and no further utility locates were initiated. The locations for the 100mm cores were based on an examination of the surface to select representative areas with cracks or no visible surface cracks that would provide core samples that could be examined to determine the extent of damage. The primary distresses were low to moderate severity alligator cracking that was in the wheelpaths, midlane, and propagating from the centerline longitudinal crack. The high severity centerline longitudinal crack had multiple cracks that progressed into each lane but were more prevalent in the SPS-8 monitored lane. In addition, there were 5 low severity partial transverse cracks, which mainly branched off of longitudinal cracks. Figure E-2 to E-5, Appendix E, provides photos of section 360801 that depict the types of distresses evident over the length of section.

Figure 2 shows the layout of sampling and test locations for the thirty-six 100mm cores that would be used to examine the asphalt layers and associated cracking, as well as the twelve 150mm cores that would be retrieved for laboratory samples, and to provide access for DCP and split-spoon testing. Figure 3 shows the layout of the sampling and testing locations for the eight 150mm replacement cores that were collected on October 7, 2008.

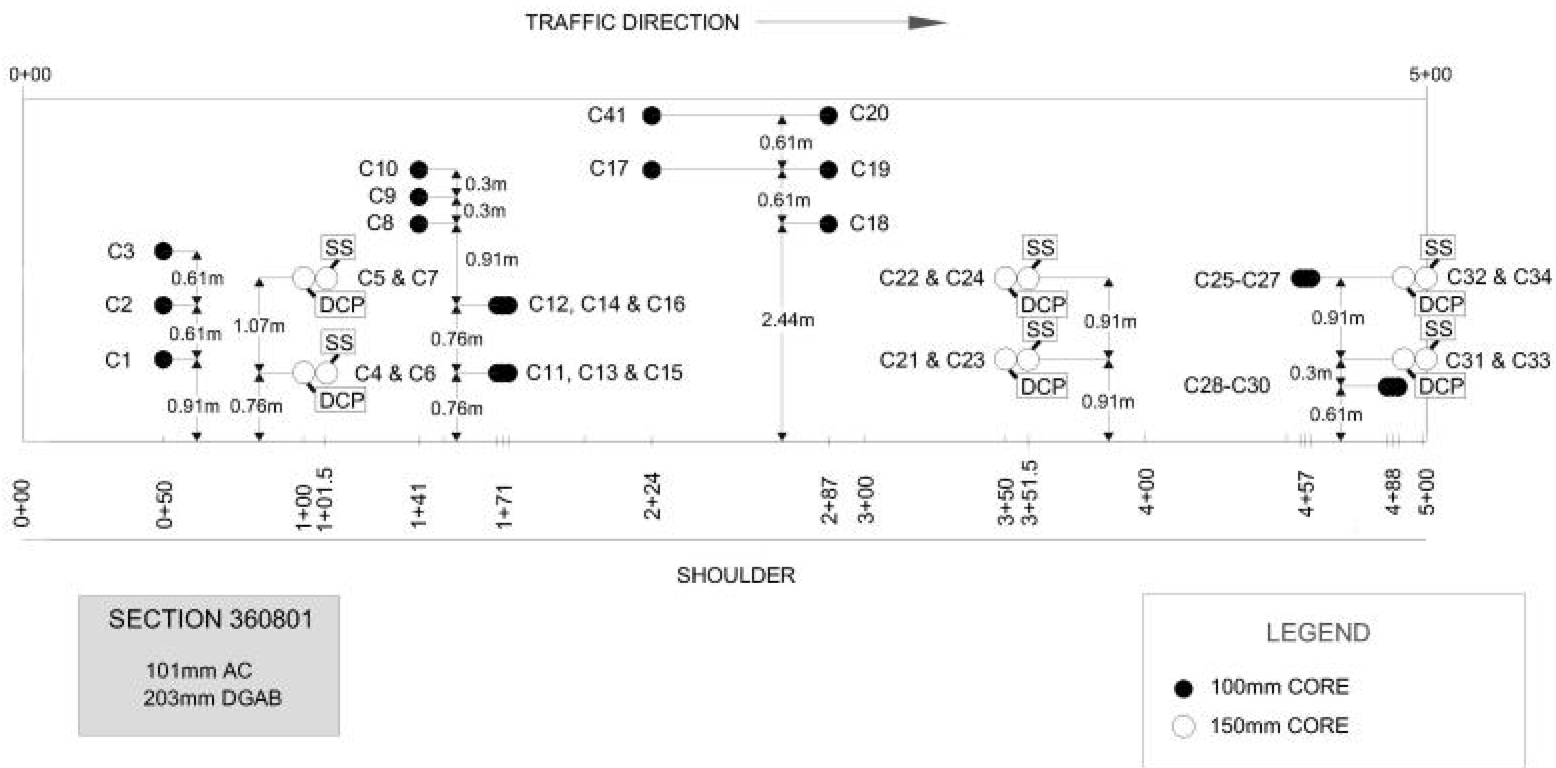

Figure 2: Layout of Sampling and Test Locations (May 21, 2008)

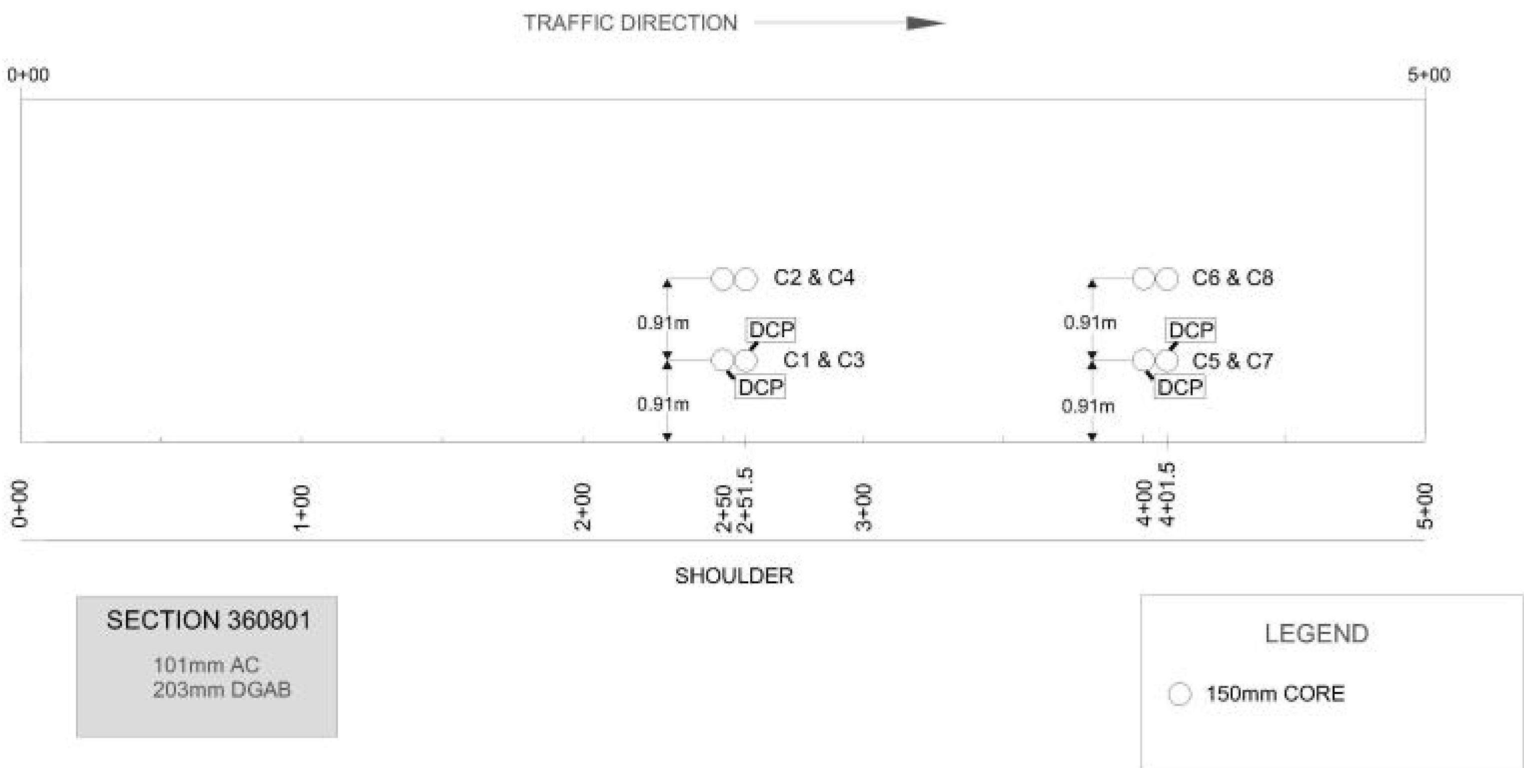

Figure 3: Layout of Sampling and Test Locations (October 7, 2008)

4.4.1 Cores and Core Examination

The selection and marking of the core locations and labeling of the cores was the responsibility of the NARSC with the core drilling and material sampling being the responsibility of the NYSDOT. The NYSDOT core unit was setup for the 100mm cores whereas the drill rig was used to take the 150mm cores at the location for the DCP and split-spoon sampling. The 150mm cores taken during the return visit on October 7, 2008 were completed with the core unit. Photos showing the marking of the core locations and the core drill unit in operation are provided in Figure F-1 and F-2, Appendix F respectively.

The 100mm cores were removed, dried and labeled, packaged and set aside for transfer to the NARSC facility for measurement and examination. A minimum of 3 cores were taken in the location of a specific distress, with the exception of the centerline longitudinal crack. Figure F-3, Appendix F shows the cores at the NARSC facility set out for examination and condition assessment. The core thickness was determined by measurements taken in 4 locations on the circumference of the core and averaged. The core condition was a visual assessment with measurement of the depth of the crack and any associated deterioration. The cores taken in areas without any visible cracking were intact with no bonding issues between layers, and some visible voids with the binder being stiff but pliable (when poked with a knife). The asphalt surface was aged and showed signs of weathering. Raveling was present in some locations and this was especially the case where other distresses were identified. There was minor stripping, if any, at the interface of the asphalt with the aggregate base. For a number of the cores, the tack coat was bonded with the asphalt and underlying aggregate. Figure F-4, Appendix F shows cores that were taken at a partial transverse crack where the crack went from being full depth (branched from a longitudinal crack) to just into the surface layer (toward the end of the crack). Cores were taken in the inner wheel path where high severity distresses were full depth as evident in photo F-5, Appendix F. The core samples from the high severity centerline longitudinal crack with associated alligator cracking indicated the crack to be full depth with associated deterioration as evident in photo F-6, Appendix F. The cores taken at the low severity midlane longitudinal crack were to the depth of the surface layer with only minor evidence of stripping or deterioration at the bond interface with the asphalt base material as evident in photo F-7, Appendix F. The low severity fatigue cracking in the outer wheel path was to the depth of the surface layer but exhibited some deterioration between the interface of the surface and base as is evident in photo F-8, Appendix F. All cracks, with the exception of the full depth cracks, were top-down as evident in the photos mentioned above. The detailed measurements and core examination results for the 100mm cores are provided in Table 5. The stationing and sample number for each core is provided to cross reference with the location as provided in the core layout diagram in Figures 2 and 3.

The 150mm cores were removed from the core hole at the completion of drilling and set aside to air dry. When dry, the interface of the surface and layer was determined and marked. The examination and measurement of the initial set of 150mm cores was not completed in the field as this would have been completed as part of the laboratory testing. For the second set of cores taken on October 7, 2008 the cores were labeled to determine the location and type of distress with cracks noted as being top down or bottom up and to what depth, and measured in 4 locations on the circumference of the core and averaged. These cores were then packed in PVC tubes for transfer to the NYSDOT laboratory for testing. Example photos that depict the measurement and labeling are provided in Appendix F. Figure F-13 (Station 1+00), F-14 (Station 3+50) and F-15 (Station 4+98) for the May 21st core sampling, and F-17 (Station 2+50) and F-18 (Station 4+00) from the October 7th sampling. The above photos also provide an indication of the type of distress evident in the cores taken at these locations. The details of the measurements and examination of the cores are provided in Table 5.

Based on the examination of the cores, roughly 70% of the cores had visible void areas primarily near the interface of the asphalt surface and base layer. The surface was substantially weathered with some raveling; only 2% of the cores had aggregate particles loose enough to be separated. Lack of bond between layers or separation due to stripping at the location of cracks was documented for 18% of the cores. All cracks identified were; top down with the low severity longitudinal cracks to the depth of the surface layer, low severity fatigue cracks penetrating approximately 20mm in the asphalt base layer and high severity longitudinal and alligator cracks being full depth. The partial transverse cracks were full depth from where it abutted the longitudinal crack, but diminished toward the end of the crack.

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Table 5: Summary of Core Measurement and Examination

150mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
21-May-08	1+00	0.76	C4	4							25.4	DCP					
				3							104.1						
	1+00	1.83	C5	4							22.9	DCP					
				3							104.1						
	3+50	0.91	C21	4							20.3	DCP					
				3							96.5						
	3+50	1.83	C22	4							20.3	DCP					
				3							96.5						
	4+98.5	0.91	C31	4							20.3	DCP					
				3							127						
	4+98.5	1.83	C32	4							20.3	DCP					
				3							134.6						
	1+01.5	0.76	C6	4							25.4	Split Spoon					
				3							104.1						
	1+01.5	1.83	C7	4							22.9	Split Spoon					
				3							101.6						
	3+51.5	0.91	C23	4							20.3	Split Spoon					
				3							96.5						
	3+51.5	1.83	C24	4							20.3	Split Spoon					
				3							94						
	5+00	0.91	C33	4							17.8	Split Spoon					
				3													
	5+00	1.83	C34	4							20.3	Split Spoon					
				3							132.1						
7-Oct-08	2+50	0.91	C1	4	7.7	7.7	7.7	7.7	7.7	7.7	7.7	DCP	Y	Y	Y	12.7	T
				3	34.1	33.3	34.1	34.1	33.3	34.1	33.9						
	2+51.5	0.91	C3	4	7	7	7	7	7	7	7	DCP	Y	Y	N	NA	NA

Table 5 Continued: Summary of Core Measurement and Examination

150mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
7-Oct-08	2+51.5	0.91	C3	3	31	30.2	31	31	30.2	31	30.8	DCP	Y	Y	N	NA	NA
	4+00	0.91	C5	4	6.2	6.2	6.2	6.2	6.2	6.2	6.2	DCP	Y	Y	N	NA	NA
				3	35.6	36.4	35.6	35.6	35.6	36.4	35.8						
	4+01.5	0.91	C7	4	6.2	6.2	7	6.2	6.2	7	6.4	DCP	N	Y	Y	22.9	T
				3	33.3	31.7	31.7	33.3	31.7	33.3	32.5						
	2+50	1.83	C2	4	6.2	7	6.2	7	6.2	7	6.6		Y	Y	Y	22.9	T
				3	34.1	34.1	34.1	34.1	34.1	34.1	34.1						
	2+51.5	1.83	C4	4	7	6.2	6.2	7	6.2	7	6.6		N	Y	Y	5.1	T
				3	29.4	29.4	29.4	29.4	29.4	29.4	29.4						
	4+00	1.83	C6	4	6.2	6.2	6.2	6.2	6.2	6.2	6.2		Y	Y	N	NA	NA
				3	36.4	34.8	35.6	36.4	34.8	36.4	35.8						
	4+01.5	1.83	C8	4	6.2	6.2	6.2	6.2	6.2	6.2	6.2		Y	Y	Y	45.7	T
				3	33.3	34.8	32.5	33.3	32.5	34.8	33.5						
100mm Core																	
21-May-08	0+50	0.91	C1	4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	Ravelling	Y	Y	N	NA	NA
				3	96.5	96.5	96.5	94	94	96.5	95.9						
	0+50	1.52	C2	4	27.9	25.4	27.9	27.9	25.4	27.9	27.3	Ravelling	Y	Y	N	NA	NA
				3	88.9	91.4	91.4	88.9	88.9	91.4	90.2						
	0+50	2.13	C3	4	27.9	27.9	27.9	27.9	27.9	27.9	27.9	Ravelling	Y	Y	Y	15.2	T
				3	83.8	86.4	83.8	83.8	83.8	86.4	84.5						
	1+41	2.44	C8	4	25.4	25.4	22.9	22.9	22.9	25.4	24.1	Transverse Crack	Y	Y	Y	22.9	T
				3	94	94	96.5	96.5	94	96.5	95.3						
	1+41	2.74	C9	4	30.5	30.5	27.9	30.5	27.9	30.5	29.8	Transverse Crack	Y	Y	Y	124.5	T
				3	94	94	94	91.4	91.4	94	93.3						
	1+41	3.05	C10	4	30.5	27.9	27.9	27.9	27.9	30.5	28.6	Transverse Crack	Y	Y	Y	111.8	T
				3	83.8	81.3	81.3	83.8	81.3	83.8	82.6						
	1+69	0.76	C11	4	30.5	30.5	30.5	30.5	30.5	30.5	30.5	No Distress	Y	Y	N	NA	NA

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Table 5 Continued: Summary of Core Measurement and Examination

100mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
21-May-08	1+69	0.76	C11	3	106.7	106.7	106.7	109.2	106.7	109.2	107.3	No Distress	Y	Y	N	NA	NA
	1+69	1.52	C12	4	30.5	30.5	30.5	30.5	30.5	30.5	30.5	No Distress	N	Y	N	NA	NA
				3	96.5	99.1	99.1	101.6	96.5	101.6	99.1						
	1+71	0.76	C13	4	30.5	30.5	33	30.5	30.5	33	31.1	No Distress	Y	Y	N	NA	NA
				3	106.7	109.2	109.2	106.7	106.7	109.2	108						
	1+71	1.52	C14	4	30.5	30.5	30.5	30.5	30.5	30.5	30.5	No Distress	Y	Y	N	NA	NA
				3	101.6	101.6	101.6	99.1	99.1	101.6	101						
	1+73	0.76	C15	4	30.5	30.5	30.5	27.9	27.9	30.5	29.8	No Distress	Y	Y	N	NA	NA
				3	109.2	106.7	106.7	111.8	106.7	111.8	108.6						
	1+73	1.52	C16	4	27.9	30.5	27.9	27.9	27.9	30.5	28.6	No Distress	Y	Y	N	NA	NA
				3	104.1	101.6	101.6	104.1	101.6	104.1	102.9						
	2+24	3.05	C17	4	27.9		30.5	30.5	27.9	30.5	29.6	Fatigue IWP	N	Y	Y	30.5	T
				3	86.4		86.4	83.8	83.8	86.4	85.5						
	2+24	3.66	C41	4								Center Line Crack		N			
				3													
	2+87	2.44	C18	4	20.3	22.9	22.9	22.9	20.3	22.9	22.2	Fatigue propagating from Center Line	N	Y	N	NA	NA
				3	94	91.4	91.4	88.9	88.9	94	91.4						
	2+87	3.05	C19	4								Fatigue propagating from Center Line		N			
				3													
	2+87	3.66	C20	4				22.9	22.9	22.9	22.9	Fatigue propagating from Center Line	N	N	Y	119.4	T
				3				96.5	96.5	96.5	96.5						
	4+55	1.83	C25	4	20.3	20.3	22.9	22.9	20.3	22.9	21.6	Slight Longitudinal Crack @ Midlane	N	Y	Y	22.9	T
				3	101.6	101.6	101.6	99.1	99.1	101.6	101						
	4+57	1.83	C26	4	20.3	20.3	22.9	20.3	20.3	22.9	21	Slight Longitudinal Crack @ Midlane	N	Y	Y	20.3	T
				3	101.6	96.5	94	94	94	101.6	96.5						
	4+59	1.83	C27	4	20.3	20.3	22.9	20.3	20.3	22.9	21	Slight Longitudinal Crack @ Midlane	N	Y	N	NA	NA
				3	101.6	101.6	101.6	101.6	101.6	101.6	101.6						

Table 5 Continued: Summary of Core Measurement and Examination

100mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
21-May-08	4+86	0.61	C28	4	17.8	15.2	15.2	17.8	15.2	17.8	16.5	Fatigue OWP	N	N	Y	38.1	T
				3	127	132.1	132.1	129.5	127	132.1	130.2						
	4+88	0.61	C29	4	17.8	17.8	17.8	17.8	17.8	17.8	17.8	Fatigue OWP	N	Y	Y	45.7	T
				3	134.6	134.6	132.1	134.6	132.1	134.6	134						
	4+90	0.61	C30	4	20.3	17.8	17.8	20.3	17.8	20.3	19.1	Fatigue OWP	Y	Y	Y	35.6	T
				3	132.1	134.6	129.5	134.6	129.5	134.6	132.7						

Notes: Measurements 1-4 are starting with traffic direction going clockwise.

4.4.2 Pavement Quality Indicator (PQI) Density

Nuclear density tests were taken at the completion of constructing of the subgrade, aggregate base and asphalt surface. To evaluate if the density of the asphalt material had changed from the time of construction to the time of the forensic study, density tests were to be collected at the location of the testing and material sampling. The Pavement Quality Indicator (PQI) density meter was to be used in place of the nuclear gauge. This device is rapidly gaining acceptance due to the safety of operation and accuracy. The shortfall of this device is that it has to be locally calibrated. In this instance, the local calibration was to be provided from the core samples, but was lost due to asbestos contamination. The results of the PQI gauge show high variability in readings but are not calibrated to the location and therefore density values are not provided. Table 6 provides the results of the data collected. A photo of the PQI density meter data collection is provided in Figure E-13, Appendix E.

Table 6: Summary of PQI Data Collection

Core #	Station	Offset	Gauge Reading
C4	1+00	0.76	2522
C5	1+01.5	0.76	2076
C6	1+00	1.83	3087
C7	1+01.5	1.83	3429
C21	3+50	0.91	2325
C22	3+51.5	0.91	2440
C23	3+50	1.83	3982
C24	3+51.5	1.83	4032
C31	4+98.5	0.91	3628
C32	4+98.5	0.91	3910
C33	5+00	1.83	3443
C34	5+00	1.83	3230

4.4.3 Split-Spoon Sampling & Dynamic Cone Penetrometer (DCP) Results

Split spoon sampling has been in use in North America since the early days of construction as a measure of soil resistance to penetration. The Standard Penetration Test (SPT), which records the number of blows for a specific distance (i.e. blow count number/150mm), can be used to determine the shear strength and bearing capacity of soils to that of excellent to very poor. The advantage of split-spoon sampling over the FWD and DCP is that a relatively undisturbed sample of the soil is retrieved as part of the penetration of the sampling probe into the soil materials. The retrieved soil samples can be used to determine layer thickness, moisture content, perform Atterberg Limit tests and classification of the soils; all very useful when evaluating the strength characteristics of the soil. Aside from familiarity with the process and results, this is probably one of the main reasons this test method is still popular with highway agencies, even though quicker and more consistent results can be obtained from FWD or DCP tests. Table 7 provides the results of the split-spoon sampling for the three midlane and outer wheelpath locations sampled. The results indicate the aggregate base and subgrade materials to be on the low side. Blow counts of 25 or greater are considered to have excellent support with a blow count of 10 or less having poor support. The values from the base material can be considered rather questionable as the base was damp from the core activity, along with the core spin off causing the top 25-50mm of material to loosen. Figures G-1 to G-3, Appendix G are photos showing the split-spoon sampling, split spoon sample material, and packaging and labeling of sample material for moisture determination, respectively. The split-spoon field data sheets are provided in Appendix H.

Table 7: Summary of Split Spoon Sampling Results – 17-May-08

Location	Station (ft)	Offset (m)	Lane	Description	Moisture Content (%)	Depth (m)		Blows/150mm					
						From	*To*	*N-count*					
C7	1+01.5	1.83	ML	~200mm crushed gravel	4.0	0	0.91	9	11	9	8	9	11
				coarse-grained silty sand	13.6								
C23	3+51.5	0.91	OWP	~200mm crushed gravel	4.0	0	0.91	16	15	13	7	10	42
				coarse-grained silty sand	14.0								
C24		1.83	ML	~250mm crushed gravel	4.0	0	0.91	12	13	11	7	6	6
				coarse-grained silty sand	12.4								
C33	5+00	0.91	OWP	~250mm crushed gravel	5.0	0	0.91	12	10	13	10	10	11
				coarse-grained silty sand	12.5								
C34		1.83	ML	~200mm crushed gravel	4.0	0	0.91	12	14	11	9	10	13
				coarse-grained silty sand	11.9								

The Dynamic Cone Penetrometer (DCP) has become more popular in recent years amongst highway agencies for determining the strength of pavement soils, particularly during construction, and to a lesser degree for rehabilitation evaluations. The DCP is very versatile in that it is easily transported, requires minimal skill to operate and the results can be obtained with very little effort. The Dynamic Cone Penetration Index (DCPI) has been correlated to CBR, unconfined compressive strength, resilient modulus and shear strength. The weakness for the DCP is that the penetration is highly dependent on the moisture content and there is no sample recovered for visual inspection or to determine moisture content.

Table 8 provides the results from the DCP tests performed at the five locations selected from FWD tests in the midlane and outer wheelpath for the testing done in the spring and fall. The field moisture values were taken from the soil samples retrieved as part of the split-spoon sampling on May 21st with no moisture data available for October 7th. In the results provided in Table 8, no adjustments were made to the DCP values; similarly there were no seasonal adjustment factors applied to the FWD results. The results from the DCP test indicate the aggregate base to be stiffer than the subgrade with both values seeming reasonable for the types of material and conditions at time of test. There are a number of different models available for converting the DCPI value to CBR for which different results can be obtained, therefore if this procedure is to be extensively used some local calibration is advisable. A photo of the operators performing the DCP test is provided in Figure G-4, Appendix G. The field data sheets are provided in Appendix I.

Table 8: Summary of DCP Test Results – 360801

Test Date	Location	Station *(ft)*	Offset *(m)*	Lane	Layer	Layer Type	Field Moisture *(%)*	DCPI *(mm/blow)*	DCP CBR	DCP Moduli *(MPa)*	FWD CBR	FWD Moduli *(MPa)*
21-May-08	C4	1+00	0.76	OWP	3 to 4	AC						4530
					2	Base	4.0	4.6	53.6	74.1		
					1	Subgrade	14.6	6.3	40.8	61.9	42	63.2
	C5		1.83	ML	3 to 4	AC						3927
					2	Base	4.0	3.6	68.2	86.2		
					1	Subgrade	13.6	6.4	43	63.5	42	63.4
	C21	3+50	0.91	OWP	3 to 4	AC						4010
					2	Base	4.0	2.9	82.3	97.2		
					1	Subgrade	14.0	3.7	70	87.1	49	70.2
	C22		1.83	ML	3 to 4	AC						2306
					2	Base	4.0	3.5	72.7	89.6		
					1	Subgrade	12.4	8	39.7	59.8	42	63.2
	C31	4+98.5	0.91	OWP	3 to 4	AC						4680
					2	Base	5.0	3.4	73	90.1		
					1	Subgrade	12.5	3.7	68.6	86.1	38	59.5
	C32		1.83	ML	3 to 4	AC						3437
					2	Base	4.0	2.5	88.2	101.6		
					1	Subgrade	11.8	3.9	68.3	85.5	37	58.6
7-Oct-08	C1	2+50	0.91	OWP	3 to 4	AC						3564
					2	Base		2.4	90.8	103.5		
					1	Subgrade		5.7	45.7	66.4	47	68.2
	C3	2+51.5	1.83	ML	3 to 4	AC						4031
					2	Base		3.7	70	87.3		
					1	Subgrade		6.8	39.6	60.3	53	73.8
	C5	4+00	0.91	OWP	3 to 4	AC						4443.8
					2	Base		2.1	93.3	105.6		
					1	Subgrade		4.3	58.9	78.3	22	128.7
	C7	4+01.5	1.83	ML	3 to 4	AC						2811.2
					2	Base		2.5	87.5	101		
					1	Subgrade		3.4	75	90.9	78	94

$CBR=(MR/17.58)^{1.5625}$

4.5 Material Properties and Laboratory Test Results

As part of the construction and testing done at the SPS-8 project in 1994, laboratory tests were conducted on the subgrade, aggregate base material, and asphalt bound layers from material samples obtained during the processing and placement of the various pavement layers. The results of the sampling and laboratory analysis that could be obtained from the LTPP database have been summarized and included in this report. As part of the forensic investigation, core samples were collected from the midlane and outer wheelpath and transported to the NYSDOT laboratory where the following tests were conducted:

- Binder extraction (% air voids, flexural creep stiffness-aged and indirect tension failure stress)
- Bulk and maximum specific gravity
- Resilient Modulus (Indirect Tension tests at 25 °C)

These tests were conducted to determine the effects of aging on the hot mix asphalt and if any of these properties were factors in the deterioration of the bound pavement layers. The material properties for the unbound layers (base and subgrade) are provided in Table 9. The subgrade was identified as silty sand. This subgrade is considered an ‘active sand’ as it tends to have easy infiltration of water which can result in ice lensing during the freeze periods. The subgrade was proof rolled, leveled and fine graded prior to the placement of the surface layers. This material was well compacted with the density results exceeding the requirements. The crushed stone base was placed directly on the subgrade to an average depth of 213mm, but was highly variable as previously mentioned. The nuclear density tests taken at the time of construction indicate the material was not compacted within the 95% tolerance of the standard proctor test. The moisture content was below optimum which may have had an effect on the compaction; issues with water containment and drainage may have made the contractor reluctant to water down the aggregate base material during compaction (See Figure D-2, Appendix D). The results of the nuclear density tests taken during the time of construction are provided in Table 10. The pavement structure has shown no signs of settlement or fatigue in the bottom layers of the asphalt bound layers, which would indicate no issues were evident with the support structure, especially with this location having a relatively high and variable water table with no external drains or drain layer in the monitoring lane. The tack-coat placed at the completion of the aggregate base preparation was still tacky at the time of placement of the asphalt pavement. The material properties of the aggregate used in the asphalt mix design are provided in Table 11. The AC friction surface layer consists of 16% gravel with a maximum stone size of 9.5mm and 81% sand; the AC base layer had equal amounts of gravel and sand with a maximum stone size of 19mm. The core samples taken from this section indicated that the locations of cracks and associated stripping at the layer interfaces were associated with the surface layer having the higher percentage of sand and smaller maximum stone size.

Table 9: Material Properties – Unbound Layers

Description	Granular Base @ 5+35 0.91m Offset	Subgrade @ 5+40 0.91 m Offset	Subgrade @ 4+00 3.05 m Offset	Subgrade @ 2+50 3.05 m Offset
Material (Code)	Crushed Gravel (304)	Coarse-Grained Soil: Silty Sand (214)	Coarse-Grained Soil: Silty Sand (214)	Coarse-Grained Soil: Silty Sand (214)
Resilient Modulus (MPa)		49.6		
Lab Max. Dry Density (kg/m^3)	2419	1938		
Lab Opt. Moisture Content (%)	5.0	10.0		
In-situ Wet Density (kg/m^3)	2242	2197		
In-situ Dry Density (kg/m^3)	2192	2108		
In-situ Moisture Content (%)	2.3	4.2		
Liquid Limit	16	14	0	23
Plastic Limit	15	13	0	16
Plasticity Index	1	1	NP	7
% Gravel	70	12	3	20
% Sand	22	66.1	68.3	48.4
% Silt / % Clay		20 / 8	20 / 8	23 / 8
% Passing #200	8	21.9	28.7	31.6
Max Stone Size (mm)	38.1	25.4	12.7	50.8
Specific Gravity	2.831	2.72	2.718	2.728

Table 10: Post-Construction Testing – Nuclear Density Testing

Date	Station	Offset (*m*)	Layer	Layer Type	In-situ Dry Dens. (*kg/m^3*)	In-situ Moisture (*%*)
15/16-Jul-94	1+00	1.52	1	Subgrade	2057	5.6
	2+50	1.52			2143	5.1
	4+00	1.52			2098	5.4
	5+40	0.91			2132	0.5
25-Jul-94	1+00	1.83	2	DGAB	2177	2.1
	2+50	1.83			2185	2.2
	4+00	2.13			2228	2.6
	5+35	0.91			2177	2.4
11-Nov-94	1+00	1.83	4	AC - Surface	2292	
	2+50	1.83			2251	
	4+00	1.83			2254	

Table 11: Aggregate Material Properties – Bound Layers

Description	AC – Surface	AC – Base
Material (Code)	Hot Mixed, Hot Laid AC, Dense Graded (1)	Hot Mixed, Hot Laid AC, Dense Graded (1)
Layer #	4	3
% Gravel	16.0	47.0
% Sand	81.0	48.0
% Passing #200	3.0	5.0
Max Stone Size (mm)	9.5	19.1
BSG of Coarse Agg.	2.64	2.66
Absorption (%)	0.5	0.4
BSG of Fine Agg.	2.60	2.61
Absorption (%)	1.0	1.0

The binder properties at time of construction of the AC-15 and AC-20 asphalt are provided in Table 12. The AC-15 binder was used for the asphalt base layer with the AC-20 binder used in the friction surface layer. There was no mention or information on the inclusion of mineral fillers or anti-stripping agents in the construction report, or available from the IMS database. The various AC properties for the materials sampled and tested shortly after construction are provided in Table 13. These results are from the flexural creep stiffness, indirect tension failure and resilient modulus tests performed by the contracted laboratory. The tests performed by the NYSDOT laboratory as part of the forensic investigation are provided in Table 14 and 15. The results provided in Table 14 indicate that with the exception of the AC-15 binder, which had a specific gravity 5% lower than the previous average, there is little difference in the specific gravity of the materials. The result of the complex modulus, asphalt stiffness, failure stress and strain tests performed by the NYSDOT laboratory are provided in Table 15. These results indicate there are no issues with the complex modulus or phase angle. For the layer 4 surface AC-20 binder, the stiffness @ 60s should be less than 300 MPa and the m-value @ 60s should be greater than or equal to 0.3; these values were slightly off based on the test results. Table 16 provides a comparison of the asphalt layer properties (voids, bulk and maximum specific gravity) for the tests performed post construction and those performed as part of the forensic study. The information available indicated the air voids post construction for the AC base layer was 6.6%. The test performed as part of the forensic study found the AC base layer to be in the range of 4.7% to 7.9% with an average of 6.2%, a very minimal change from the time of construction. The air voids for the AC surface was 8.7% at the time of construction and ranged from 8% to 12.6% with an average of 10.5% at the time of the forensic study. The high variability and increase in the air void for the AC surface is consistent with the observed weathering and raveling of this thin surface lift. A comparison of the Bulk Specific Gravity (BSG) post construction and from the forensic tests shows a minimal difference between the timeframes for the AC binder and surface layers. The results are the same for the Maximum Specific Gravity (MSG) with very little change identified in the specific gravity properties.

Table 12: Binder Properties – Bound Layers

Layer Type	Layer #	AC Content (%)	Avg. Specific Gravity			Kinematic Viscosity @ 135°C ($g*cm^{-1}*s^{-1}$)			Absolute Viscosity @ 60°C (mm^2/s)			Penetration of AC @ 25°C (.1mm)		
			Min	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*
AC – Base (AC-15)	3		1.112			657			6064			45.0		
AC – Surface (AC-20)	4		1.024	1.100	1.062	389	766	578	2000	8712	5356	39.0	70.0	54.5

Table 13: Post-Construction Test Results - Asphalt Layers

Description	AC – Surface	AC – Base
Layer #	4	3
Creep Compliance at 1s @ 25°C (Gpa^{-1})	0.88	0.742
Creep Compliance at 2s @ 25°C (Gpa^{-1})	1.059	1.104
Creep Compliance at 5s @ 25°C (Gpa^{-1})	1.973	1.737
Creep Compliance at 10s @ 25°C (Gpa^{-1})	3.055	2.54
Creep Compliance at 20s @ 25°C (Gpa^{-1})	5.03	3.7
Creep Compliance at 50s @ 25°C (Gpa^{-1})	9.696	5.801
Creep Compliance at 100s @ 25°C (Gpa^{-1})	16.04	8.095
Creep Poisson, *v*	0.41	0.56
Indirect Tensile Strength (MPa)	0.62	0.91
Indirect Tensile Poisson, *v*	0.32	0.5
M_R @ 25°C (MPa)	2050	5490
M_R Poisson, *v*	0.39	0.43

Table 14: Forensic Laboratory Test Results - Specific Gravity of Asphalt Mix

Layer Type	Layer #	Specific Gravity			SG of Coarse Agg.			SG of Fine Agg.		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
AC – Base (AC-15)	3	1.050	1.054	1.052	2.656	2.681	2.670	2.552	2.582	2.573
AC – Surface (AC-20)	4	1.052	1.061	1.056	2.576	2.873	2.674	2.534	2.574	2.551

Table 15: Forensic Laboratory Test Results – Asphalt Layers

Layer #	Complex Modulus *G* (kPa)*			Phase Angle *d (°)*			Stiffness @ 60s *MPa*			m-value @ 60s			Fracture Properties - Failure Stress *MPa*			Fracture Properties - % Failure Strain *(mm/mm) x 100*		
	Min	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*
3	5462	7797	6877	42.2	46.1	44.0	173	203	184	0.299	0.329	0.316	2.19	2.84	2.63	0.52	0.73	0.63
4	11068	23746	16947	33.2	36.3	35.0	283	390	317	0.247	0.273	0.264	2.62	3.03	2.85	0.61	0.78	0.66

Table 16: Comparison of Asphalt Layer Properties-Void and Specific Gravity

Sampling Date	Layer Type	Layer #	Air Voids (%)			BSG			MSG		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Post-Construction ('95-'96)	AC - Base	3	6.6	6.6	6.6	2.280	2.414	2.345	2.510	2.510	2.510
	AC - Surface	4	8.7	8.7	8.7	2.156	2.241	2.206	2.416	2.416	2.416
7-Oct-08	AC - Base	3	4.7	7.9	6.2	2.278	2.366	2.329	2.466	2.506	2.483
	AC - Surface	4	8.0	12.6	10.0	2.145	2.217	2.176	2.392	2.470	2.418

4.6 Ground Penetrating Radar

Ground Penetrating Radar (GPR) data was collected on May 14, 2008 by Stantec Consulting Services Inc. using a GSSI air coupled GPR unit. This data was collected for the purpose of documenting the variability in thickness of the asphalt surface and aggregate base layers of the pavement structure. Figure J-1 to J-3, Appendix J provides the results of the GPR survey for the inner wheel path, midlane and outer wheel path of section 360801, respectively. To determine layer thickness at the time of construction, rod and level measurements were taken at 50-foot (15.2m) intervals at the completion of final grade for each pavement layer. These results were used to determine the average, minimum, maximum thickness and standard deviation of each layer. In addition to the rod and level measurements, core samples taken outside the limits of the 500-foot (152.4m) section were also used to determine the sectional layer thickness. The results of these surveys indicate a high variability in the thickness of the various layers with the average thickness for both the aggregate base and asphalt surface layers being thicker than the design specifications. This variability was confirmed by the results from the GPR survey. Table 17 provides a comparison of the layer thicknesses as determined from the rod and level survey and the GPR survey. The results show a lower minimum and higher maximum thickness for the AC material in most cases. There is also a fairly large difference in AC thickness from centerline to edge of pavement. The midlane, on average, is thicker than the inner and outer wheelpath. The aggregate material also shows high variability as is evident by the higher standard deviation over the length and width of the section. In general, the thickness is at or below specifications at the inner wheelpath and increases in thickness towards the outer edge of the pavement. GPR is an excellent method of determining variability within a pavement structure with some tolerance limitations when determining actual thickness. The GPR data for this section would indicate that the construction platform was variable with the construction tolerances being outside the design specification of +/- 7mm.

Table 17: Section 360801- Comparison between GPR & LTPP Layer Data

Location	Layer	GPR Thickness (mm)			Standard Deviation	LTPP Layer Thickness (mm)			Standard Deviation
		Min	Max	Avg		Min	Max	Avg	
IWP	AC	84.38	133.35	100.99	10.74	106.00	141.00	120.27	9.33
	Granular	142.85	250.47	187.92	22.34	201.00	247.00	218.73	12.43
ML	AC	111.51	170.61	141.14	11.40	109.00	150.00	124.64	10.28
	Granular	179.40	308.91	238.38	29.24	213.00	250.00	224.73	10.32
OWP	AC	100.05	152.10	119.85	10.54	103.00	150.00	124.36	12.03
	Granular	201.80	269.11	233.23	16.04	219.00	265.00	236.27	14.28

4.7 Collection and Reporting of Monitoring Data

As part of the forensic testing at this LTPP SPS-8 site, Falling Weight Deflectometer (FWD), Manual Distress Survey (MDS), Transverse and Longitudinal Profiles and Elevation data were collected. This data has been added to the LTPP Information Management System (IMS) database. The pavement performance monitoring data has been analyzed and historical trends are reported as part of this document. FWD data was collected during the construction of the subgrade and aggregate base with the post construction FWD testing done on November 9, 1994. The post construction profiles were collected on September 6, 1994 and the Manual Distress Survey (MDS) on November 11, 1994. The bulk material sampling was undertaken during the construction with the 100mm core samples taken on November 22, 1994. The 100mm cores forwarded to the Law/PCS laboratory could not be processed which resulted in the need for additional coring. A number of cores were extracted, until finally a set of acceptable cores were collected in the fall of 1995. The following provides the results of the analysis and reports on the trends in the data from the initial data collected as part of the LTPP program to the last set of data collected as part of the forensic study.

4.7.1 Deflection Data Analysis Results

The FWD data was collected with the FHWA-LTPP FWD following the guidelines and protocols established for collecting FWD data for the LTPP program. A total of nineteen drops (3 seating, 4 at 26kN, 4 at 40kN, 4 at 54kN and 4 at 72kN) were taken at each test point. A photo showing the FWD in operation is provided in Figure E-14, Appendix E.

The average normalized temperature corrected deflections for the 40-kN equivalent loading for all the stations for both midlane and outer wheelpath were plotted with time. The surface deflection trends, as reported from the sensor located under the load plate, are provided for all stations in Figure K-1, Appendix K. Similarly, the results representing the subgrade deflection trends, as reported from the sensor located 1.524 meters from the load plate, are provided for all stations in Figures K-2, Appendix K. The deflection trend, as presented in the Figure K-1 shows a continual increase in deflection indicating the pavement is losing strength as time progresses. The deflection trend as provided in Figure K-2 indicate that the subgrade deflections have been very stable with time as only a slight change is evident. The results indicate only a small difference between the midlane and outer wheel path deflections. The backcalculated pavement resilient moduli from the historical FWD deflection data is provided in Figure K-5, Appendix K. The pavement moduli, as observed over time, show little or no decrease for the outer wheel path with a steady decrease in strength for the midlane. The distressed surface layers, as evident from the core review, would indicate that some decrease in pavement strength should be evident on this section. The historical trend in subgrade resilient moduli is provided in Figure K-6, Appendix K. The results would indicate a slight weakening of the subgrade support but for the most part a minimal change over time. There was minimal difference observed between the midlane and outer wheelpath; this again is somewhat consistent with the distress observed on the surface which were located over the complete surface area rather than being primarily associated with the wheelpaths.

The layer analysis, for the FWD deflection data collected on May 20th and October 6th, 2008, is provided in Tables 18a and 18b with the statistical comparison provided in Tables 19a & 19b. These results show the support layers to be variable over the length of the section. The variations in the pavement layer thickness, the variability in the subgrade, variable drainage and surface distress would indicate these results are consistent with the site conditions at the location of this thin pavement structure. The backcalculated moduli values for the aggregate base material were variable and lower than expected. These results have not been provided; the issue is currently under investigation and any updated information would not be ready in time for this reporting.

Table 18a: Summary of FWD Layer Analysis

Date	Lane	Chainage	AC (*MPa*)	Gran. Base (*MPa*)	Subgrade (*MPa*)	E_P *(MPa)*
20-May-08	ML	0+00	3362.44		72.10	446.35
	OWP		4323.59		72.79	514.21
	ML	0+50	3294.23		69.03	404.29
	OWP		3543.20		62.75	448.69
	ML	1+00	3927.05		63.39	477.35
	OWP		4529.48		63.17	502.54
	ML	1+50	3582.17		73.53	470.72
	OWP		5231.55		90.29	552.82
	ML	2+00	4137.16		66.44	507.34
	OWP		6457.19		61.80	679.07
	ML	2+50	2358.62		50.45	340.83
	OWP		5127.44		53.60	492.07
	ML	3+00	1461.46		47.35	375.30
	OWP		5336.52		71.38	557.10
	ML	3+50	2306.32		63.17	388.20
	OWP		4010.34		70.19	529.85
	ML	4+00	2603.72		71.94	369.74
	OWP		5402.82		107.97	545.59
	ML	4+50	2853.12		63.95	442.20
	OWP		3691.15		67.83	468.90
	ML	5+00	3437.35		58.60	697.60
	OWP		4680.43		59.46	690.36

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

Table 18b: Summary of FWD Layer Analysis

Date	Lane	Chainage	AC (*MPa*)	Gran. Base (*MPa*)	Subgrade (*MPa*)	E_P *(MPa)*
6-Oct-08	ML	0+00	3636.65		85.98	497.69
	OWP		2953.07		73.53	605.60
	ML	0+25	3573.22		89.17	491.16
	OWP		3504.83		73.70	606.86
	ML	0+75	1471.53		62.29	321.51
	OWP		2416.15		70.19	517.21
	ML	1+25	3803.46		95.75	435.46
	OWP		3967.76		92.32	652.51
	ML	1+50	3649.38		86.08	489.03
	OWP		4791.98		94.58	607.11
	ML	2+00	4400.35		92.32	507.82
	OWP		4586.70		77.81	702.24
	ML	2+25	4264.21		129.96	530.74
	OWP		4120.90		86.70	739.33
	ML	2+50	4031.21		73.83	488.98
	OWP		3564.28		63.17	585.28
	ML	2+75	2997.17		90.98	419.86
	OWP		3429.91		80.93	515.15
	ML	3+00	2990.38		90.78	444.41
	OWP		5057.14		102.35	656.55
	ML	3+25	2845.39		77.07	444.35
	OWP		3828.95		90.78	558.37
	ML	3+75	2626.65		94.36	355.67
	OWP		3470.54		112.48	439.66
	ML	4+00	2811.20		93.99	425.94
	OWP		4443.76		128.73	620.65
	ML	4+25	3048.48		76.90	510.42
	OWP		4925.17		86.85	710.79
	ML	4+75	3690.96		78.77	542.60
	OWP		1881.88		62.29	419.64

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

Table 19a: Statistical Summary of FWD Layer Analysis – May 20, 2008

Layer	Lane	M_R *(MPa)*			
		Min	Max	Avg	Std. Dev.
AC	ML	1461.5	4137.2	3029.4	795.6
	OWP	3543.2	6457.2	4757.6	861.3
Gran. Base	ML				
	OWP				
Subgrade	ML	47.4	73.5	63.6	8.6
	OWP	53.6	108.0	71.0	15.5
E_P	ML	340.8	697.6	439.9	96.7
	OWP	448.7	690.4	538.9	75.8

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

Table 19b: Statistical Summary of FWD Layer Analysis – October 6, 2008

Layer	Lane	M_R (MPa)			
		Min	Max	Avg	Std. Dev.
AC	ML	1471.5	4400.3	3322.7	750.1
	OWP	1881.9	5057.1	3796.2	914.0
Gran. Base	ML				
	OWP				
Subgrade	ML	62.3	130.0	87.9	15.0
	OWP	62.3	128.7	86.4	18.2
E_P	ML	321.5	542.6	461.8	60.6
	OWP	419.6	739.3	592.0	88.6

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

4.7.2 Manual Distress Data Analysis Results

The historical trend for the four distress types (fatigue, longitudinal wheelpath and non wheelpath, and transverse cracking) evident on the pavement surface of site 360801 are provided in Figures L-1 to L-3 of Appendix L. The results are from both photo interpretation of the PASCO film and the Manual Distress surveys conducted from 1994 to the final distress survey on May 20, 2008. The survey results indicate distress started to appear at the centerline pavement joint in the September 1997 distress survey. A small amount of longitudinal wheelpath cracking started to appear in the September 1998 survey eventually turning into fatigue cracking in the July 2001 survey. First signs of transverse cracking began to show up at this time as well. All distresses became more predominant in 2002 progressing steadily up until the final survey on May 20, 2008. Slight scraping marks on the pavement surface in the midlane and edges were first noted in the August 1995 survey and were visible throughout the life of the pavement. These marks were attributed to snowplow blade damage.

Photos that show the pavement condition at the time of the final MDS, taken in conjunction with the forensic data collection, are provided in Figures E-2 to E-5, Appendix E. The photo in Figure E-2 shows the high severity centerline longitudinal crack which extends the length of the section. The photo in Figure E-3 shows the multiple cracks that were evident over the entire width of the section but not continuous throughout the length of the section. The photo in Figure E-4 shows a low severity intermittent midlane longitudinal crack. The photo in Figure E-5 shows alligator crack formations in and out of the wheelpath. These were the predominant distresses evident on section 360801.

4.7.3 Longitudinal Profile Data Analysis Results

Figure 4 provides the historical IRI data for section 360801. A review of the historical IRI shows that the pavement roughness remained fairly constant up until 2001 and then steadily increased up to the final set of data collected in 2008. The increase in roughness seems to mirror that of the accumulated distress that occurred on this section. The surface distresses on this section are mainly in the slight to moderate category with minimal distortion on a section with practically no longitudinal grade. At the time of the final survey, profile data was collected on the passing lane, which had significantly less distress than the monitored lane, and an average IRI over the same section length of 1.27 m/km or 15% less than the monitored lane. Seasonal variations in ride quality were notable on this section which could be related to the 'active' silty sand subgrade that could become unstable during the freeze/thaw cycles. Based on these results the ride quality can be considered acceptable with no near term intervention required, although due to the high and increasing levels of distress the long term preservation of this pavement section could require some remedial intervention.

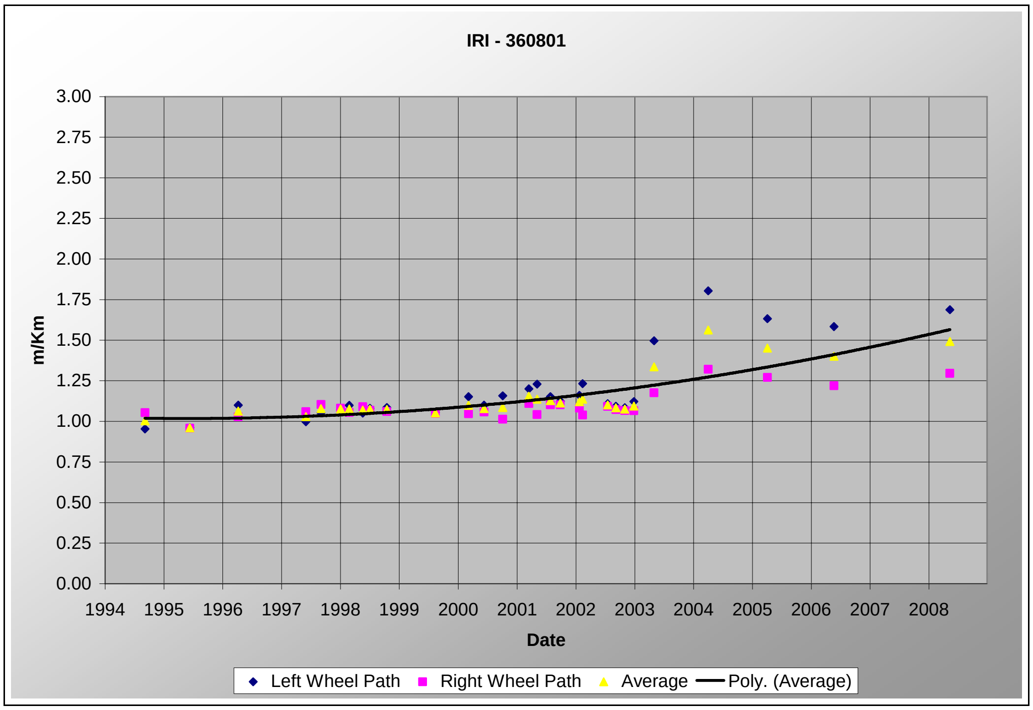

Figure 4: Historical Trend in IRI

4.7.4 Transverse Profile Data Analysis Results

The historical trends in rut depth from the Dipstick® transverse profiles are provided in Table 20. The average results are also provided in graphical format in Figure 5. These results indicate a very slight progression in rut depth over time with the left rut in most cases being slightly deeper than the right. The average rut depth for the survey on May 20, 2008 was 3.4mm in the right wheelpath and 3.8mm in the left wheelpath. Typically the rut formations in the right wheelpath are deeper than the left as there is less lateral support, but the differences are so small in this instance that they could be considered the same. The rut depth has increased from the first survey in 1995 but not to any great extent. The variations in rut depths from the surveys could be attributed to seasonal changes. It is odd that the deepest rut depth appeared during the survey in February 2000.

The results of the transverse profile survey would indicate that rutting is not an issue for this section.

Table 20: Summary of the Historical Trend in Rut Depth – Dipstick

Survey Date	Left Depth (Wire Ref)			Right Depth (Wire Ref)			Max Mean (Wire Ref) Left or Right
	Mean	Min	Max	Mean	Min	Max	
23-Aug-95	2.2	1.5	3.4	1.9	0.8	3.0	2.2
9-Apr-96	2.7	1.7	4.0	1.9	1.0	2.8	2.7
17-Sep-96	3.1	2.1	4.3	2.4	1.3	3.3	3.1
3-Sep-97	2.9	2.2	3.8	2.2	1.2	3.0	2.9
3-Mar-98	2.8	2.0	3.4	1.9	1.0	3.1	2.8
15-Sep-98	3.3	2.4	4.1	2.0	1.1	3.1	3.3
17-Aug-99	3.2	2.1	4.4	2.0	1.0	3.2	3.2
8-Feb-00	4.7	2.5	7.3	2.9	1.4	4.8	4.7
12-Sep-00	3.5	2.6	4.7	2.3	1.0	3.6	3.5
10-May-01	2.7	1.0	3.6	2.2	0.8	3.9	2.7
31-Jul-01	3.3	2.1	4.7	2.3	1.0	3.8	3.3
15-May-02	3.0	1.2	4.8	2.1	0.8	4.2	3.0
24-Jun-03	3.6	1.7	6.8	3.4	0.8	7.5	3.6
10-Mar-04	3.5	1.0	6.1	3.8	1.0	7.8	3.8
11-May-05	3.7	0.4	7.3	3.7	1.2	7.8	3.7
27-Sep-07	4.0	0.4	8.3	3.9	1.0	8.6	4.0
20-May-08	3.8	1.3	7.3	3.4	0.8	8.3	3.8

*All Rut values are in mm

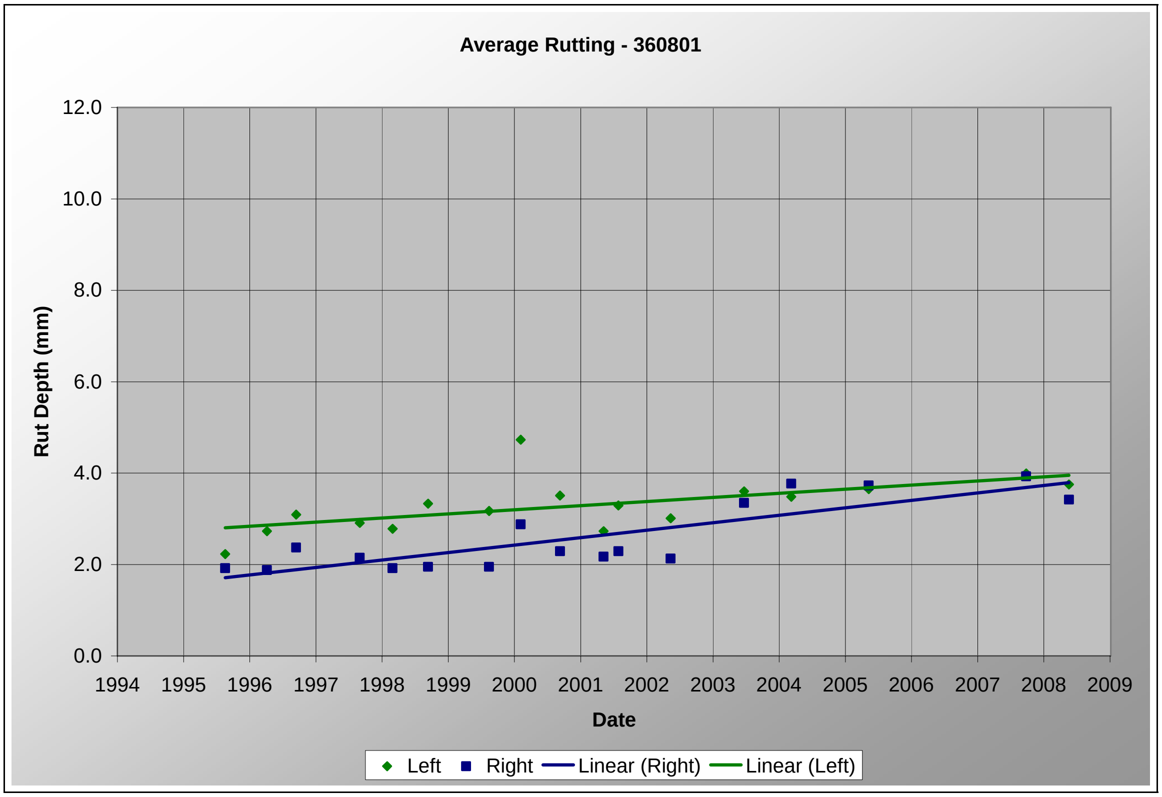

Figure 5: Graphical Presentation of Rut Depth

4.7.5 Elevation Data Analysis Results

An Eleven-Point set of levels were taken at 15.24m intervals over the 152.4m length of the section at the:

- Inner lane edge (non-testing lane)
- Centerline
- Inner lane edge
- Right wheelpath
- Midlane
- Left wheelpath
- Inner pavement edge
- Pavement edge
- Shoulder
- Shoulder edge
- And just off the paved shoulder

The results of the elevation survey are provided in Figure 6. The results show a slight deviation in elevation at the wheelpath location with a 1.7% slope for the pavement (both lanes) and a 3.6% slope from edge to just off the paved shoulder. These results would indicate sufficient slope for water runoff from the pavement surface but a slightly greater slope for the right lane could accelerate the runoff. Between the shoulder edge and just off the shoulder there is an increase in elevation for a portion of the section which could impede the runoff of the moisture from the pavement. These results are consistent with those observed during the site review and as evident in the photo provided in Figure E-11 and E-12, Appendix E.

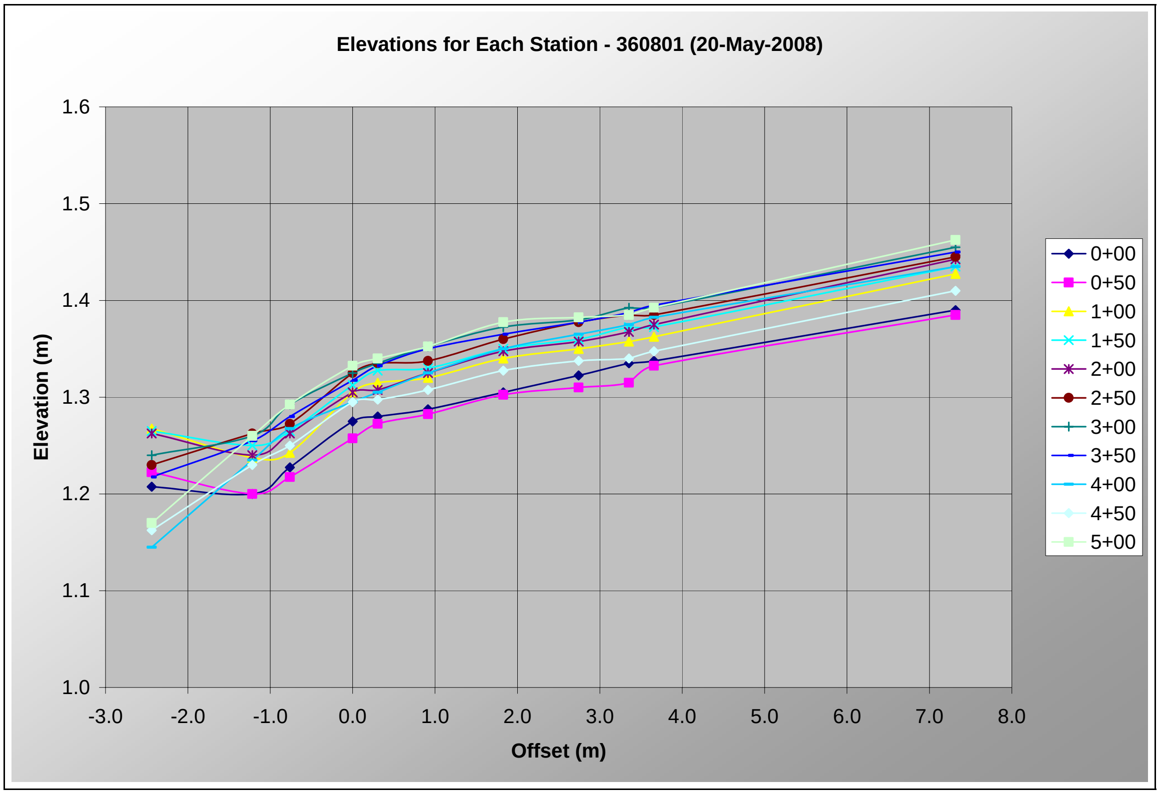

Figure 6: Results of Elevation Survey

4.8 Summary of Performance for 360801

The inputs and analysis conducted using the MEPDG indicated that a very short life span could be expected from the pavement design based on subgrade type, layer thickness, material selection and projected traffic inputs. The environmental conditions, material properties and traffic information were extracted from the LTPP database, with MEPDG defaults used in instances where information was not available from the database. A comparison analysis using the AASHTO 1993 Design Guide procedure, based on material coefficients, SN and historical traffic and growth rate projections were substantially different. In reviewing the two methods, the biggest factor in the discrepancies would have been the environmental effects that are taken into account with greater detail than the AASHTO 1993 Design Guide. That being said, limited traffic inputs and slight modifications in asphalt material characteristics and their performance capabilities may have also played a factor in the MEPDG analysis. These results would indicate that engineering judgment and refinements are needed when taking into account the many variables that go into the design of a pavement. The performance of this pavement section falls somewhere in between the two analysis predictions, as there has been some structural weakening and considerable surface distress.

MDS, Profile and FWD data collected on a regular basis tracked the performance of this section from the time of construction for a 13.5 year period until the forensic investigation in May 2008. The results from the MDS survey indicate the first noticeable sign of any surface distress occurred after the first winter (summer 1995) which revealed scrape marks on the high points at the midlane and edge of pavement. At this time there was very minor rutting with the maximum mean of 2.2mm. The first signs of cracking occurred in the fall of 1997 as a longitudinal crack at the paving construction joint near centerline. This longitudinal crack continually progressed to the full length of the section by the fall of 2000 and started to progress into multiple cracking in 2001. There has been no crack sealing or maintenance performed at the area of the longitudinal crack. The first signs of cracking in the wheelpaths appeared in the fall of 1998 as a slight longitudinal crack. This cracking progressed slowly until 2002 at which time there was a considerable increase in the amount of distress that had expanded into the non-wheelpath areas with the total amount of distress covering some 450m^2. Other cracks that are not as predominant are slight intermittent midlane longitudinal cracks and partial transverse cracks branching off of longitudinal cracking. Rutting on this section has progressed on a steady basis with the highest depth recorded as 8.6mm and a maximum mean of 3.8mm during the last survey in May 2008. This level of rutting would indicate no major issue for this section. The initial ride quality index (IRI) of 1.00m/km would indicate the contractors finished product was of average quality. The deterioration in ride quality mirrored the increase in distress on this section but also showed signs of high variability, especially in the last 5 years, which seem to be attributed to seasonal variation. The subgrade at this location can be classified as an active silty sand, which under freeze/thaw conditions can experience ice lensing resulting in instability during thaw periods. The IRI at the time of the final survey in May 2008 was 1.49m/km which would be considered acceptable for the functional use of this roadway. The transverse levels taken on this section indicate the slope of the pavement and shoulder are within specification but the turf at the edge of the pavement, for a good portion of the length of the section, is higher than the paved shoulder. There are no signs of edge deterioration but it was felt that this could impede the flow of water from the surface. From observation, water remained on the surface for a fair length of time after rainfall. With this section having minimal traffic, the removal of surface water relies on drainage. The pavement response, based on the FWD deflections, increased slightly over time with a slight reduction in the overall pavement moduli which was more predominant in the midlane as presented in Figure K-5, Appendix K. For this section, the thickness of the aggregate base and asphalt pavement layers were highly variable with the pavement structure. This may have been one of the factors in the variability of the deflections and support at this location.

An examination of the cores taken at the time of the forensic survey indicated the pavement failure was mainly in the surface layer with the exception of the centerline paving joint cracks. The more severe wheelpath cracking was also penetrating into the asphalt base layer and showing some signs of stripping at the interface between the base and surface layer. For the areas with no cracking or low severity cracks, the asphalt base was sound and there were no bonding issues with minimal, if any, stripping at the interface to the aggregate base. For a significant number of cores, the aggregate base had become imbedded in the tack coat and portions were lifted out as part of the core. The core surfaces were weathered with some signs of raveling, but at close examination the only loose materials were at the locations of medium to high severity cracking.

The laboratory analysis of the different bound layers indicated a slight change in the air void content and stiffness of the AC surface layer, but aside from that there was minimal change in the material properties from the time of construction until the forensic study in May 2008. The mix design properties, aggregate properties, bituminous content, air voids, penetration etc. were all within the specifications acceptable to NYSDOT.

A review of the construction report indicated there were some issues with water containment during construction, problems with the compaction of the aggregate base layer, maintaining a uniform thickness for the aggregate base and asphalt surface layers and some delays in the delivery of asphalt due to problems at the processing plant. The reporting on these problems is consistent with the findings from the core sampling, GPR and FWD data collection. A high variability in thickness and to a lesser degree in pavement response was evident from this data collection although no weak areas (soft spots) were encountered.

Based on the results, observations and information provided, reasons for the failures on this section could be attributed to design, lack of maintenance and environmental conditions. Although this section had curb and good drainage to the left lane and median, the turf at the right lane shoulder could have been sloped away from the pavement edge as a good portion was higher than the pavement. The slightly rutted and weathered surface has a tendency to retain water as there is minimal traffic which would help in drying out the pavement. In addition, the left lane drains through the right lane as they are both sloped in the same direction. A slight increase in pavement slope may help in this regard. The centerline joint crack may not have progressed if sealing had occurred during the initial stages. If the single crack that was observed in the fall of 2000 was sealed this may have prevented the progressions that took place thereafter. In discussion with NYSDOT staff, sealing was an inconsistent maintenance activity. Many agencies have gone away from the butt joint, using a wedge or other techniques to alleviate or reduce the construction joint cracking problem. Road salt used in winter maintenance could have been a contributing factor in the weathering and associated low severity cracking. From the seasonal data analysis, which has not been included as part of this document, the Time Domain Reflectometry (TDR) probes would short out in the spring period due to the high salinity of the soil ground water. The cores and laboratory analysis results indicate the observed surface distresses are primarily related to failure in the AC surface layer. Based on the limited amount of traffic (with no commercial vehicles), the failures for this section would have to be associated to either poor construction and/or to environmental conditions. Although there were some issues with the construction, there were no major issues that could be associated specifically with build problems. The insufficient compaction of the aggregate base may have contributed to the rutting but no sampling or testing was done to substantiate this. There was no indication that the AC surface was not within the material design specifications or problems with laydown or compaction.

5.0 Section 360802

5.1 Design and Life Expectancy

Using the design procedure from the 2007 Mechanistic Empirical Pavement Design Guide (MEPDG) the following would be the predicted levels of cracking, rutting and cumulative heavy traffic at 90% reliability for 13.75 years.

- Longitudinal Cracking – 147 meters for 152.4-meter section
- Alligator Cracking – 63.6% bottom up (81.71% at Reliability)
- AC Thermal Fracture (Transverse Cracking) – 0.01 meters for 152.4-meter section (2.41 meters at Reliability)
- Rut Depth – 21.61mm at Reliability (4.61mm AC, 2.68mm Base, 10.80mm Subgrade, Total 18.09mm)
- IRI – 2.78 m/km (3.64 m/km at Reliability)
- The cumulative heavy loads are 62,319.

The 20-year analysis indicated this section would not meet the reliability criteria for the full design term with the exception of thermal cracking. Unlike 360801, this thicker design section showed a more gradual deterioration prediction with alligator cracking to progress more readily than any of the other distresses. Figure C-2, Appendix C provides the summary of the input variables for the MEPDG analysis for data extracted from the LTPP database. In instances where data inputs were not available from the LTPP database, default values provided in the MEPDG program were used. The predicted cumulative heavy loads, based on the default values, are higher than the monitored values, but would be typically considered for designing a rural commuter traffic roadway. The results from the MEPDG analysis are significantly different than those using the procedures from the AASHTO Guide for Design of Pavement Structures, 1993. Based on the material types and thicknesses the design Structural Number (SN) was 4.75 with an initial Present Serviceability Rating (PSR) of 3.8. Using the 1994 estimated Equivalent Single Axle Loads (ESAL's) of 1, 483 and a 4% growth rate it would be 428 years before this section would reach a terminal PSR of 2.5.

5.2 Pavement Structure

The Design and as-built thickness are provided in Table 21. The as-built layer thickness were highly variable when compared with the design specifications with the AC binder and aggregate base being significantly outside of the specified tolerance of +/- 7mm, as required for this project. Some disruption of the aggregate base after final grading and tack coat, delays in delivery of asphalt, changes to asphalt supply contractor and adjustments for thickness changes between the sections could have contributed to the thickness variations.

Table 21: Pavement Structure - 360802

Layer	Layer No.	Design Thickness (mm)	As-Built Thickness (mm)	Description
AC Friction Coarse Surface Layer	5	25	20	Dense-Graded, Hot-Laid AC (Hot-Mixed, Hot-Laid Asphalt Concrete, Dense-Graded)
AC Layer Below Surface (Binder Course)	4	38	53	
AC Layer Below Surface (AC Binder/Base Course)	3	114	117	
Aggregate Base Layer	2	305	310	Dense-Graded Aggregate Base (Crushed Stone)
Subgrade	1	-	-	Course Grained Soil (Clayey Sand)

5.3 Construction

The construction of 360802 was under the same contract as 360801 using the same contractor and construction equipment with preparation, grading and paving being part of the same construction process. The pavement layers placed on 360802 were thicker than that of 360801; a few changes were required to accommodate the additional layer thickness. The aggregate base was placed and compacted in two lifts of 203mm and 102mm based on a design thickness of 305mm. The same issue as identified for 360801 was observed for the placement of the RS-1 emulsion on the aggregate base at the completion of fine grading. The construction traffic (trucks, paver and roller) were tracking the emulsion which lifted the aggregate which in turn resulted in disturbance and unevenness of the aggregate base prior to the placement of the asphalt base layer. The placement of the asphalt bound layers started on August 11th, 1994 with the placement of the asphalt base layer. The AC-15 dense graded hot mix asphalt was placed in one lift with a design thickness of 114 mm. The asphalt was processed from two mixing plants. First, a batch style plant, Genesee LeRoy Stone Corporation Plant from Stafford, New York, provided AC-15 hot mix asphalt transported a distance of 53km (with haul times averaging 60 minutes) to the placement location. Problems at the plant required a switch in asphalt suppliers. The second supplier, also using a drum mix plant, Iroquois Rock Products plant from Brockport, New York, provided AC-15 hot mix asphalt transported a distance of 21km (with haul times averaging 30 minutes) to the placement location. The placement of the binder layer with a design thickness of 38mm followed the placement of the base coarse layer using the same AC-15 asphalt mix. Table 22 provides the placement locations for the paving materials sourced from the two asphalt batch plants. An AC-20 high friction type 7F asphalt surface layer was placed on August 12th, 1994 in one lift with a design thickness of 25mm. Table 23 provides the detailed information on the paving and compaction of the hot mix asphalt layers. There were no unusual circumstances identified with the exception of delays in receiving asphalt material from the plant. The weather was ideal for paving and there were no identified problems with the transportation or paving equipment.

Table 22: Location of Paving Materials from the Two Asphalt Batch Plants

Paving Lane	AC Base		AC Binder		AC Top	
Right	0+00-0+17	ST	0+00-0+78	ST	0+00-5+00	ST
	0+17-1+30	BR	0+78-2+00	BR		
	1+30-2+43	ST	2+00-4+75	ST		
	2+43-5+00	BR	4+75-5+00	BR		
Left	0+00-5+00	ST	0+00-0+50	BR	0+00-5+00	ST
			0+50-2+50	ST		
			2+50-3+80	BR		
			3+80-4+75	ST		
			4+75-5+00	BR		

ST - Genesee LeRoy Stone Corp. Stafford Asphalt Batch Plant
BR - Iroquois Rock Products Brockport Asphalt Batch Plant
Right Paving Lane: 1.52 m outside shoulder + 3.15 m of the right GPS lane
Left Paving Lane: 0.51 m of the right GPS lane + 3.66 m left passing lane

Table 23: Plant Mixed Asphalt Bound Layers – Paving and Compaction

Layer	Lift No.	Placement Dates	Placement Thickness (mm)	Average Plant Mix Temp. (ºC)	Min/Max Placement Temp. (ºC)	Breakdown Roller (Metric Tonnes)	Breakdown Coverage	Finish Roller (Metric Tonnes)	Finish Coverage	Mean Air Temp. (ºC)	Compacted Thickness (mm)	Mean Density (kg/m^3)	Density Standard Deviation (kg/m^3	Min. Density (kg/m$^{3)}$	Max. Density (kg/m^3)	No. of Samples	Curing period (days)
AC Base*	1	11-Aug-94	208**	152	132-149	Double-Drum Vibr	2	Double-Drum Vibr	2	27	117	-	-	-	-	-	-
AC Binder*	1	11-Aug-94	-	157	138-149	Double-Drum Vibr	1	Double-Drum Vibr	2	27	53	-	-	-	-	-	-
AC Surface	1	12-Aug-94	30	154	141-143	Double-Drum Vibr	1	Double-Drum Vibr	1	27	20	2234	3.2	2231	2239	3	-

*Note: Breakdown roller completed the intermediate and final compaction
**Note 2: Value most likely combined AC Base and Binder

As part of the construction, rod and level measurements were taken at the completion of the preparation of the subgrade, aggregate base and the asphalt base and surface layers by the contractor. Nuclear densities were also taken at the completion of the compaction of the subgrade, aggregate base and asphalt surface by PSI who was also responsible for the material sampling and testing activities. FWD tests were taken on the subgrade and aggregate base layers at time of construction with the FHWA-LTPP FWD using testing protocol P059.

The eastbound portion of the Lake Ontario State Parkway containing the SPS-8 section 360802 was constructed as follows:

- The driving lanes are 3.66 meter wide with the outside (right) lane being monitored
- The outside monitoring lane was constructed with a hot mix asphalt surface friction course over a hot mix asphalt base, with a crushed stone underlying base layer over a compacted clayey sand subgrade with fragments of shale
- The inside shoulder is comprised of curb with catch basins draining to a turf median. The outside lane drains to the turf shoulder
- A left turn from the left lane is located in the area of station 1+00 to 2+00 which provides access to the westbound lanes and a local roadway on the north side
- The outside shoulder (adjacent to the monitored lane) is 1.52 meters wide with a 203mm crushed stone base and 102mm hot mix asphalt surface
- There is no subsurface drainage for the monitored lane
- The longitudinal surface joint was 3.65 meters from the outside shoulder lane edge joint or edge stripe

5.4 Forensic Material Sampling and Observation

The profile, MDS and FWD surveys were completed on May 20, 2008 prior to selecting the locations for coring, DCP and split-spoon sampling. The locations for the surface material, DCP and split-spoon sampling, were based on a review of the FWD data, manual distress and drainage conditions. As the primary site under review was 360801, only one location was selected for DCP and split-spoon sampling. The site review indicated the deflections and surface distress conditions were variable. There was a large amount of water on the shoulder area between stations 2+20 and 2+50; NYSDOT personnel indicated a possible broken water pipe under the roadway at this location was under investigation. The 150mm cores that would be used for laboratory analysis and provide access for DCP and split-spoon sampling were located in the midlane and outer wheelpath at stations 3+00 (91.4m). The DCP location was at the spot of the FWD test with the split spoon sampling offset by 450mm in the eastbound direction. The cores from the DCP location were selected for the laboratory analysis with the second set of cores retained as spares, in the event additional materials were needed. The initial set of cores, which were transferred to the NYSDOT laboratory, had to be disposed of due to asbestos contamination from a leaky roof. Replacement cores were collected on October 7, 2008. A set of FWD tests were collected at 7.62-meter intervals on October 6, 2008 to select the location for 150mm core samples for transfer to the NYSDOT laboratory. The location for these set of cores was at stations 2+50 (76.2m) and 4+25 (129.5m). DCP tests were also taken at the core locations; selectively from the core holes that had the least amount of water infiltration from the coring activities. Split-spoon sampling was not possible as the utility clearance had expired and no further utility locates were initiated. The locations for the 100mm cores were based on an examination of the surface to select representative areas with cracks that would provide core samples that could be examined to determine the extent of damage. The primary distresses were low to moderate severity alligator cracking that was in the wheelpaths, midlane, and propagating from the centerline longitudinal crack. The high severity centerline longitudinal crack had multiple cracks that progressed into each lane but were more prevalent in the SPS-8 monitored lane. In addition there were 25 low severity partial transverse cracks. Figure E-7 to E-10, Appendix E, provides photos of section 360802 that depict the types of distresses evident over the length of section. Severe cracking prior to the start of the section at station 0+00, as seen in the photo Figure E-6, Appendix E, and progressing into the end of the section at station 5+00 could be partially associated with the cores taken at each end of the section. In these locations the patching of the cores was deteriorated with a noticeable amount of cracking in the area of the cores.

Figure 7 shows the layout of sampling and testing locations for the twelve 100mm cores that would be used to examine the asphalt layers and associated cracking, and the four 150mm cores that would be retrieved for laboratory samples, and to provide access for DCP and split-spoon testing. Figure 8 shows the layout of the sampling and test locations for the eight 150mm replacement cores that were collected on October 7, 2008.

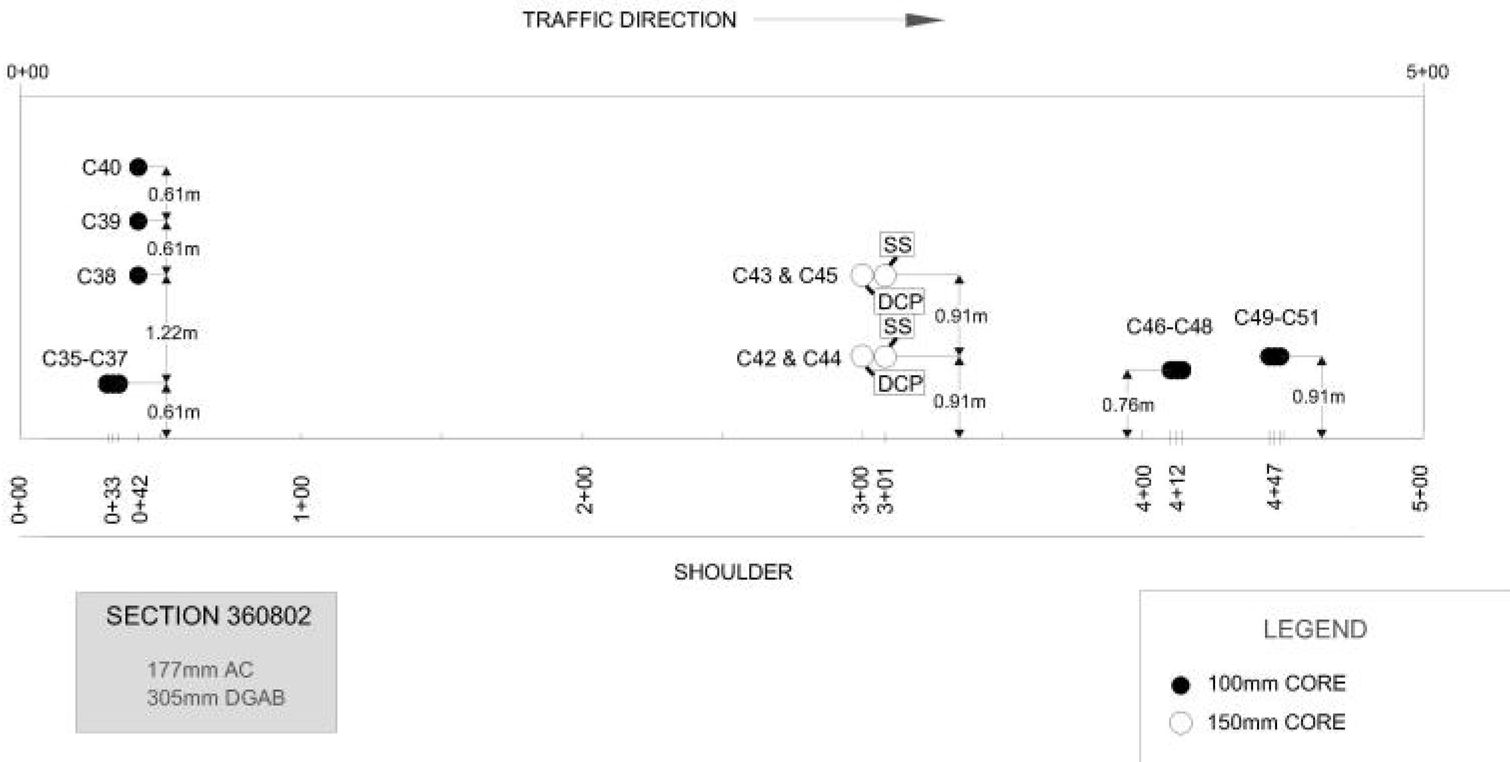

Figure 7: Layout of Sampling and Test Locations (May 21, 2008)

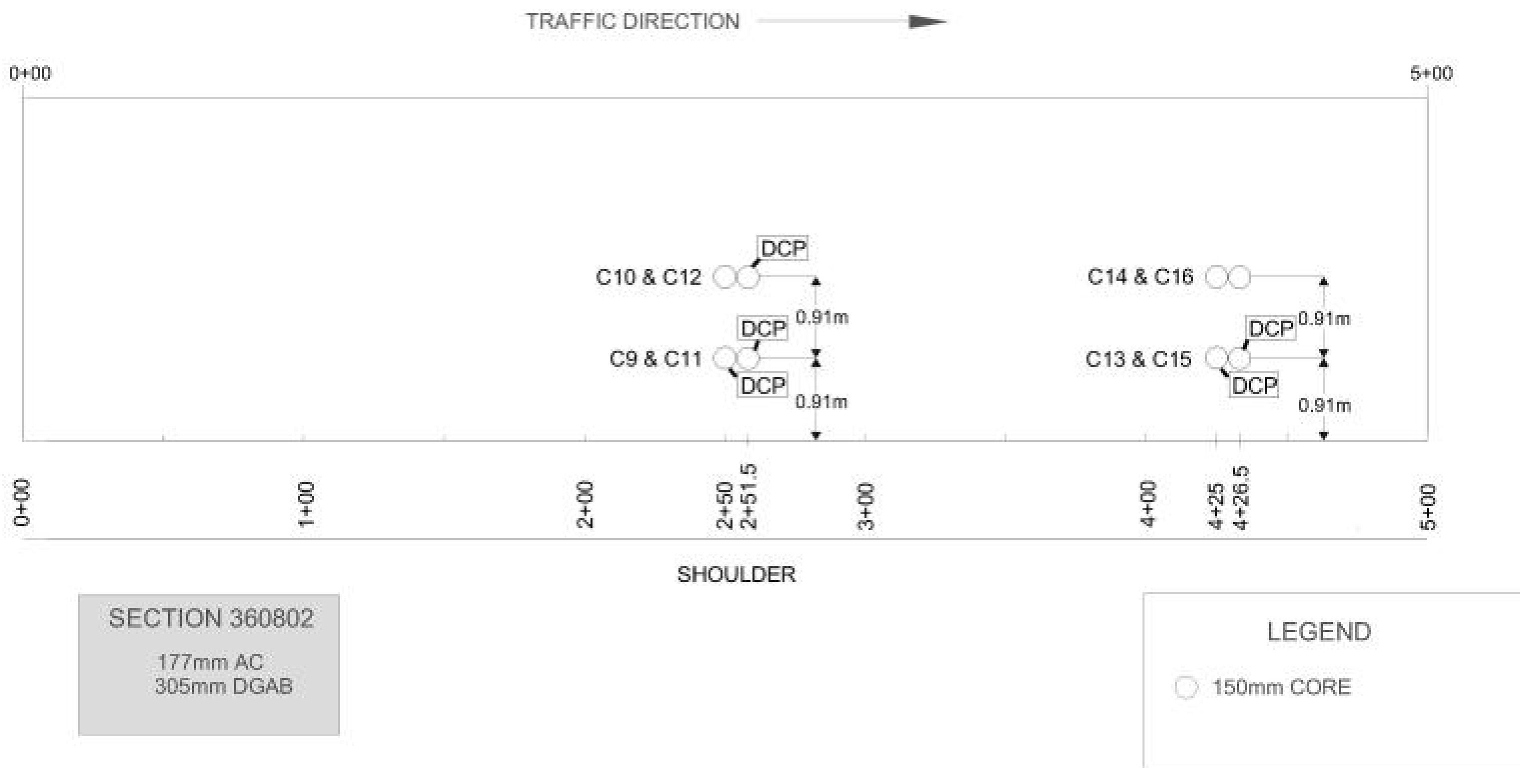

Figure 8: Layout of Sampling and Test Locations (October 7, 2008)

5.4.1 Cores and Core Examination

The core sampling, handling, measurement and marking followed the same procedure as for section 360801. The photo in Figure F-9, Appendix F shows the marks to locate the cores at the location of fatigue cracking in the outer wheelpath. A photo of the cores, taken in this location is provided in Figure F-10, Appendix F showing the top-down cracking and variable depth and condition of the cores. The crack depths ranged from 2.5 mm to 66mm within the surface and binder layer with no visible distress in the AC base layer. The cores taken at a partial transverse crack branching from the centerline longitudinal crack had top-down cracking through the surface and binder layer which diminished to the surface layer at the edge of the crack as evident in the photo in Figure F-11, Appendix F. Two sets of cores were taken at the longitudinal crack in the area of the outer wheel path. The low severity longitudinal crack penetrated the surface with the moderate severity crack in both the surface and binder layers with some stripping as evident in Figure F-12, Appendix F. All cracks were top-down as evident in the photos mentioned above. There was no lack of bond issues between layers or stripping at the bottom of the cores. The detailed measurements and core examination results for the 100mm cores are provided in Table 24. The stationing and sample number for each core is provided to cross reference with the location as provided in the core layout diagram in Figures 7 and 8.

The handling, packing and shipping of the 150mm cores was the same as for section 360801. Example photos that depict the measurement and labeling are provided in Appendix F. Figure F-16 (Station 3+00) for the May 21st core sampling, and F-19 (Station 2+50) and F-20 (Station 4+25) from the October 7th sampling. The above photos also provide an indication of the type of distress evident in the cores taken at these locations. The details of the measurements and examination of the cores are provided in Table 24.

Based on the examination of the cores, roughly 55% of the cores had visible void areas primarily near the interface of the different AC paving layers. The surface was substantially weathered, but none of the cores had aggregate particles loose enough to be separated. There was no indication of lack of bond between layers; there was evidence of separation due to stripping at the locations of cracks, especially for the cracks that penetrated both the surface and binder layer. All cracks identified were top-down with the low severity longitudinal cracks to the depth of the surface layer and the moderate severity longitudinal cracks penetrating to the depth of the binder layer. The partial transverse crack penetrated to the depth of the AC base layer near the abutment to the longitudinal crack but diminished toward the end of the crack.

Table 24: Summary of Core Measurement and Examination

150mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
21-May-08	3+00	0.91	C42	5							25.4	DCP					
				4							45.7						
				3							160						
	3+00	1.83	C43	5							45.7	DCP					
				4							45.7						
				3							132.1						
	3+01	0.91	C44	5							27.9	Split Spoon					
				4							43.2						
				3							139.7						
	3+01	1.83	C45	5							25.4	Split Spoon					
				4							45.7						
				3							134.6						
7-Oct-08	2+50	0.91	C9	5	22.9	22.9	20.3	22.9	20.3	22.9	22.2	DCP	Y	Y	N	NA	NA
				4	53.3	50.8	53.3	50.8	50.8	53.3	52.1						
				3	121.9	121.9	121.9	121.9	121.9	121.9	121.9						
	2+51.5	0.91	C11	5	22.9	22.9	22.9	22.9	22.9	22.9	22.9	DCP	Y	Y	N	NA	NA
				4	48.3	48.3	50.8	48.3	48.3	50.8	48.9						
				3	121.9	116.8	124.5	119.4	116.8	124.5	120.7						
	2+51.5	1.83	C12	5	20.3	22.9	20.3	20.3	20.3	22.9	21	DCP	Y	Y	N	NA	NA
				4	48.3	48.3	48.3	48.3	48.3	48.3	48.3						
				3	121.9	119.4	119.4	119.4	119.4	121.9	120						
	4+25	0.91	C13	5	20.3	20.3	17.8	17.8	17.8	20.3	19.1	DCP	Y	Y	N	NA	NA
				4	53.3	50.8	53.3	50.8	50.8	53.3	52.1						
				3	134.6	121.9	132.1	127	121.9	134.6	128.9						
	4+26.5	0.91	C15	5	20.3	20.3	20.3	20.3	20.3	20.3	20.3	DCP	Y	Y	N	NA	NA
				4	50.8	50.8	50.8	48.3	48.3	50.8	50.2						
				3	109.2	109.2	116.8	109.2	109.2	116.8	111.1						

Table 24 Continued: Summary of Core Measurement and Examination

150mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
7-Oct-08	2+50	1.83	C10	5	20.3	22.9	20.3	22.9	20.3	22.9	21.6		Y	Y	N	NA	NA
				4	50.8	50.8	53.3	48.3	48.3	53.3	50.8						
				3	127	127	127	127	127	127	127						
	4+25	1.83	C14	5	20.3	20.3	20.3	20.3	20.3	20.3	20.3		Y	Y	N	NA	NA
				4	50.8	50.8	48.3	50.8	48.3	50.8	50.2						
				3	127	121.9	127	132.1	121.9	132.1	127						
	4+26.5	1.83	C16	5	20.3	20.3	20.3	20.3	20.3	20.3	20.3		Y	Y	N	NA	NA
				4	50.8	50.8	48.3	48.3	48.3	50.8	49.5						
				3	114.3	116.8	114.3	116.8	114.3	116.8	115.6						
100mm Core																	
21-May-08	0+31	0.61	C35	5	17.8	20.3	17.8	20.3	17.8	20.3	19.1	Fatigue OWP	N	Y	Y	33	T
				4	50.8	45.7	50.8	55.9	45.7	55.9	50.8						
				3	144.8	144.8	144.8	139.7	139.7	144.8	143.5						
	0+33	0.61	C36	5	17.8	17.8	20.3	17.8	17.8	20.3	18.4	Fatigue OWP	N	N	Y	66	T
				4	25.4	25.4	27.9	25.4	25.4	27.9	26						
				3	170.2	165.1	165.1	172.7	165.1	172.7	168.3						
	0+35	0.61	C37	5	17.8	17.8	17.8	17.8	17.8	17.8	17.8	Fatigue OWP	N	Y	Y	2.5	T
				4	63.5	61	58.4	61	58.4	63.5	61						
				3	139.7	139.7	144.8	152.4	139.7	152.4	144.1						
	0+42	1.83	C38	5	20.3	17.8	17.8	17.8	17.8	20.3	18.4	Fatigue	Y	N	Y	68.6	T
				4	38.1	40.6	43.2	43.2	38.1	43.2	41.3						
				3	132.1	132.1	132.1	132.1	132.1	132.1	132.1						
	0+42	2.44	C39	5	22.9	20.3	22.9	22.9	20.3	22.9	22.2	Transverse Crack	Y	Y	Y	78.7	T
				4	53.3	55.9	50.8	50.8	50.8	55.9	52.7						
				3	127	129.5	132.1	132.1	127	132.1	130.2						
	0+42	3.05	C40	5	22.9	25.4	25.4	25.4	22.9	25.4	24.8	Fatigue	Y	Y	Y	22.9	T
				4	53.3	53.3	53.3	53.3	53.3	53.3	53.3						

Table 24 Continued: Summary of Core Measurement and Examination

100mm Core		PE Offset (m)	Sample #	Layer #	Measurements				Min.	Max.	Average	Surface Distress	Void present	Layer intact	Crack present	Avg. Crack depth (mm)	Crack at Top/ Bottom
Date Sampled	Station				1	2	3	4									
21-May-08	0+42	3.05	C40	3	119.4	119.4	116.8	116.8	116.8	119.4	118.1	Fatigue	Y	Y	Y	22.9	T
	4+10	0.76	C46	5	17.8	17.8	17.8	17.8	17.8	17.8	17.8	Longitudinal within OWP	N	Y	Y	5.1	T
				4	50.8	50.8	50.8	50.8	50.8	50.8	50.8						
				3	139.7	139.7	139.7	139.7	139.7	139.7	139.7						
	4+12	0.76	C47	5	20.3	20.3	20.3	20.3	20.3	20.3	20.3	Longitudinal within OWP	N	Y	Y	17.8	T
				4	50.8	50.8	48.3	48.3	48.3	50.8	49.5						
				3	139.7	139.7	139.7	139.7	139.7	139.7	139.7						
	4+14	0.76	C48	5	17.8	17.8	17.8	17.8	17.8	17.8	17.8	Longitudinal within OWP	N	Y	Y	17.8	T
				4	55.9	53.3	53.3	50.8	50.8	55.9	53.3						
				3	132.1	132.1	137.2	132.1	132.1	137.2	133.4						
	4+45	0.91	C49	5	15.2	15.2	15.2	17.8	15.2	17.8	15.9	Longitudinal within OWP	N	Y	Y	63.5	T
				4	53.3	45.7	45.7	45.7	45.7	53.3	47.6						
				3	139.7	134.6	144.8	139.7	134.6	144.8	139.7						
	4+47	0.91	C50	5	17.8	17.8	17.8	17.8	17.8	17.8	17.8	Longitudinal within OWP	N	Y	Y	53.3	T
				4	53.3	53.3	50.8	48.3	48.3	53.3	51.4						
				3	134.6	132.1	132.1	132.1	132.1	134.6	132.7						
	4+49	0.91	C51	5	20.3	20.3	20.3	20.3	20.3	20.3	20.3	Longitudinal within OWP	N	Y	Y	63.5	T
				4	58.4	58.4	55.9	55.9	55.9	58.4	57.2						
				3	127	127	129.5	129.5	127	129.5	128.3						

Notes: Measurements 1-4 are starting with traffic direction going clockwise.

5.4.2 Pavement Quality Indicator (PQI) Density Test

The Pavement Quality Indicator (PQI) density unit was used to take density readings at the location of the DCP and split-spoon sampling at station 3+00. The results of these tests are provided in Table 25. The circumstances regarding calibration and conversion of output value to a density are the same as for 360801; there were no available laboratory density values to calibrate the device readings.

Table 25: Summary of PQI Data Collection

Core #	Station	Offset	Gauge Reading
C42	3+00	0.91	2255
C43	3+00	1.83	2005
C44	3+01	0.91	2076
C45	3+01	1.83	2034

5.4.3 Split Spoon Sampling & Dynamic Cone Penetrometer (DCP) Results

Table 26 provides the results of the split-spoon sampling for the midlane and outer wheelpath locations sampled. The results indicate the aggregate base and subgrade materials are poor supporting layers. The values from the base material can be considered rather questionable as the base was damp from the core activity, along with the core spin off causing the top 25-50mm of material to loosen. The split-spoon field data sheets are provided in Appendix H.

Table 26: Summary of Split Spoon Sampling Results – 21-May-08

Location	Station (*ft*)	Offset (*m*)	Lane	Description	Moisture Content (%)	Depth (m)		Blows/150mm					
						From	*To*	*N-count*					
C44	3+01	0.91	OWP	~260mm crushed gravel	6.0	0	0.91	9	6	5	5	5	5
				coarse-grained clayey sand	16.9								
C45		1.83	ML	~330mm crushed gravel	5.0	0	0.91	10	7	7	5	5	7
				coarse-grained clayey sand	16.5								

Table 27 provides the results from the DCP tests performed at the FWD test points in the midlane and outer wheelpath. The field moisture values were taken from the soil samples retrieved as part of the split-spoon sampling. Although the field moistures were slightly above optimum there were no adjustments to the DCP results; similarly there were no seasonal adjustment factors applied to the FWD results. There was refusal for the DCP in the outer wheelpath at station 2+51.5. The subgrade CBR was on average lower than that encountered for 360801. The field data sheets are provided in Appendix I.

Table 27: Summary of DCP Test Results (360802)

Test Date	Location	Station *(ft)*	Offset *(m)*	Lane	Layer	Layer Type	Field Moisture *(%)*	DCPI *(mm/blow)*	DCP CBR	DCP Moduli *(MPa)*	FWD CBR	FWD Moduli *(MPa)*
21-May-08	C42	3+00	0.91	OWP	3 to 5	AC						5583
					2	Base	6.0	5.6	49	69.0		
					1	Subgrade	16.9	14.5	17	34.3	37	58.5
	C43		1.83	ML	3 to 5	AC						3717
					2	Base	5.0	5.6	51	70.3		
					1	Subgrade	16.6	11.6	20	39.5	35	56.6
7-Oct-08	C9	2+50	0.91	OWP	3 to 5	AC						3752
					2	Base		5.3	51	70.6		
					1	Subgrade		7.4	38	58.0	49	70
	C11	2+51.5	0.91	OWP	3 to 5	AC						3752
					2	Base		4.4	59	77.7		
					1	Subgrade					49	70
	C12		1.83	ML	3 to 5	AC						3997
					2	Base		5.5	46	67.2		
					1	Subgrade		8.3	31	51.1	80	95.7
	C13	4+25	0.91	OWP	3 to 5	AC						3462.7
					2	Base		4.8	57	76.0		
					1	Subgrade		13.8	16	34.4	46	67
	C15	4+26.5	0.91	OWP	3 to 5	AC						3462.7
					2	Base		3.6	70	87.6		
					1	Subgrade		10.9	26	45.2	46	67

*Note: DCP Moduli values for the base/subgrade layers may not be representative due to refusal at some locations during DCP testing

5.5 Material Properties and Laboratory Test Results

The material sampling at the time of construction included field samples collected from the paver, cores and asphalt binder from the asphalt processing plants. For the AC material, samples were retrieved from both the Stafford and Brockport plants. As part of the forensic data collection and laboratory testing, the core samples and testing were done the same as for 360801. The material properties for the unbound layers (aggregate base and subgrade) are provided in Table 28. From the soil samples retrieved at time of construction, the subgrade was classified as a sand or clayey sand depending on location. The subgrade was proof rolled, leveled and fine graded prior to the placement of the surface layers. This material was well compacted with the density results exceeding 95% of the standard proctor. The crushed stone base was placed directly on the subgrade in two lifts to an average depth of 314mm, but was highly variable as previously mentioned. The nuclear density tests taken at time of construction indicate the material was not compacted within the 95% tolerance of the standard proctor test. The moisture content was below optimum which may have had an effect on the compaction. The results of the nuclear density tests taken during the time of construction are provided in Table 29. The pavement structure has shown no signs of settlement or fatigue in the bottom layers of the asphalt bound layers, which would indicate no issues were evident with the support structure, especially with this location having a relatively high and variable water table with no external drains or drain layer in the monitoring lane. The tack-coat placed at the completion of the aggregate base preparation was still tacky at the time of placement of the asphalt pavement. The material properties of the aggregate used in the asphalt mix are provided in Table 30. The materials gradations and properties are the same for the AC surface and base layer of 360801 with the binder layer having the same maximum stone size as the asphalt base but with a higher stone content at 65% with 32% sand. The core samples taken from this section indicated that the locations of cracks and associated stripping at the layer interfaces were associated with the surface layer having the higher percentage of sand and smaller maximum stone size.

Table 28: Material Properties – Unbound Layers

Description	Granular Base, @ 5+35, .91 m Offset	Subgrade, @ 5+40, .91 m Offset	Subgrade, @ 5+40, .91 m Offset
Material (Code)	Crushed Gravel (304)	Coarse-Grained Soils: Clayey Sand (216)	Coarse-Grained Soils: Clayey Sand (216)
Resilient Modulus (MPa)		49.6	
Lab Max. Dry Density (kg/m^3)	2419	1826	
Lab Opt. Moisture Content (%)	5	14	
In-situ Wet Density (kg/m^3)	2265	2078	
In-situ Dry Density (kg/m^3)	2210	1917	
In-situ Moisture Content (%)	2.5	8.4	
Liquid Limit	16	12	19
Plastic Limit	15	13	14
Plasticity Index	1	NP	5
% Gravel	64.7	2	2
% Sand	26	90.2	91.6
% Silt / % Clay			2.5 / 3.5
% Passing #200	9.3	7.8	6.4
Max Stone Size (mm)	38.1	19.1	9.5
Specific Gravity	2.83	2.749	2.737

Table 29: Post-Construction Testing – Nuclear Density Testing

Date	Station	Offset (*m*)	Layer	Layer Type	In-situ Dry Dens. (*kg/m^3*)	In-situ Moisture (%)
15/16-Jul-94	1+00	1.52	1	Subgrade	1876	9.4
	2+50	1.52			2001	8.9
	4+00	1.52			1929	8.1
	5+40	0.91			1863	7.1
25-Jul-94	1+00	1.83	2	DGAB	2193	2.6
	2+50	1.83			2204	2.4
	4+00	1.83			2231	2.7
	5+35	0.91			2212	2.2
11-Nov-94	1+00	1.83	5	AC - Surface	2235	
	2+50				2231	
	4+00				2239	

Table 30: Aggregate Material Properties – Bound Layers

Description	AC - Surface	AC - Binder	AC - Base
Material (Code)	Hot Mixed, Hot Laid AC, Dense Graded (1)	Hot Mixed, Hot Laid AC, Dense Graded (1)	Hot Mixed, Hot Laid AC, Dense Graded (1)
Layer #	5	4	3
% Gravel	16.0	65.0	50.0
% Sand	83.0	32.0	46.0
% Passing #200	1.0	3.0	4.0
Max Stone Size (mm)	9.5	19.1	25.4
BSG of Coarse Agg.	2.63	2.66	2.68
Absorption (%)	0.5	0.4	0.7
BSG of Fine Agg.	2.59	2.61	2.63
Absorption (%)	1.2	1.1	1.2

The AC-15 asphalt cements were sourced from the tank reservoir of the two plants providing asphalt to the project. The asphalt concrete mix using the AC-15 asphalt cement was also produced at two different batch plants; Genesee LeRoy Stone Corporation Plant from Stafford, New York and the Iroquois Rock Products plant from Brockport, New York. The AC-20 asphalt cement was only sourced from the Stafford plant. The binder properties are provided in Table 31. The AC-15 asphalt cement was used for the asphalt base/binder layer with the AC-20 asphalt cement used in the friction surface layer. There was no mention or information on the inclusion of mineral fillers or anti-stripping agents in the construction report, or available from the IMS database. The test results for the AC-20 are similar to those of 360801 but there is a noticeable difference for the AC-15 asphalt cements that were tested from the supply for the base and binder asphalt layers. The various AC properties for the materials sampled and tested shortly after construction are provided in Table 32. These results are from the flexural creep stiffness, indirect tension failure and resilient modulus tests performed by the contracted laboratory. The tests performed by the NYSDOT laboratory as part of the forensic investigation are provided in Table 33 and 34. The results provided in Table 33 indicate that there is little difference in the specific gravity of the materials. The result of the complex modulus, asphalt stiffness, failure stress and strain tests performed by the NYSDOT laboratory are provided in Table 34. These results indicate there are no issues with the complex modulus or phase angle. For layers 4 and 5 the stiffness @ 60s and m-value @ 60s were variable and slightly outside the expectation of stiffness at 60s having an MPa < 300 and m-value > 0.3. Table 35 provides a comparison of the asphalt layer properties (voids, bulk and maximum specific gravity) for the tests performed post construction and those performed as part of the forensic study. When comparing the post construction air voids in the asphalt mix with those at the time of the forensic investigation, there is a slight decrease in the percentage of air void for the three AC mixes. A comparison of the Bulk Specific Gravity (BSG) shows a minimal difference between the timeframes for the three AC mixes. The results are the same for the Maximum Specific Gravity (MSG) with very little change identified in the specific gravity properties.

Table 31: Binder Properties – Bound Layers

Layer Type	Layer #	AC Content (%)	Avg. Specific Gravity			Kinematic Viscosity @ 135°C (*g*cm^{-1}*s^{-1}*)			Absolute Viscosity @ 60°C (*mm^2/s*)			Penetration of AC @ 25°C (*.1mm*)		
			Min	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*
AC – Base (AC-15)	3		1.044	1.098	1.071	690	927	809	7487	15458	11473	36.0		
AC – Binder (AC-15)	4		1.029	1.070	1.050	403	680	542	2257	6637	4447	42.0		
AC – Surface (AC-20)	5		1.08			747			8856			39	63	51

Table 32: Post-Construction Test Results - Asphalt Layers

Description	AC - Binder	AC - Base	AC - Base
Layer #	4	3	3
Creep Compliance at 1s @ 25°C (GPa^{-1})	0.657	1.006	0.599
Creep Compliance at 2s @ 25°C (GPa^{-1})	0.917	1.292	0.847
Creep Compliance at 5s @ 25°C (GPa^{-1})	1.486	2.177	1.559
Creep Compliance at 10s @ 25°C (GPa^{-1})	2.135	3.037	2.302
Creep Compliance at 20s @ 25°C (GPa^{-1})	2.997	4.320	3.525
Creep Compliance at 50s @ 25°C (GPa^{-1})	4.875	6.967	6.280
Creep Compliance at 100s @ 25°C (GPa^{-1})	6.928	9.638	9.963
Creep Poisson, *v*	0.26	0.45	0.39
Indirect Tensile Strength (MPa)	1.99	0.95	1.11
Indirect Tensile Poisson, *v*	0.22	0.34	0.53
M_R @ 25°C (MPa)	4940	3660	4300
M_R Poisson, *v*	0.2	0.41	0.25

Table 33: Forensic Laboratory Test Results - Specific Gravity of Asphalt Mix

Sampling Date	Layer Type	Layer #	Specific Gravity			SG of Coarse Agg.			SG of Fine Agg.		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
7-Oct-08	AC - Base	3	1.046	1.089	1.059	2.654	2.658	2.656	2.569	2.585	2.578
	AC - Binder	4	1.049	1.053	1.050	2.649	2.676	2.663	2.589	2.621	2.602
	AC - Surface	5	1.049	1.051	1.050	2.368	2.514	2.472	2.535	2.561	2.552

Table 34: Forensic Laboratory Test Results – Asphalt Layers

Sampling Date	Layer #	Complex Modulus (*G** *(kPa)*)			Phase Angle *D (°)*			Stiffness @ 60s (*MPa*)			m-value @ 60s			Fracture Properties - Failure Stress (*MPa*)			Fracture Properties - % Failure Strain (*(mm/mm) x 100*)		
		Min	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*	*Min*	*Max*	*Avg*
7-Oct-08	3	6395	8874	7216	42.5	45.8	44.7	175	209	187	0.307	0.336	0.321	2.89	3.42	3.16	0.71	0.77	0.73
	4	8507	18187	13333	34.1	42.3	38.0	204	373	294	0.245	0.306	0.273	2.66	2.94	2.75	0.57	0.74	0.66
	5	10354	14523	12530	33.9	39.9	37.2	244	313	276	0.261	0.281	0.270	2.59	3.48	3.11	0.47	0.99	0.75

Table 35: Comparison of Asphalt Layer Properties-Void and Specific Gravity

Sampling Date	Layer Type	Layer #	Air Voids (%)			BSG			MSG		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Post-Construction ('95-'96)	AC - Base	3	7.3			2.250	2.471	2.360	2.510	2.563	2.545
	AC - Binder	4	8.8			2.121	2.391	2.306	2.529	2.529	2.529
	AC - Surface	5	11.1			2.135	2.169	2.154	2.422		
7-Oct-08	AC - Base	3	4.4	9.2	7.1	2.264	2.365	2.317	2.473	2.508	2.495
	AC - Binder	4	5.0	8.5	6.6	2.300	2.391	2.337	2.468	2.539	2.501
	AC - Surface	5	7.8	9.9	8.5	2.172	2.279	2.228	2.411	2.478	2.436

5.6 Ground Penetrating Radar Results

The results of the rod and level surveys and core thickness measurements indicated a high variability in the thickness of the various layers with the average thickness for the aggregate base being within the design specification, but the asphalt surface layers being thicker than the design specifications. This variability was confirmed by the results from the GPR survey. Figure J-4 to J-6, Appendix J provides the results of the GPR survey for the inner wheel path, midlane and outer wheel path of section 360802, respectively. The interpretation of the GPR data for the aggregate base was incomplete for the three runs taken on the section; the location at the beginning and end of section could be interpreted but the middle length of the section did not provide a determinable layer. Table 36 provides a comparison of the thickness as determined from the rod and level survey, core sample information and GPR survey. In most cases, the results show a lower minimum and higher maximum thickness for the AC material than that of the surveys taken at the time of construction. The aggregate material also shows a fair amount of variability as is evident by the higher standard deviation over the length and width of the section. Overall, the GPR average thicknesses are lower than the surveys taken at the time of construction. The GPR data for this section would indicate that the construction platform is variable with the construction tolerances being outside the design specification of +/- 7mm.

Table 36: Section 360802: Comparison Between GPR & LTPP Layer Data

Location	Layer	GPR Thickness (mm)			Standard Deviation	LTPP Layer Thickness (mm)			Standard Deviation
		Min	Max	Avg		Min	Max	Avg	
IWP	AC	144.63	187.16	163.14	9.03	164.00	201.00	181.00	12.52
	Granular	198.73	324.74	253.32	28.00	271.00	329.00	307.09	16.60
ML	AC	163.77	241.55	192.86	16.14	162.00	207.00	183.36	15.02
	Granular	239.90	327.84	277.68	21.03	287.00	338.00	311.82	14.82
OWP	AC	160.48	217.61	189.51	12.58	171.00	231.00	188.45	17.22
	Granular	225.30	343.08	271.13	28.05	293.00	329.00	311.00	13.42

5.7 Collection of Monitoring Data

As part of the forensic testing at this LTPP SPS-8 site, Falling Weight Deflectometer (FWD), Manual Distress Survey (MDS), Transverse and Longitudinal Profiles and Elevation data were collected. This data has been added to the LTPP Information Management System (IMS) database. The pavement performance monitoring data has been analyzed and historical trends are reported as part of this document. The data collection at the time of construction and post construction data collection was done in conjunction with that performed on 360801 and followed the same procedures and timeline. The following provides the results of the analysis and reports on the trends in the data from the initial data collected as part of the LTPP program to the last set of data collected as part of the forensic study.

5.7.1 Deflection Data Analysis Results

The FWD data was collected with the FHWA-LTPP FWD following the guidelines and protocols established for collecting FWD data for the LTPP program. A total of nineteen drops (3 seating, 4 at 26kN, 4 at 40kN, 4 at 54kN and 4 at 72kN) are taken at each test point. The average normalized temperature corrected deflections for the 40-kN equivalent loading for all the stations for both midlane and outer wheelpath were plotted with time. The surface deflection trends, as reported from the sensor located under the load plate, are provided for all stations in Figure K-3, Appendix K. Similarly, the results representing the subgrade deflection trends, as reported from the sensor located 1.524 meters from the load plate, are provided for all stations in Figures K-4, Appendix K. The deflection trends, as presented in the Figure K-3, show a continual but slight increase in deflection. The deflection trend, as provided in Figure K-4, indicate that the subgrade deflections have also shown a slight increase with time. The results indicate only a small difference between the midlane and outer wheel path deflections. The backcalculated pavement resilient moduli from the historical FWD deflection data is provided in Figure K-7, Appendix K. The pavement moduli, as observed over time, show minimal change in pavement strength with time. The historical trend in subgrade resilient moduli is provided in Figure K-8, Appendix K. The results would indicate a slight weakening of the subgrade support but for the most part a minimal change over time. There was minimal difference observed between the midlane and outer wheelpath; this again is somewhat consistent with the distresses observed on the surface which were located over the complete surface area rather than being primarily associated with the wheelpaths. Figure K-9, Appendix K compares the overall pavement moduli of the two sections and shows that 360802 has had a greater pavement strength throughout the testing period. A comparison of the subgrade resilient moduli between both sections indicates reasonably similar values with 360801 having a higher rate of loss in strength.

The layer analysis, for the FWD deflection data collected on May 20th and October 6th, 2008, is provided in Table 37a and 37b with the statistical comparison provided in Tables 38a and 38b. These results show the support layers to be variable over the length of the section. The variations in the pavement layer thickness, the variability in the subgrade, the possibility of leakage from a water pipe crossing the roadway near station 2+20, the variable drainage and the surface distress would indicate the results are consistent with the site conditions. The backcalculated moduli values for the aggregate base material were variable and lower than expected. These results have not been provided; the issue is currently under investigation and any updated information would not be ready in time for this reporting.

Table 37a: Summary of FWD Layer Analysis

Date	Lane	Chainage	AC (*MPa*)	Gran. Base (*MPa*)	Subgrade (*MPa*)	E_P (*MPa*)
20-May-08	ML	0+00	1943.99		59.32	860.89
	OWP		4303.54		60.06	1464.67
	ML	0+50	1959.94		61.38	888.91
	OWP		3497.56		65.26	1211.72
	ML	1+00	2752.33		71.06	909.63
	OWP		3312.26		72.67	1027.22
	ML	1+50	3164.42		78.59	1101.56
	OWP		4179.99		84.78	1268.75
	ML	2+00	2708.34		88.18	825.47
	OWP		1609.01		61.66	571.47
	ML	2+50	3322.64		64.30	1103.11
	OWP		3155.77		52.20	990.92
	ML	3+00	3717.47		56.62	1408.06
	OWP		5583.31		58.46	2001.23
	ML	3+50	3434.49		65.40	1069.40
	OWP		3517.60		61.09	1053.45
	ML	4+00	2874.28		56.62	1037.89
	OWP		3510.70		59.49	1157.32
	ML	4+50	2840.86		66.84	977.11
	OWP		2611.19		60.98	876.88
	ML	5+00	1728.85		66.84	696.39
	OWP		1943.99		59.32	811.36

“Subgrade” column has been corrected using a factor of 0.33 in order to match field moduli.

Table 36b: Summary of FWD Layer Analysis

Date	Lane	Chainage	AC (*MPa*)	Gran. Base (*MPa*)	Subgrade (*MPa*)	E_P (*MPa*)
6-Oct-08	ML	0+00	3230.63		74.48	808.53
	OWP		4303.55		66.74	1134.59
	ML	0+50	3124.94		74.27	761.16
	OWP		3155.77		72.67	895.21
	ML	0+75	3736.81		98.15	806.06
	OWP		4437.71		84.04	1140.27
	ML	1+00	3424.56		86.03	768.46
	OWP		3220.53		80.16	868.55
	ML	1+25	3636.65		86.65	1001.98
	OWP		2371.53		74.27	935.33
	ML	1+50	4489.11		111.59	1143.27
	OWP		4030.62		101.09	1296.35
	ML	1+75	3726.23		140.31	948.06
	OWP		3718.92		86.85	1031.87
	ML	2+00	3435.29		102.58	770.90
	OWP		2332.47		78.08	755.67
	ML	2+25	4461.68		96.74	896.78
	OWP		4668.13		67.52	1115.44
	ML	2+50	3997.82		95.65	840.32
	OWP		3752.75		70.03	878.94
	ML	2+75	5001.34		134.82	1041.86
	OWP		5805.42		102.11	1429.31
	ML	3+25	4110.49		81.03	834.85
	OWP		4500.95		67.52	1212.20
	ML	3+50	3577.59		80.23	751.58
	OWP		3818.49		63.81	935.15
	ML	3+75	2647.16		69.21	652.94
	OWP		3156.51		60.77	875.86
	ML	4+00	3547.85		73.58	780.72
	OWP		3597.84		64.64	934.88
	ML	4+25	3215.89		81.07	676.13
	OWP		3462.67		67.00	859.38
	ML	4+75	3628.11		80.74	940.91
	OWP		3578.44		68.20	1216.57
	ML	5+00	1930.13		77.99	569.90
	OWP		2083.07		72.67	651.32

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

Table 38a: Statistical Summary of FWD Layer Analysis – May 20, 2008

Layer	Lane	M_R *(MPa)*			
		Min	Max	Avg	Std. Dev.
AC	ML	1728.8	3717.5	2768.0	651.4
	OWP	1609.0	5583.3	3384.1	1106.4
Gran. Base	ML				
	OWP				
Subgrade	ML	56.6	88.2	66.8	9.6
	OWP	52.2	84.8	63.3	8.7
E_P	ML	696.4	1408.1	979.3	188.5
	OWP	571.5	2001.2	1130.5	375.6

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

Table 37b: Statistical Summary of FWD Layer Analysis – October 6, 2008

Layer	Lane	M_R *(MPa)*			
		Min	Max	Avg	Std. Dev.
AC	ML	1930.1	5001.3	3606.8	695.3
	OWP	2083.1	5805.4	3666.4	913.3
Gran. Base	ML				
	OWP				
Subgrade	ML	69.2	140.3	91.4	20.3
	OWP	60.8	102.1	74.9	12.0
E_P	ML	569.9	1143.3	827.7	140.9
	OWP	651.3	1429.3	1008.2	195.4

"Subgrade" column has been corrected using a factor of 0.33 in order to match field moduli.

5.7.2 Manual Distress Data Analysis Results

The historical trend for the four distress types (fatigue, longitudinal wheelpath and non wheelpath, and transverse cracking) evident on the pavement surface of site 360802, are provided in Figures L-4 to L-6 of Appendix L. The results are from both photo interpretation of the PASCO film and the Manual Distress surveys conducted from 1994 to the final distress survey on May 20, 2008. The survey results indicate distress started to appear at the centerline pavement joint in the September 1997 distress survey. Low severity longitudinal wheelpath cracking started in 1998 with the first sign of transverse cracking showing up in the 2003 survey. Fatigue or alligator cracking became predominant in 2001 at which time there was also a large increase in the length of longitudinal cracking which steadily increased until the final survey on May 20, 2008.

Photos that show the pavement condition at the time of the final MDS taken in conjunction with the forensic data collection are provided in Figures E-7 to E-10, Appendix E. The photo in Figure E-7 shows the high severity centerline longitudinal crack, which extends the length of the section, and longitudinal midlane cracking along with cracks in the wheelpath. The photo in Figure E-8 shows the water accumulating in the area of the water line that crosses under the roadway in the area of station 2+20 to 2+50. Figure E-9 shows the low severity cracking in the wheelpath that was predominant over the section length. The photo in Figure E-10 shows the high severity cracking at the end of the section that appears to be part of the distress associated with the coring that was done outside the section limits. These were the predominant distresses evident on section 360802.

5.7.3 Longitudinal Profile Data Analysis Results

Figure 9 provides the historical IRI data for section 360802. A review of the historical IRI shows a substantial change in roughness over time. Although there is less distress on this section when compared with 360801 it is considerably rougher. The initial IRI for this section was also slightly higher than 360801. Again, there is a high seasonal variability. The results indicate the IRI for this section is approaching the design limit and near term corrective action should be considered.

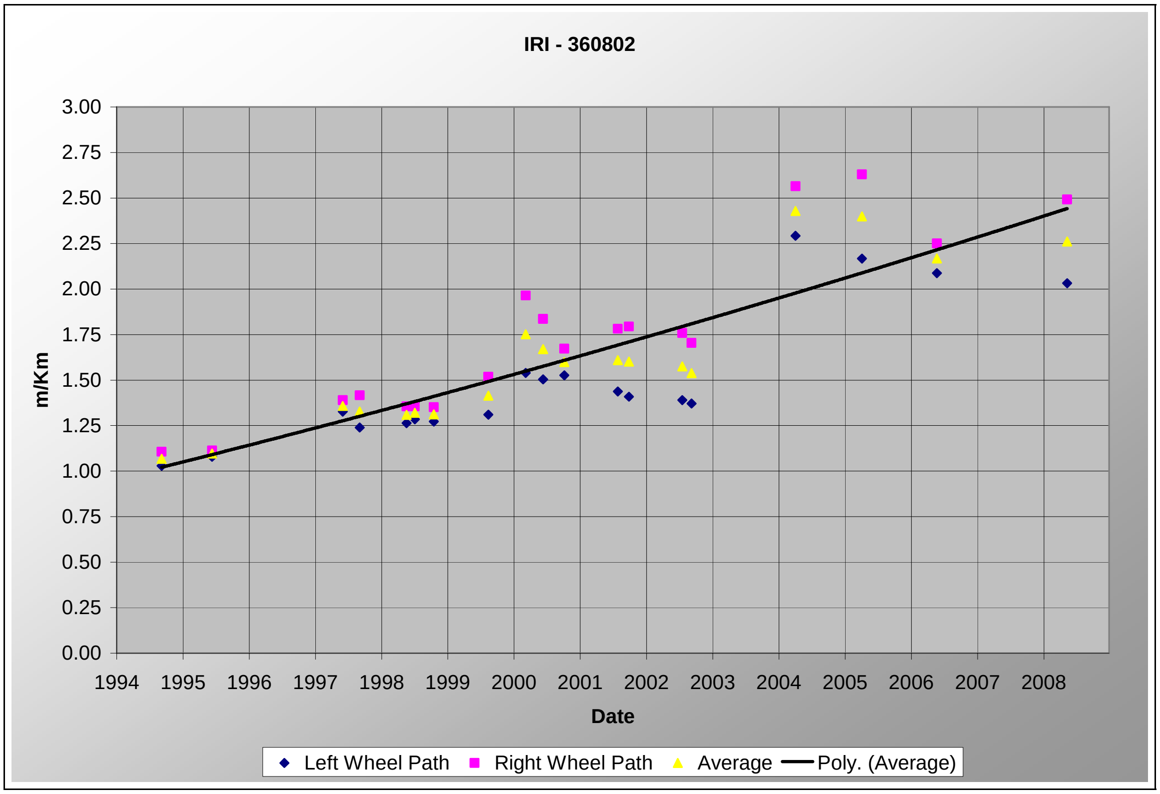

Figure 9: Historical Trend in IRI

5.7.4 Transverse Profile Data Analysis Results

The historical trends in rut depth from the Dipstick® transverse profiles are provided in Table 39. The average results are also provided in graphical format in Figure 10. These results indicate rutting appeared fairly early on this section and increased steadily up until the final survey. The average rut depth for the survey on May 20, 2008 was 9.4mm in the right wheelpath and 3.9mm in the left wheelpath. The results of the transverse profile survey would indicate that rutting is higher than what would be expected based on the traffic volume and lack of commercial content**.**

Table 39: Summary of the Historical Trend in Rut Depth - Dipstick

Survey Date	Left Depth (Wire Ref)			Right Depth (Wire Ref)			Max Mean (Wire Ref) Left or Right
	Mean	Min	Max	Mean	Min	Max	
2-Sep-97	2.8	0.8	5.5	3.4	2.1	6.5	3.4
17-Aug-99	2.3	0.6	4.9	4.0	2.5	6.2	4.0
12-Sep-00	3.5	1.2	7.8	5.7	3.1	10.1	5.7
31-Jul-01	3.3	1.2	7.3	5.4	3.1	9.7	5.4
15-May-02	3.7	0.6	8.7	5.4	3.0	10.9	5.4
24-Jun-03	4.0	0.8	10.2	7.2	3.6	14.8	7.2
10-Mar-04	5.7	0.9	11.3	10.0	4.7	17.7	10.0
11-May-05	4.7	1.2	11.6	9.7	5.0	18.7	9.7
27-Sep-07	5.5	1.2	11.2	10.2	5.4	16.4	10.2
20-May-08	3.9	0.9	8.3	9.4	4.7	17.8	9.4

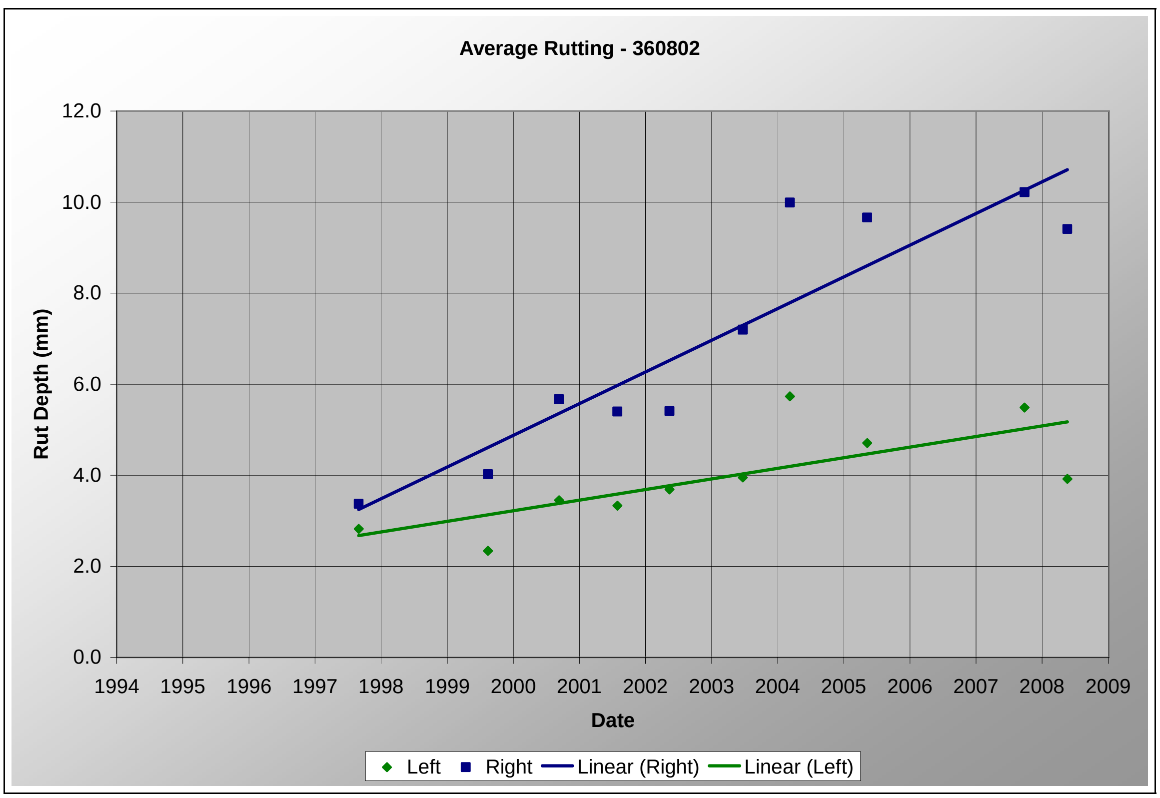

Figure 10: Graphical Presentation of Rut Depth

5.7.5 Elevation Data Analysis Results

An Eleven-Point set of levels were taken at 15.24m intervals over the 152.4m length of the section at the:

- Inner lane edge (non-testing lane)
- Centerline
- Inner lane edge
- Right wheelpath
- Midlane
- Left wheelpath
- Inner pavement edge
- Pavement edge
- Shoulder
- Shoulder edge
- And just off the paved shoulder

The results of the elevation survey are provided in Figure 11. The results show a slight deviation in elevation at the wheelpath location with a 1.8% slope for the pavement (both lanes) and a 4.5% slope from edge to just off the paved shoulder. These results would indicate sufficient slope for water runoff from the pavement surface. Between the shoulder edge and just off the shoulder there is an increase in elevation for a portion of the section which could impede the runoff of the moisture from the pavement. These results would indicate sufficient slope for water runoff from the pavement surface but improvements could be considered for the abutting turf embankment area. These results are consistent with those observed during the site review.

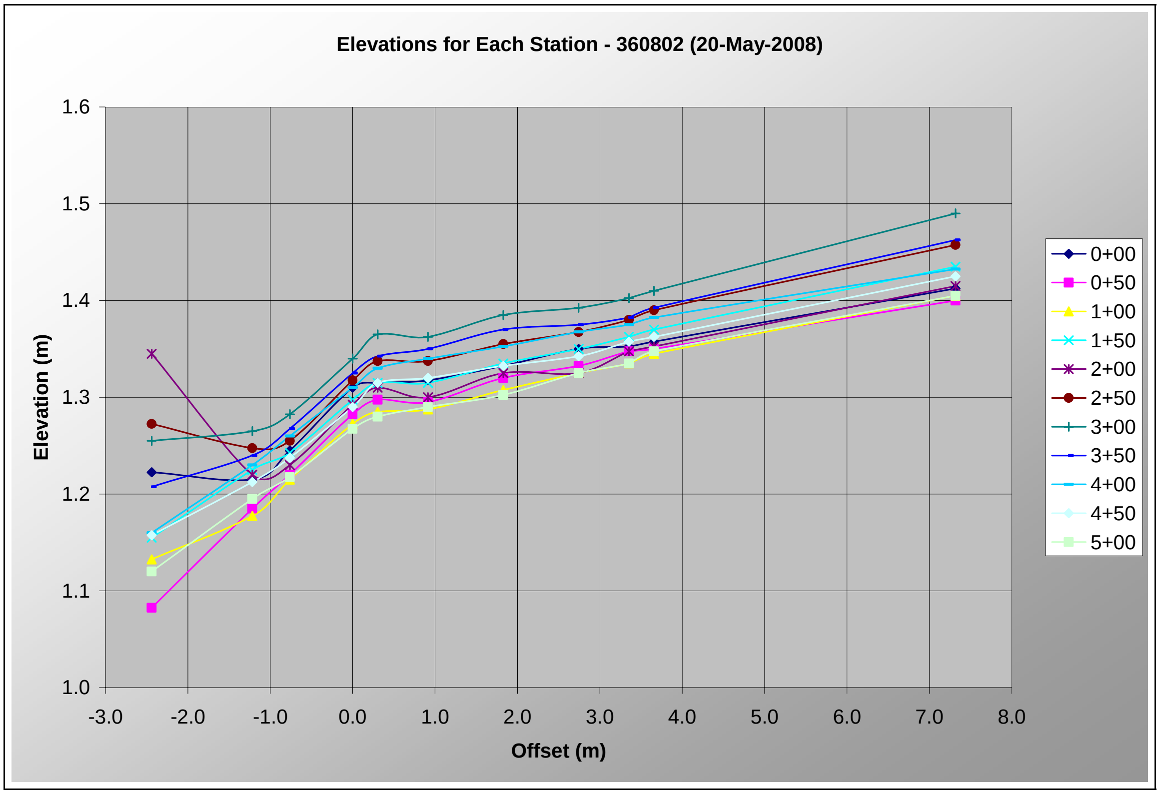

Figure 11: Results of Elevation Survey

5.8 Summary of Performance for 360802

Similar to section 360801, the inputs and analysis conducted using the MEPDG indicated that a very short life span could be expected from the pavement design based on subgrade type, layer thickness, material selection and projected traffic inputs. This was in contrast with the results from the AASHTO 1993 Design Guide. In reviewing the two methods, the biggest factor in the discrepancies would have been the environmental effects that are taken into account with greater detail than the AASHTO 1993 Design Guide. That being said, limited traffic inputs and slight modifications in asphalt material characteristics and their performance capabilities may have also played a factor in the MEPDG analysis. These results would indicate that engineering judgment and refinements are needed when taking into account the many variables that go into the design of a pavement. The performance of this pavement section falls somewhere in between the two analysis predictions, as there has been a fairly significant accumulation of distress, rutting in the wheelpaths and deterioration in ride quality.

MDS, Profile and FWD data collected on a regular basis tracked the performance of this section from the time of construction for a 13.75 year period until the forensic investigation in May 2008. The results from the MDS survey indicate the first noticeable sign of any surface distress occurred 2 years after construction in the fall of 1997. At this time there was minimal rutting with the maximum mean of 3.4mm. A longitudinal crack started at the construction joint near the centerline. This crack continued to progress to the full length of the section in the fall of 2000 and became wider with associated cracking as time progressed. The first signs of cracking in the wheelpaths showed up in fall of 1998 as a slight longitudinal crack. This cracking progressed steadily, eventually turning into fatigue (alligator) cracking. In late 2000, there was a substantial increase in the amount of distress that had expanded into the non-wheelpath areas with the total amount of fatigue cracking covering some 110m² at the time of the May 2008 distress survey. Other cracks that are not as predominant are slight intermittent midlane longitudinal cracks and partial transverse cracks branching off of longitudinal cracking. Rutting on this section has progressed on a steady basis with the largest depth recorded as 17.8mm and a maximum mean of 9.4mm during the last survey in May 2008. This level of rutting would indicate some possible issue with the supporting layers or asphalt material properties as there is minimal commercial traffic on this section that would result in pavement layer and/or subgrade consolidation. The initial ride quality index (IRI) of 1.07m/km would indicate the contractors finished product was of average quality. The deterioration in ride quality mirrored the increase in distress on this section, but also showed signs of high variability, especially after the year 2000, which could be attributed to seasonal variation. The sandy subgrade at this location along with a high water table, especially since this section lacks good drainage from the monitored lane, could result in soil changes during the freeze/thaw cycle that would impact the ride quality for this section. The IRI at time of the final survey in May 2008 was 2.26m/km which would be considered approaching the terminal level for the functional use of this roadway. The IRI in the left lane adjacent to the monitored lane is substantially less at 1.62m/km. Similar to section 360801, the transverse levels taken on this section indicate the slope of the pavement and shoulder are within specification but the turf at the edge of the pavement, for a good portion of the length of the section, is higher than the paved shoulder. There are no signs of edge deterioration but it was felt that this could impede the flow of water from the surface. The pavement response, based on the FWD deflections, increased only slightly over time with a slight reduction in the overall pavement and subgrade moduli with the trends being similar for both the midlane and outer wheelpath test results. For this section, the thickness of the aggregate base and asphalt pavement layers were highly variable, with the pavement structure in general, having an increase in thickness as it moved from the center to edge of pavement. This may have been one of the factors in the variability of the deflections and support at this location.

An examination of the cores taken at the time of the forensic survey indicated the pavement failure was mainly in the surface layer. There was no core taken at the crack that started from the joint near the centerline, but it is expected that it would have followed the same trend as the centerline crack for 360801. Similarly, there were no cores taken in the non-distress areas, but it would be expected that the results would be similar to 360801. The more severe wheelpath cracking penetrated through the binder layer into the asphalt base layer and was showing signs of stripping at the interface between the binder and surface layer. For many of the cores, the aggregate base had become imbedded in the tack coat and portions were lifted out as part of the core. The core surfaces were slightly weathered, but there was no evidence of loose surface aggregate. The laboratory analysis of the different bound layers indicated a slight decrease in the air void content and changes to the stiffness of the AC surface and binder layer, but aside from that there was minimal change in the material properties from the time of construction until the forensic study in May 2008. The results from the materials sourced from the two batch plants were tested as part of the post construction materials testing; there were differences between the test results from the plants but investigation into these differences was not evaluated in this report. The mix design properties, aggregate properties, bituminous content, air voids, penetration etc. were within the specifications acceptable to NYSDOT.

A review of the construction report indicated there were problems with the compaction of the aggregate base layer, maintaining a uniform thickness for the aggregate base and asphalt surface layers as well as delays in the delivery of asphalt due to problems at the processing plant. In particular, the AC friction layer, for a big portion of the length, was below the targeted 25mm depth; although this was offset by the binder layer being thicker than the target value. Problems at the Genesee LeRoy Stone Corp plant required a switch to the Iroquois Rock Product plant with both plants providing asphalt material for the base and binder layers. This made for slight inconsistencies, as is evident from the variation in material properties from the laboratory test that were performed. The reporting on these problems is consistent with the findings from the core sampling, GPR and FWD data collection. A high variability in thickness and to a lesser degree in pavement response was evident from this data collection although no weak areas (soft spots) were encountered.

Based on the results, observations and information provided, reasons for the failures on this section could be attributed to design, lack of maintenance and environmental conditions. Section 360802 has the same drainage issues and characteristics as that of section 360801. The centerline joint crack may not have progressed if sealing had occurred during the initial stages. If the single crack that was observed in the fall of 2000 was sealed, this may have prevented the progressions that took place thereafter. In discussion with NYSDOT staff, crack sealing was an inconsistent maintenance activity. As with section 360801, road salt used in winter maintenance could have been a contributing factor in the weathering and associated low severity cracking because of the high soil salinity levels during the spring runoff. The cores and laboratory analysis results indicate the observed surface distresses are primarily related to failure in the AC surface and binder layer. Based on the limited amount of traffic (with no commercial vehicles), the failures for this section would be due to either poor construction and/or be associated with environmental conditions. Although there were some issues with the construction, there were no major issues that could be associated specifically with build problems. The insufficient compaction of the aggregate base may have contributed to the rutting but no sampling or testing was done to substantiate this. The placement of a thick (>100mm) and variable asphalt base layer in one lift may have had some issues with compaction that would have allowed for future consolidation and rutting. This could not be determined from the results from this forensic study as no trenches were cut to examine the transverse variability. There was no indication that the AC surface was not within the material design specifications, although there were some differences in the test results from the materials sampled and tested from the two plants that provided asphalt to this project.

6.0 Section Comparison

1. The difference between the SPS-8 sections selected is the thickness of the asphalt and aggregate base. Section 360801 is a ‘thin’ pavement within the SPS-8 experimental design whereas 360802 is a ‘thick’ pavement section. The design specification for 360801 was 102mm of AC over 203mm of aggregate base with 360802 being 178mm AC over 305mm aggregate base. Section 360801 was constructed having an AC layer thickness of 127mm comprising a 30mm AC surface friction layer and 97mm AC base layer on an aggregate base that was placed in one lift to a thickness of 213mm over silty sand. Section 360802 was constructed having an AC layer thickness of 193mm with a 23mm AC surface friction layer, 53mm AC binder layer, and 117mm AC base on an aggregate base placed in two lifts to an average thickness of 310mm over a clayey sand. The constructed thickness for both sections was different than the design thickness and was highly variable based on rod and level surveys and core sample measurements. Both sections use a conventional AC-15 and AC-20 hot mix for the asphalt base/binder and surface friction layers, respectively. The aggregate base for both sections was a crushed stone with a maximum stone size of 38mm. The sections were constructed without a pavement drainage layer or external drains relying on the slope of the pavement to drain the pavement to a turf shoulder. The AC binder and aggregate for this project followed NYSDOT specifications. Based on the information provided there were no mineral fillers and admixes included in the job mix formula.

2. The information from the LTPP database was used to populate the MEPDG inputs and determine the predicted performance characteristics for the two pavements. The predicted performance indicated that both sections would not meet the 90% Reliability criteria for a 20-year design term with the exception of thermal cracking. The results from the MEPDG analysis were quite a bit different than an analysis using the procedures from the AASHTO Guide for Design of Pavement Structures 1993, which had a design life expectancy greater than 100-years using the traffic information from the LTPP database. The MEPDG design method uses load spectra, environmental and material characteristics to determine pavement responses and failure rates whereas the 1993 design guide is based on structural numbers developed from material coefficient, material characteristics and traffic variables such as ESALs.

3. The same pavement surface distresses appear on both sections but to a different magnitude and quantity. A longitudinal crack at the location of the centerline paving joint extends the length of both sections. This crack initially appeared a couple of years after construction and extended to the length of the sections in the 2000 to 2002 timeframe. The centerline longitudinal crack has multiplied to include random, alligator and partial transverse cracks that can extend to the midlane. The extension and magnitude of cracking is much greater for 360801

which has a significant amount of associated alligator cracking whereas section 360802 has a number of partial transverse cracks that initiate in the area of the centerline longitudinal crack. Alligator and longitudinal cracks appear in the wheelpath and midlane of both sections. Although there is some distinct definition of cracking in the wheelpaths, the tendency of the cracking is to be more random, which would be consistent with the low levels of traffic on these sections. The total amount of fatigue cracking recorded for section 360801 was 450m² at the time of the May 2008 survey whereas 360802 has significantly less at 110m². The pavement surface for both sections looked weathered but did not have any significant aggregate loss with 360801 showing slightly more surface deterioration. It was noted that the high points at the edge and midlane of 360801 had scrape marks from the winter maintenance plowing, which were evident after the first winter period. Both sections did not have any signs of free surface AC from bleeding or flushing. Pavement rutting is in both wheelpaths of each section, but to a different degree of severity. For 360801, the rutting in the left wheelpath is slightly more than the right. The first survey in 1995 had a mean maximum value of 2.2mm which progressed to 3.8mm in the final survey in 2008, with rut depths ranging from a minimum of 0.4 to a maximum of 8.6mm over the survey timeframe. The rutting, on section 360802, was greater with the first survey in 1997, having a mean maximum rut depth of 3.4mm in the right wheelpath. It then progressed to 9.4mm, in the final survey in 2008, with a minimum of 0.6mm to a maximum of 18.7mm over the survey timeframe. The ride quality, based on IRI, is different between the two sections. 360801 had an initial IRI of 1.00m/km that progressed to 1.49m/km during the final survey in 2008, whereas 360802 had an initial IRI of 1.07m/km that progressed to 2.26m/km during the final survey. Based on IRI, section 360801 would not require any intervention, whereas 360802 is approaching a level that would require corrective action. The elevation survey indicated that both sections had pavement and shoulder slope that would be within tolerance, but the turf area that abutted the pavement shoulder in many locations was higher than the paved shoulder, which would impede the drainage of water from the pavement surface.

4. The examination of cores taken from both sections indicated that all cracking was top-down with some stripping and deterioration evident at the interface of the surface and AC base/binder layers. The cores taken at the longitudinal centerline joint crack for 360801 were full depth whereas all the remaining cracks were partial depth. The AC base from both sections had visible voids in particular at the interface between layers but there were no lack of bonds identified. The interface of the AC bound layers with the aggregate base show minimal, if any, signs of stripping. The tack coat applied to the aggregate surface, for most of the cores examined, had bonded the surface stone to the AC base layer. The surface of 360801, which was substantially weathered, had some loose aggregate when probed with a sharp edge, whereas the surface for 360802 was firm and intact.

5. The analysis of the historical FWD data indicated that there was minimal change in the structural capacity of the sections over time (comparing the historical trends in the overall pavement resilient moduli). The analysis also indicates that the thicker section 360802 is structurally more sufficient than 360801. A comparison of the trends in subgrade resilient moduli indicates that both sections have a slight decline in subgrade support, with 360801 having slightly higher moduli values. Comparison of the overall pavement moduli of the two sections shows that 360802 has had greater pavement strength throughout the testing period. The subgrade resilient moduli between both sections indicate reasonably similar values with 360801 having a higher rate of loss in strength. Overall, there is a fairly large scatter in the FWD data which is attributed to the variability within the section lengths and the seasonal effects of Lake Ontario (within sight distance of the sections) including a high and variable water table.

6. The analysis of the materials data did not reveal any results that would significantly affect the performance of these pavements. The post construction laboratory tests showed some difference between the binder and asphalt tests for the AC-15 mix, as the tests were done on materials sourced from two asphalt plants. All asphalt paving materials for 360801 were sourced from Genesee LeRoy Stone Corp plant with various portions of 360802 having asphalt supplied from the Iroquois Rock Product plant. The Specific Gravity test results from the forensic testing were very similar to the post construction results for the bitumen and asphalt mixes. There was minimal change in air void content for 360801 with a slight decrease identified in the air voids for the asphalt material at 360802. There was also a slight change in the stiffness properties for the surface and binder asphalt.

7. There was no discernable difference in the construction practice for the two sections evaluated. The delays in delivery of asphalt could have impacted section 360802 more than 360801 as materials were delivered from two different sources for 360802. For both sections, the aggregate base was highly variable with densities below 95% proctor. The asphalt surface layer thickness was also variable and outside the design specification of +/- 7mm. Although not documented, there was concern that the thick single lift asphalt base layer for 360802 may not have been compacted to specification.

7.0 Summary/Conclusions

A comparison analysis using the AASHTO 1993 Design Guide and the MEPDG illustrated substantial differences. The MEPDG indicated very short life spans for both of the 360801 and 360802 pavement sections. In reviewing both methods, the biggest factor in the contrast would be the environmental effects that are taken into account with greater detail using the MEPDG.

Reviewing the MDS, profile, and FWD data for both sections yielded similar results. Neither section utilized preventative maintenance or crack sealing at the areas of longitudinal cracking. Sections 360801 and 360802 were both fairly distressed with the former being the more distressed of the two. Rutting on both sections increased steadily over time for both sections with section 360802 having larger depth rutting, indicating the possibility of an issue with the supporting layers. The deterioration of ride quality mirrored the distresses of both sections, although at the time of the final survey, section 360802 had an IRI indicating that the section was approaching the terminal level for the functional use of the roadway. The pavement response, based on FWD deflections, increased slightly over time with slight reductions in overall pavement moduli for both sections.

A core examination for both sections revealed the pavement failure was mainly in the surface layer with the exception of the centerline paving joint cracks. Laboratory analysis concluded that there was minimal change in material properties from the time of construction to the time of the forensic study.

Based on the results, observations and information provided, reasons for the failures on both sections could be attributed to design, lack of maintenance and environmental conditions. After 13.75 years of service, the requirement for these two sections is similar but for different reasons. Section 360801 is in need of rehabilitative action to restore the surface condition. Section 360802 is in need of maintenance/rehabilitation to correct wheelpath rutting and ride quality. A significant amount of distress could have potentially been reduced if crack sealing had been performed on the centerline construction joint crack when it progressed to the full length of the section in the 2001 timeframe. This is a sometimes inconsistent maintenance activity for NYSDOT as there is not always consensus on the benefit of it. From the testing and investigations done, there was no evidence that the turf embankment, which in many locations was higher than the pavement edge, had any effect on the pavement performance. From a practice standpoint, improvement to the drainage at the edge of pavement should be considered.

A rehabilitation strategy for sections 360801 and 360802 should include milling at least 35mm, and 30mm respectively to remove the disintegrating surface to a depth that would provide a sound base to apply an overlay that would restore the structural integrity of the pavement. Repairs at the locations of the centerline joint cracks and associated transverse cracks may require some full-depth asphalt removal. Based on the information collected, both sections could benefit from geometric or drainage improvements. There does not appear to be any issue with the performance of the asphalt base, aggregate and subgrade. The traffic on these sections does not warrant a thicker AC, although this could help relieving some of the effects of the seasonal freeze/thaw for the thinner pavement section in 360801.

References

1. LTPP Pavement Studies, Construction Report on SHRP 360800, SPS-8 Project, Brockport, NY, Summer 1994. Report No. FHWA-TS-95-36-01, March 1995
2. National Cooperative Highway Research Program (NCHRP), 2007. "Mechanistic Empirical Pavement Design Guide" Version 1.003
3. AASHTO (1993). *AASHTO Guide for Design of Pavement Structures.* American Association of State Highway and Transportation Officials, Washington, D.C.
4. Traffic Monitoring Guide, May 01, 2001, U.S Department of Transportation, FHWA, Office of Highway Policy Information
5. LTPP Manual for FWD Testing: Version 3.1, August 2000 (Appendix D - FWD test Plans: Deflection testing of Subgrade and Base Layers SHRP Protocol P59)

Appendices

Appendix A – Meeting Minutes, Roles and Responsibilities

To: Meeting Attendees

From: Basel Abukhater

Date: **May 14, 2008**

Reference: **7.1.1 Notes of May 13/08 LTPP Meeting at NYS DOT**
FILE: 1-745-50057 Phase 143

NYS DOT LTPP Meeting: May 13/08 at Spencerport Residency, 2441 S. Union St., Spencerport NY, from 9:00am to 10:00am.

Attendees:

- Dawn Jindra, NYSDOT Assistant Resident Engineer, 585-352-3471, djindra@dot.state.ny.us
- Alex Pannoni, NYSDOT Maintenance, 585-392-9296
- Paul Peffers, NYSDOT Geotechnical, 585-272-3365, ppeffers@dot.state.ny.us
- Rick Morgan, NYSDOT TR & DB, 518-457-4662, rmorgan@dot.state.ny.us
- Brandt Henderson, LTPP-Stantec Field Operations, 716-632-0804, brandtworks@bellnet.com
- Gabe Cimini, LTPP-Stantec Data Base, 716-632-0804 gabe.cimini@stantec.com
- Basel Abukhater, LTPP-Stantec Materials & Traffic, 716-632-0804 basel.abukhater@stantec.com

The objective of the meeting was to discuss with the agency the details of the LTPP plan for conducting forensic investigation at the thin and thick sections of the SPS-8 experiment on Lake Ontario State Parkway. We need to find out "WHY THESE SECTIONS ARE NOT PERFORMING AS EXPECTED"

The LTPP North Atlantic Regional Office (NARO) Team handouts included the following items:

- Roles and Responsibilities
- Information Summary SPS Fact Sheets for the 2 SPS-8 sections
- NYS DOT LTPP Forensic Investigation Tasks, Internal Document, Updated 5/12/08

The meeting began with introductions while Basel Abukhater distributed the handouts for the meeting. Brandt Henderson explained the background of the forensic program and how input from the NYS DOT was part of the forensic plan.

Trenching was discussed as an option but with NYS DOT project travel budgets cut by 30% for this year and research activities initiated in other areas; Rick Morgan stated that trenching evaluation could not be undertaken at this time. Brandt Henderson agreed with this as the Federal budget for this project was limited and trenching would consume time and available funds.

Coring of the distressed locations would have to be done to investigate the cause. Brandt asked if the NYS DOT had dry cut coring capabilities and the response was that NYS DOT could not do dry cut coring. Brandt explained the process of doing a wet cut to a certain point and then cleaning out the water and punching through to simulate a dry cut. Paul agreed to let Brandt work with the coring crew to obtain this wet/dry cut core.

The work will be done over two days with monitoring activities being done the first day (FWD, Longitudinal Profile, Transverse Profile, Manual Distress, Elevations, Video and Photos). The marking of the coring locations will be done the first day with the NYS DOT present on site as well.

On the second day, coring will take place as well as documentation of activities, sampling of materials, density testing with the Nuclear Gauge and DCP unit and patching. Rick felt that the Nuclear Gauge might not be possible as a qualified operator needs to be available to perform the measurements and one may not be available. The Materials group said they had brand new automated split spoon augur that they would like to use and if it was possible to do this in the next few weeks, as it was available.

Brandt then asked about testing of the collected cores (4 to 8 cores will be extracted) in the lab. The tests would be done on each layer of every core. These tests would be voids, aging and densities. Rick felt that they could do those tests. The earlier the better for the lab as once the regular testing schedule started it would be difficult to get other tests done. Brandt asked Rick to see if the lab could do the testing in a two-week turn-a-round from receipt of cores. Rick will look into this.

Basel explained that the labeling and wrapping of the cores would be done by the NARO staff and on site. Once the cores were wrapped NYS DOT would be responsible to take them to the lab. Rick Morgan agreed to be responsible for getting the cores to the lab and tested.

NYS DOT asked about the dates and start time for this forensic project. The Materials group felt that next week would be the ideal time as they were available and did not have any other pending items. After next week there would be conflicts and it would not be easy to schedule the work.

After a discussion, the plan is to start at 8:00 am in the morning of Tuesday May 20, 2008 and to finish on Wednesday May 21, 2008. Thursday May 22, 2008 would be the rain contingency day. 1500 feet of road closure would be required but since the site had limited traffic, this closure would not pose a problem. Alex said that the NYS DOT would be responsible for the patching of the cored areas and mentioned that there were cross culverts on site to avoid. Al and his staff will be responsible for getting utility clearances, in addition to the lane closure and patching. Everybody agreed that an extended day would not be a problem if the need arises, but Dawn has to get approval for overtime.

The roles and responsibilities handout was reviewed and everyone was in agreement on what the roles were. Attached is an electronic copy of the Roles and Responsibilities handout showing the responsibility items agreed upon by NYS DOT staff and NARO staff. Equipment was available for the May 20-21 testing and clearances should be ready.

Gabe Cimini conducted a review of the Fact-Sheets, which showed that the two sites had considerable fatigue cracking and slight rutting present. Other handouts were reviewed and discussed. Questions were asked about the distress and FWD printouts.

The district asked if they would be involved in the report or receive a report as they are interested in what is happening and would like to be included in any reports or documents coming out of this effort. NARO staff agreed to provide the final report to the NYS DOT staff.

If any corrections are required please inform the author as soon as possible.

THANK-YOU

Basel Abukhater

Basel Abukhater,
LTPP NORTHERN REGIONS – Traffic and Materials Manager

Copies:
Attendees
Wes Yang NYS DOT
Jack Springer FHWA-LTPP
Frank Meyer LTPP-NARO Project Manager

Figure A-1: Meeting Minutes

LTPP Forensic Investigation

AGENCY: NEW YORK **MEETING DATE: MAY 13, 2008**

Roles and Responsibilities

There are a number of groups involved with the work done under this effort. The primary groups involved with this work include:

- FHWA-LTPP
- Highway Agency – Personnel for Materials Input, Traffic Control and Sampling
- Regional Support Contractor (RSC)
- Technical Support Services Contractor (TSSC)

	AGENCY			**RSC**
√	Traffic Control		√	FWD & ATDL
√	Core Unit with 4 ¼" and 6" OD barrel		√	MDS
	Dry Core Unit with 4 ¼" OD barrel (DCP locations)		√	Transverse Profiles
√	Boring Unit with Split Spoon		√	Longitudinal Profiles
√	Nuclear Gauge		√	DCP
√	Lab Work – Aging, Voids, Density		√	Video
√	Patching		√	Photos
√	Transport of Cores to Agency Lab		√	Water Table
			√	Inspect Drainage System
			√	Nine Point Elevations
			√	Mark Core Locations
			√	Wrap & Label Cores with Documentation
			√	Visual Examination & Thickness of Cores (Stripping – Photos)
			√	Lab Work - Moisture

Please check items approved

Agency Optional - Trenching

Figure A-2: Roles and Responsibilities

Appendix B – Environmental Data

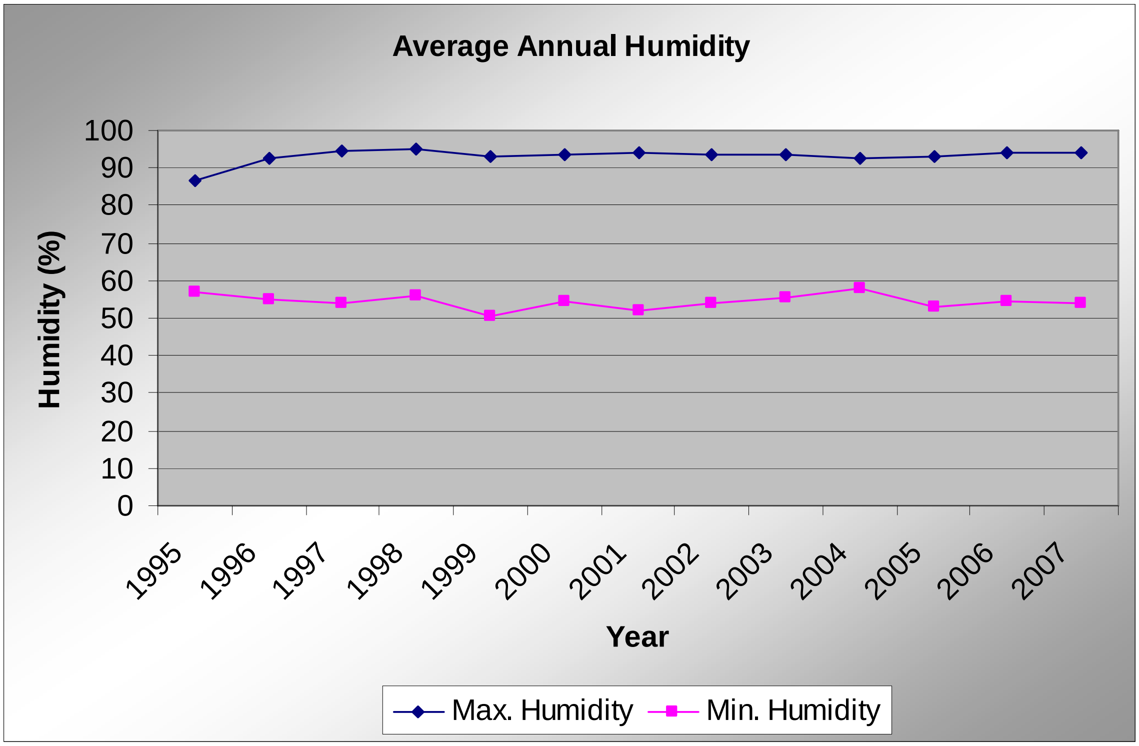

Figure B-1: Average Annual Humidity

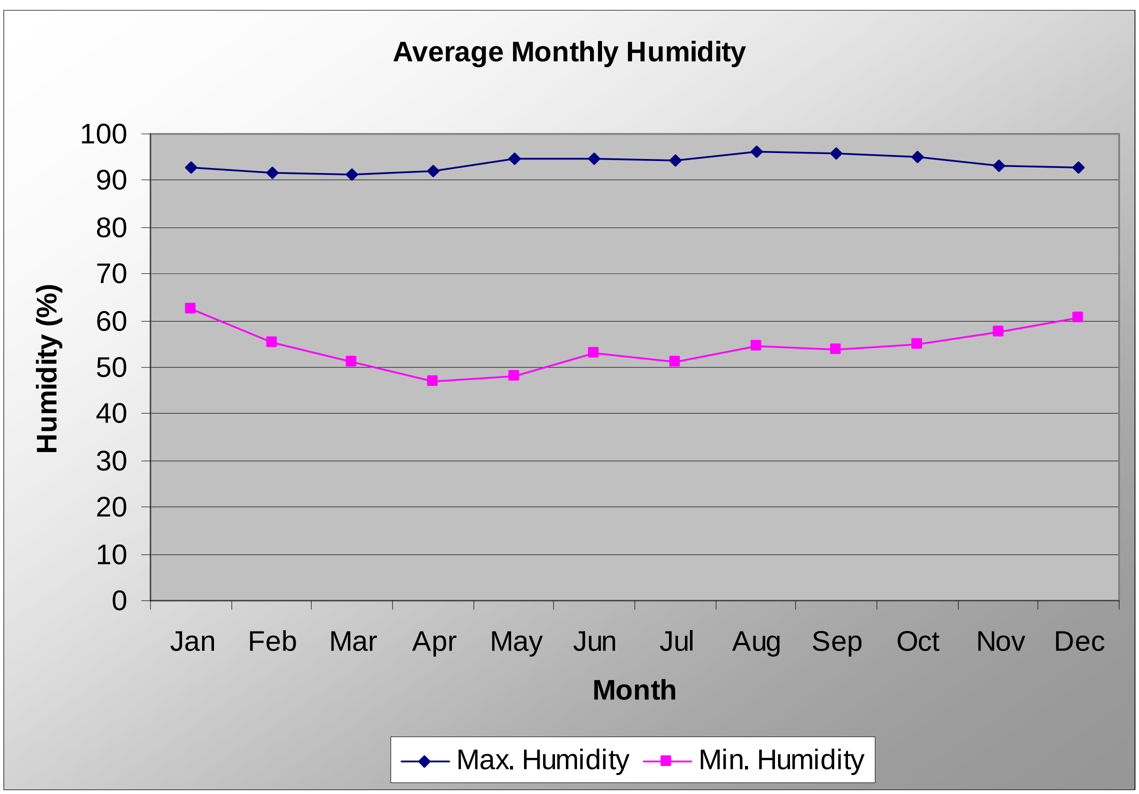

Figure B-2: Average Monthly Humidity

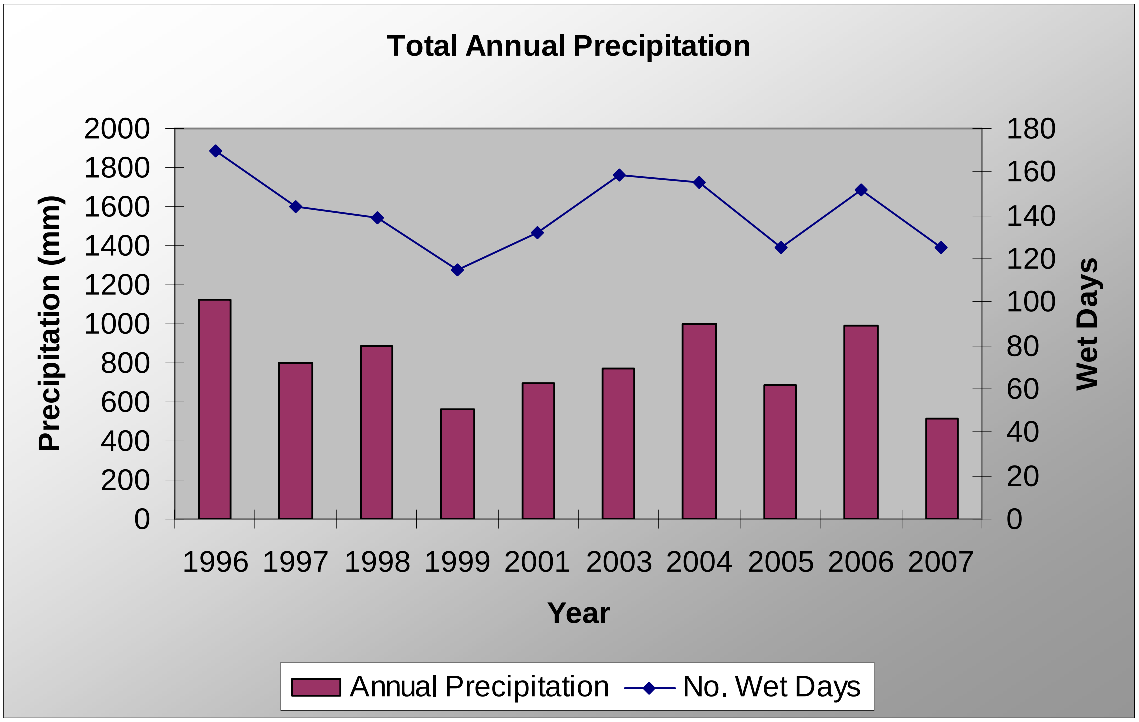

Figure B-3: Total Annual Precipitation

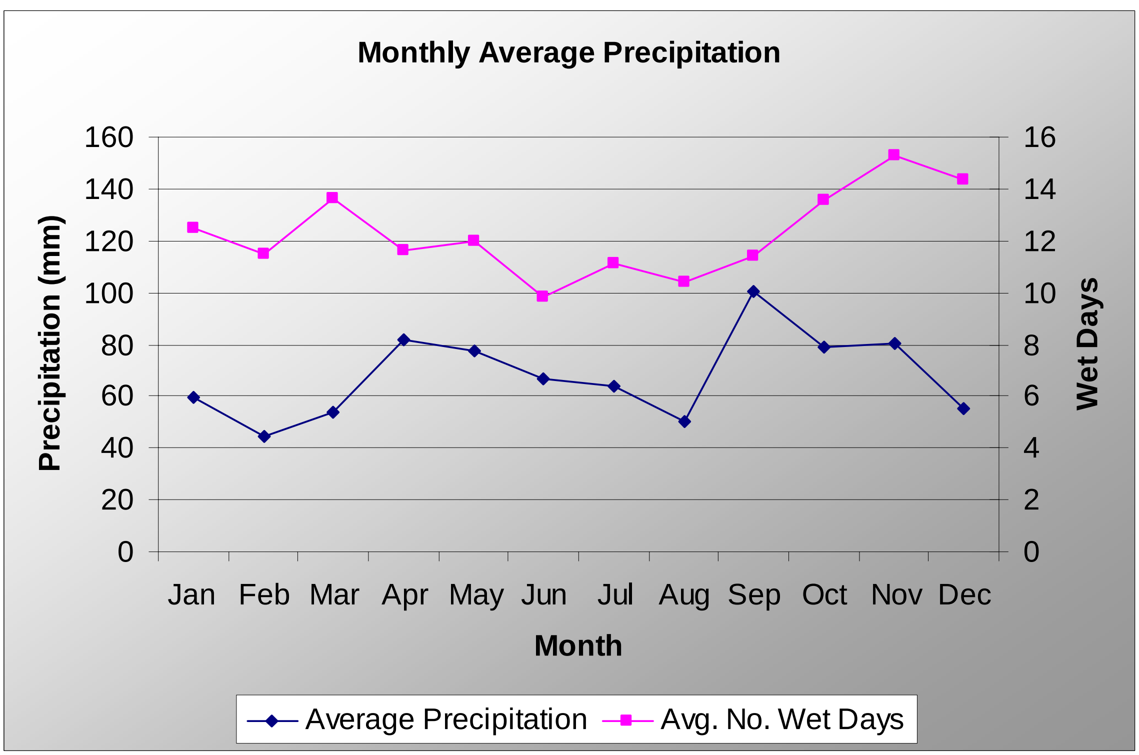

Figure B-4: Average Monthly Precipitation

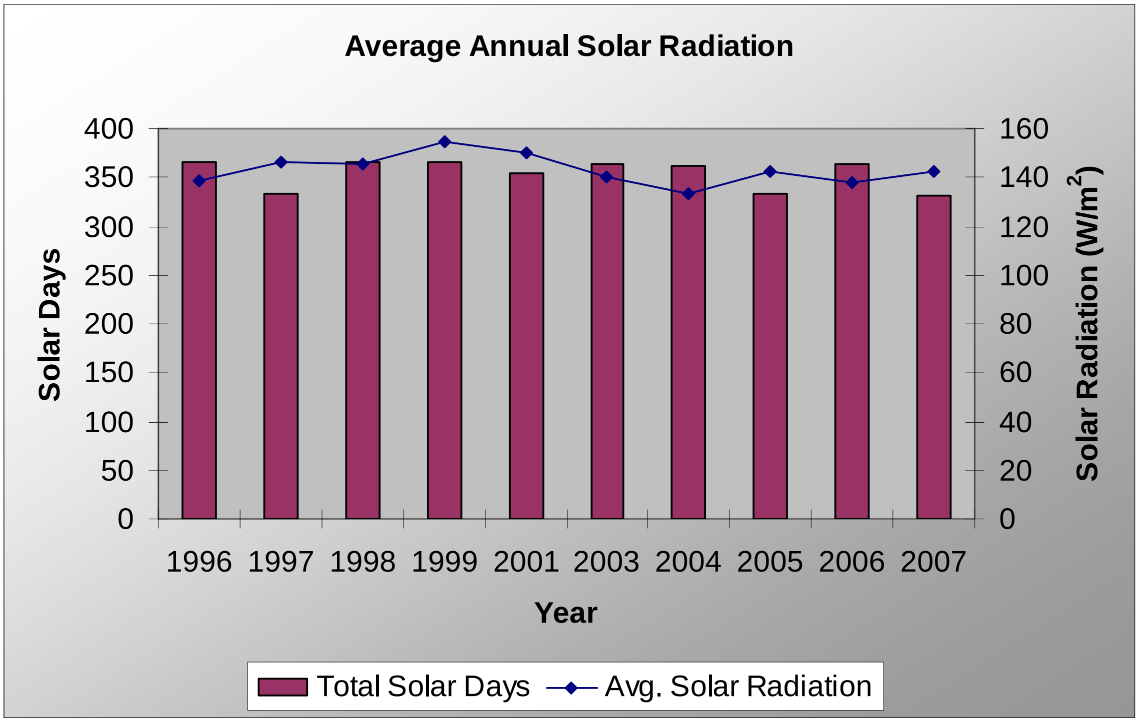

Figure B-5: Average Annual Solar Radiation

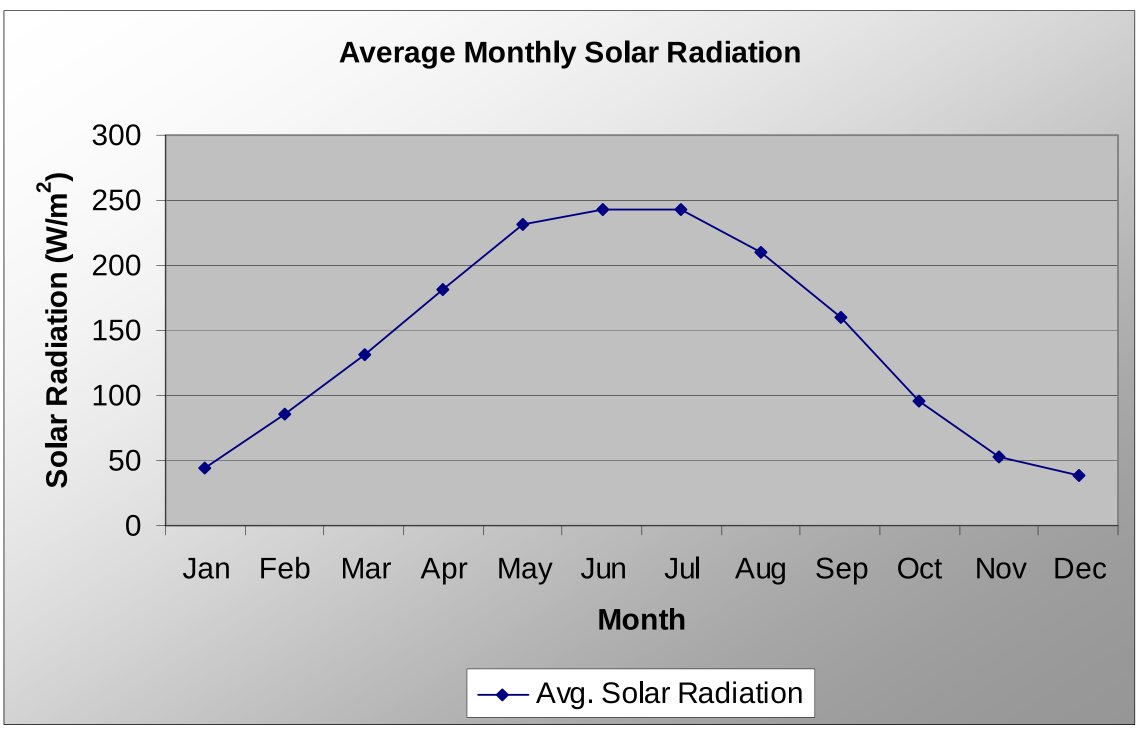

Figure B-6: Average Monthly Solar Radiation

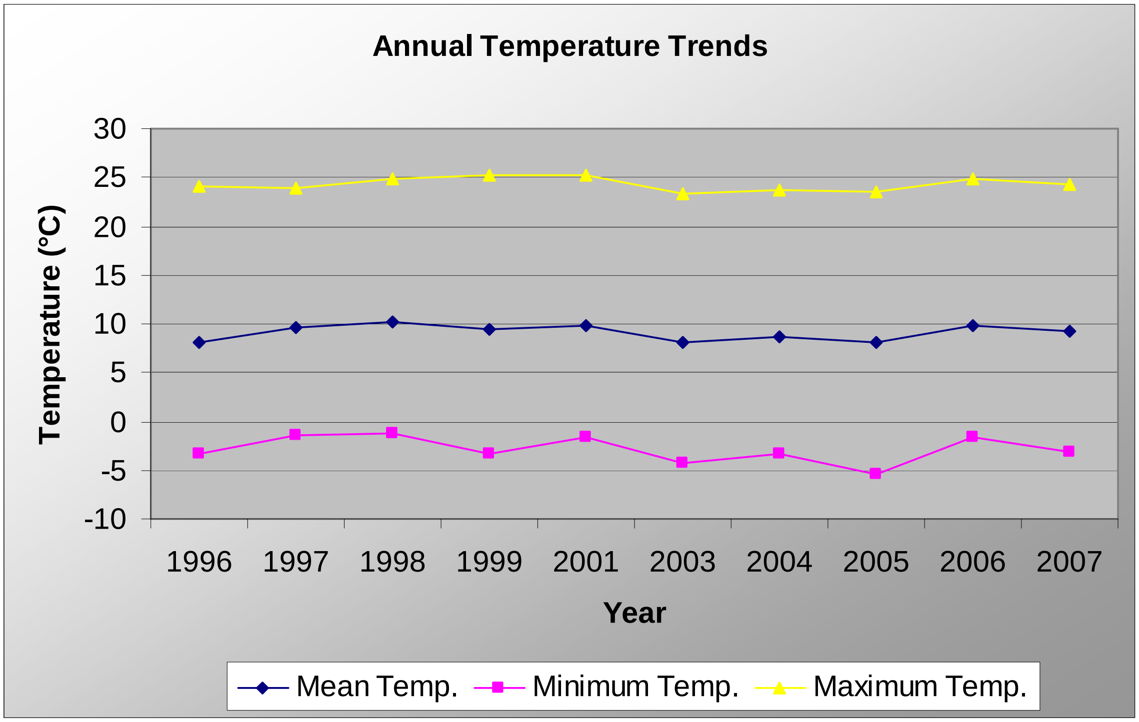

Figure B-7: Annual Temperature Trends

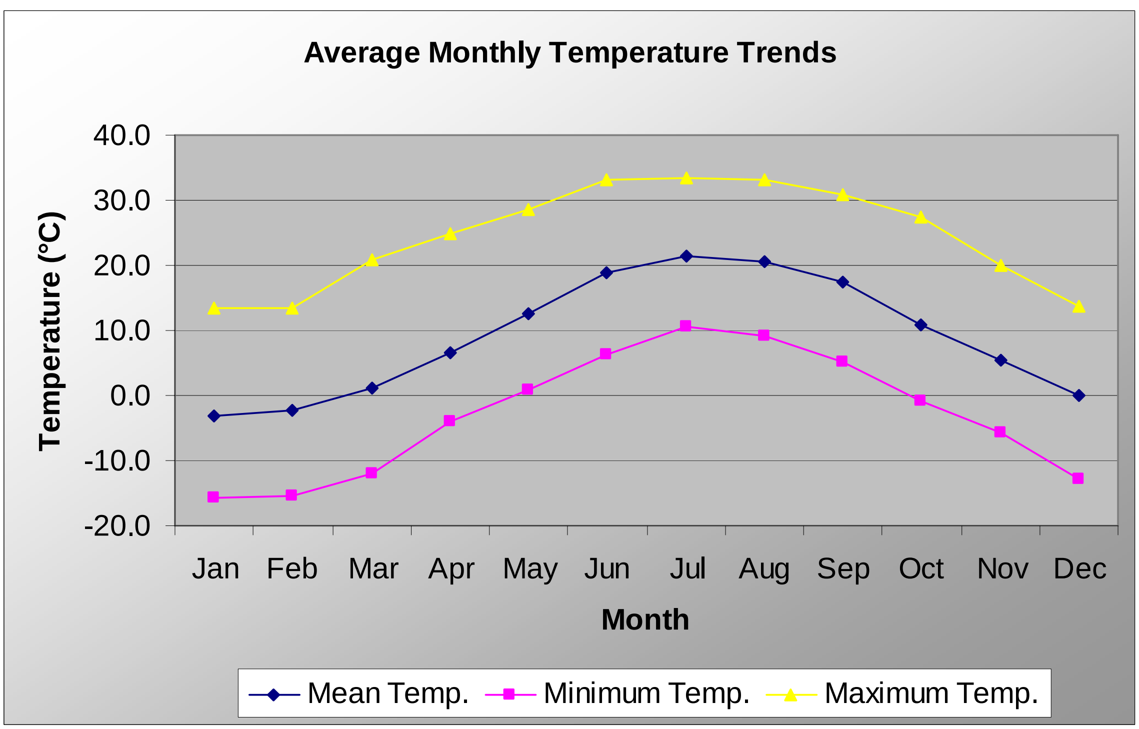

Figure B-8: Average Monthly Temperature Trends

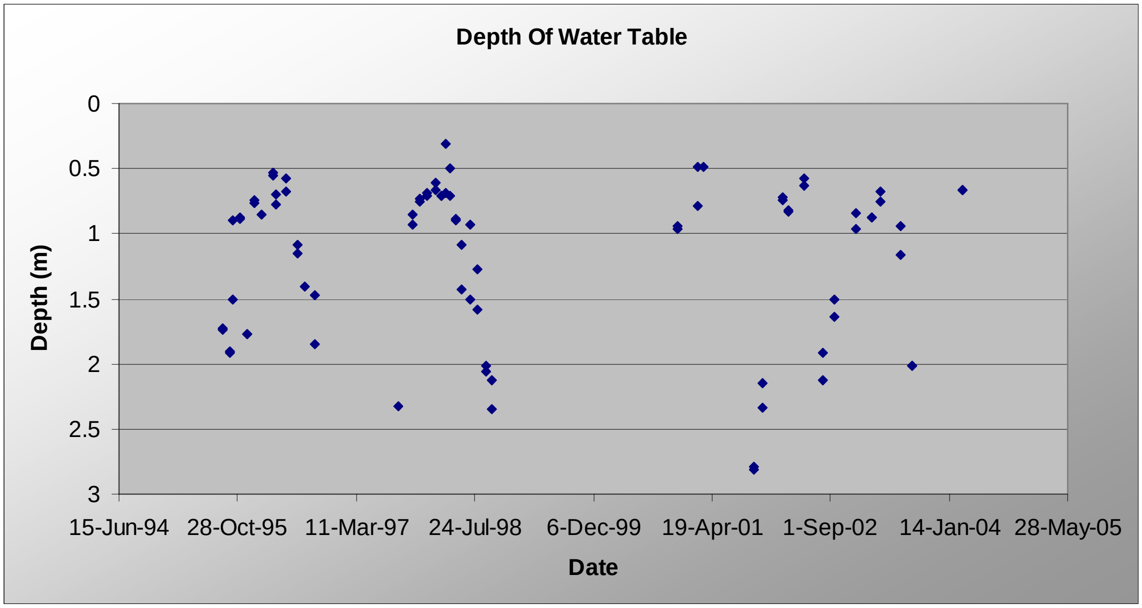

Figure B-9: Annual Water Table Trend From Section 360801

Appendix C – MEPDG Input Summary

Project: NY-360801.dgp

General Information

Design Life	20 years
Base/Subgrade construction:	July, 1994
Pavement construction:	August, 1994
Traffic open:	September, 1994
Type of design	Flexible

Description:
360801

Analysis Parameters

Performance Criteria

	Limit	Reliability
Initial IRI (in/mi)	63.58	
Terminal IRI (in/mi)	172	90
AC Surface Down Cracking (Long. Cracking) (ft/mile):	2000	90
AC Bottom Up Cracking (Alligator Cracking) (%):	25	90
AC Thermal Fracture (Transverse Cracking) (ft/mi):	1000	90
Chemically Stabilized Layer (Fatigue Fracture)	25	90
Permanent Deformation (AC Only) (in):	0.25	90
Permanent Deformation (Total Pavement) (in):	0.75	90
Reflective cracking (%):	100	

Location:	New York
Project ID:	LOSP
Section ID:	360801
Date:	7/13/2009
Station/milepost format:	Feet: 00 + 00
Station/milepost begin:	16+15
Station/milepost end:	16+65
Traffic direction:	East bound

Default Input Level

Default input level — Level 3, Default and historical agency values.

Traffic

Initial two-way AADTT:	21
Number of lanes in design direction:	2
Percent of trucks in design direction (%):	50
Percent of trucks in design lane (%):	95
Operational speed (mph):	55

Traffic -- Volume Adjustment Factors

Monthly Adjustment Factors (Level 3, Default MAF)

Month	Vehicle Class									
	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
January	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
February	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April	1.00	0.36	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00
May	1.00	0.90	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
June	1.00	1.17	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
July	1.00	1.71	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
August	1.00	1.53	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
September	1.00	1.35	0.00	1.00	3.15	1.00	1.00	1.00	1.00	1.00
October	1.00	1.08	9.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
November	1.00	0.45	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00

Vehicle Class Distribution

(Level 3, Default Distribution)

AADTT distribution by vehicle class

Class 4	0.2%
Class 5	88.2%
Class 6	2.1%
Class 7	0.1%
Class 8	8.7%
Class 9	0.6%
Class 10	0.1%
Class 11	0.0%
Class 12	0.0%
Class 13	0.0%

Hourly truck traffic distribution

by period beginning:

Midnight	2.3%	Noon	5.9%
1:00 am	2.3%	1:00 pm	5.9%
2:00 am	2.3%	2:00 pm	5.9%
3:00 am	2.3%	3:00 pm	5.9%
4:00 am	2.3%	4:00 pm	4.6%
5:00 am	2.3%	5:00 pm	4.6%
6:00 am	5.0%	6:00 pm	4.6%
7:00 am	5.0%	7:00 pm	4.6%
8:00 am	5.0%	8:00 pm	3.1%
9:00 am	5.0%	9:00 pm	3.1%
10:00 am	5.9%	10:00 pm	3.1%
11:00 am	5.9%	11:00 pm	3.1%

Traffic Growth Factor

Vehicle Class	Growth Rate	Growth Function
Class 4	4.0%	Linear
Class 5	4.0%	Linear
Class 6	4.0%	Linear
Class 7	4.0%	Linear
Class 8	4.0%	Linear
Class 9	4.0%	Linear
Class 10	4.0%	Linear
Class 11	4.0%	Linear
Class 12	4.0%	Linear
Class 13	4.0%	Linear

Traffic -- Axle Load Distribution Factors

Level 1: Site Specific

Traffic -- General Traffic Inputs

Mean wheel location (inches from the lane marking):	18
Traffic wander standard deviation (in):	10
Design lane width (ft):	12.14

Number of Axles per Truck

Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.57	0.43	0.00	0.00
Class 5	2.00	0.00	0.00	0.00
Class 6	1.00	1.00	0.00	0.00
Class 7	1.00	1.00	0.00	0.00
Class 8	3.16	0.12	0.00	0.00
Class 9	1.91	1.55	0.00	0.00
Class 10	1.00	1.67	0.33	0.00
Class 11	0.00	0.00	0.00	0.00
Class 12	0.00	0.00	0.00	0.00
Class 13	0.00	0.00	0.00	0.00

Axle Configuration

Average axle width (edge-to-edge) outside dimensions,ft):	8.5
Dual tire spacing (in):	12

Axle Configuration

Tire Pressure (psi) :	120

Average Axle Spacing

Tandem axle(psi):	51.6
Tridem axle(psi):	49.2
Quad axle(psi):	49.2

Climate

icm file:	C:\DG2002\Projects\LOSP-Interpolated.icm
Latitude (degrees.minutes)	43.35047
Longitude (degrees.minutes)	-77.8977
Elevation (ft)	259.186
Depth of water table (ft)	-1

Structure--Design Features

HMA E* Predictive Model:	NCHRP 1-37A viscosity based model.
HMA Rutting Model coefficients:	NCHRP 1-37A coefficients
Endurance Limit (microstrain):	None (0 microstrain)

Structure--Layers

Layer 1 -- Asphalt concrete

Material type:	Asphalt concrete
Layer thickness (in):	1.2

General Properties

General

Reference temperature (F°):	77

Volumetric Properties as Built

Effective binder content (%):	11
Air voids (%):	8.7
Total unit weight (pcf):	148

Poisson's ratio:	0.37 (user entered)

Thermal Properties

Thermal conductivity asphalt (BTU/hr-ft-F°): 0.67
Heat capacity asphalt (BTU/lb-F°): 0.23

Asphalt Mix

Cumulative % Retained 3/4 inch sieve: 0
Cumulative % Retained 3/8 inch sieve: 0
Cumulative % Retained #4 sieve: 16
% Passing #200 sieve: 3

Asphalt Binder

Option: Conventional penetration grade
Viscosity Grade Pen 85-100
A 10.8232 (correlated)
VTS: -3.621 (correlated)

Thermal Cracking Properties

Average Tensile Strength at 14ºF: 384.49
Mixture VMA (%) 19.7
Aggreagate coeff. thermal contraction (in./in.) 0.000005
Mix coeff. thermal contraction (in./in./ºF): 0.000013

Load Time (sec)	Low Temp. -4ºF (1/psi)	Mid. Temp. 14ºF (1/psi)	High Temp. 32ºF (1/psi)
1	2.63E-07	4.72E-07	6.81E-07
2	2.9E-07	5.53E-07	8.72E-07
5	3.29E-07	6.8E-07	1.21E-06
10	3.63E-07	7.96E-07	1.55E-06
20	4E-07	9.31E-07	1.98E-06
50	4.56E-07	1.15E-06	2.75E-06
100	5.02E-07	1.34E-06	3.52E-06

Layer 2 -- Asphalt concrete

Material type: Asphalt concrete
Layer thickness (in): 3.8

General Properties

General
Reference temperature (F°): 77

Volumetric Properties as Built
Effective binder content (%): 11
Air voids (%): 6.6
Total unit weight (pcf): 148

Poisson's ratio: 0.43 (user entered)

Thermal Properties

Thermal conductivity asphalt (BTU/hr-ft-F°):	0.67
Heat capacity asphalt (BTU/lb-F°):	0.23

Asphalt Mix

Cumulative % Retained 3/4 inch sieve:	18
Cumulative % Retained 3/8 inch sieve:	29
Cumulative % Retained #4 sieve:	47
% Passing #200 sieve:	5

Asphalt Binder

Option:	Conventional penetration grade
Viscosity Grade	Pen 85-100
A	10.8232 (correlated)
VTS:	-3.621 (correlated)

Layer 3 -- Crushed stone

Unbound Material:	Crushed stone
Thickness(in):	8.4

Strength Properties

Input Level:	Level 3
Analysis Type:	ICM inputs (ICM Calculated Modulus)
Poisson's ratio:	0.35
Coefficient of lateral pressure,Ko:	0.5
Modulus (input) (psi):	30000

ICM Inputs

Gradation and Plasticity Index

Plasticity Index, PI:	1
Liquid Limit (LL)	16
Compacted Layer	Yes
Passing #200 sieve (%):	8.1
Passing #40	12.2
Passing #4 sieve (%):	30.1
D10(mm)	0.192
D20(mm)	1.791
D30(mm)	4.707
D60(mm)	17.28
D90(mm)	34.29

Sieve	Percent Passing
0.001mm	
0.002mm	
0.020mm	
#200	8.1
#100	
#80	10.2
#60	
#50	
#40	12.2
#30	
#20	
#16	
#10	20.6
#8	
#4	30.1
3/8"	42.6
1/2"	49.1
3/4"	63.2
1"	75.9
1 1/2"	94
2"	100
2 1/2"	
3"	100
3 1/2"	
4"	

Calculated/Derived Parameters

Maximum dry unit weight (pcf):	124.2 (derived)
Specific gravity of solids, Gs:	2.83 (user input)
Saturated hydraulic conductivity (ft/hr):	0.2616 (derived)
Optimum gravimetric water content (%):	9.1 (derived)
Calculated degree of saturation (%):	61.3 (calculated)

Soil water characteristic curve parameters: Default values

Parameters	Value
a	11.144
b	2.185
c	0.76211
Hr.	116.2

Layer 4 -- A-2-4

Unbound Material:	A-2-4
Thickness(in):	Semi-infinite

Strength Properties

Input Level:	Level 3
Analysis Type:	ICM inputs (ICM Calculated Modulus)
Poisson's ratio:	0.35
Coefficient of lateral pressure,Ko:	0.5
Modulus (input) (psi):	21500

ICM Inputs

Gradation and Plasticity Index

Plasticity Index, PI:	1
Liquid Limit (LL)	14
Compacted Layer	Yes
Passing #200 sieve (%):	21.9
Passing #40	76
Passing #4 sieve (%):	88
D10(mm)	0.002055
D20(mm)	0.04223
D30(mm)	0.1118
D60(mm)	0.3033
D90(mm)	9.5

Sieve	Percent Passing
0.001mm	
0.002mm	
0.020mm	
#200	21.9
#100	
#80	43
#60	
#50	
#40	76
#30	
#20	
#16	
#10	86
#8	
#4	88
3/8"	90
1/2"	92
3/4"	93
1"	100
1 1/2"	100
2"	100
2 1/2"	
3"	100
3 1/2"	
4"	

Calculated/Derived Parameters

Maximum dry unit weight (pcf):	125.7 (derived)
Specific gravity of solids, Gs:	2.72 (user input)
Saturated hydraulic conductivity (ft/hr):	0.0004564 (derived)
Optimum gravimetric water content (%):	8.4 (derived)
Calculated degree of saturation (%):	65.0 (calculated)

Soil water characteristic curve parameters: Default values

Parameters	Value
a	9.7424
b	0.51954
c	3.4218
Hr.	143.8

Distress Model Calibration Settings - Flexible

AC Fatigue	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	0.007566
k2	3.9492
k3	1.281
AC Rutting	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	-3.35412
k2	1.5606
k3	0.4791
Standard Deviation Total Rutting (RUT):	0.24*POWER(RUT,0.8026)+0.001
Thermal Fracture	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	1.5
Std. Dev. (THERMAL):	0.1468 * THERMAL + 65.027
CSM Fatigue	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	1
k2	1
Subgrade Rutting	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
Granular:	
k1	2.03
Fine-grain:	
k1	1.35
AC Cracking	
AC Top Down Cracking	
C1 (top)	7
C2 (top)	3.5
C3 (top)	0
C4 (top)	1000
Standard Deviation (TOP)	200 + 2300/(1+exp(1.072-2.1654*log(TOP+0.0001)))

AC Bottom Up Cracking

C1 (bottom)	1
C2 (bottom)	1
C3 (bottom)	0
C4 (bottom)	6000
Standard Deviation (TOP)	1.13+13/(1+exp(7.57-15.5*log(BOTTOM+0.0001)))

CSM Cracking

C1 (CSM)	1
C2 (CSM)	1
C3 (CSM)	0
C4 (CSM)	1000
Standard Deviation (CSM)	CTB*1

IRI

IRI HMA Pavements New

C1(HMA)	40
C2(HMA)	0.4
C3(HMA)	0.008
C4(HMA)	0.015

IRI HMA/PCC Pavements

C1(HMA/PCC)	40.8
C2(HMA/PCC)	0.575
C3(HMA/PCC)	0.0014
C4(HMA/PCC)	0.00825

Figure C-1: 360801 MEPDG Input Summary

Project: NY-360802.dgp

General Information

Design Life	20 years
Base/Subgrade construction:	July, 1994
Pavement construction:	August, 1994
Traffic open:	September, 1994
Type of design	Flexible

Description:
360801

Analysis Parameters

Performance Criteria

	Limit	Reliability
Initial IRI (in/mi)	63.58	
Terminal IRI (in/mi)	172	90
AC Surface Down Cracking (Long. Cracking) (ft/mile):	2000	90
AC Bottom Up Cracking (Alligator Cracking) (%):	25	90
AC Thermal Fracture (Transverse Cracking) (ft/mi):	1000	90
Chemically Stabilized Layer (Fatigue Fracture)	25	90
Permanent Deformation (AC Only) (in):	0.25	90
Permanent Deformation (Total Pavement) (in):	0.75	90
Reflective cracking (%):	100	

Location:	New York
Project ID:	LOSP
Section ID:	360802
Date:	7/13/2009
Station/milepost format:	Feet: 00 + 00
Station/milepost begin:	16+15
Station/milepost end:	16+65
Traffic direction:	East bound

Default Input Level

Default input level: Level 3, Default and historical agency values.

Traffic

Initial two-way AADTT:	21
Number of lanes in design direction:	2
Percent of trucks in design direction (%):	50
Percent of trucks in design lane (%):	95
Operational speed (mph):	55

Traffic -- Volume Adjustment Factors

Monthly Adjustment Factors (Level 3, Default MAF)

Month	Vehicle Class									
	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
January	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
February	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April	1.00	0.36	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00
May	1.00	0.90	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
June	1.00	1.17	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
July	1.00	1.71	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
August	1.00	1.53	0.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
September	1.00	1.35	0.00	1.00	3.15	1.00	1.00	1.00	1.00	1.00
October	1.00	1.08	9.00	1.00	1.17	1.00	1.00	1.00	1.00	1.00
November	1.00	0.45	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00
December	1.00	0.45	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00

Vehicle Class Distribution
(Level 3, Default Distribution)

AADTT distribution by vehicle class

Class 4	0.2%
Class 5	88.2%
Class 6	2.1%
Class 7	0.1%
Class 8	8.7%
Class 9	0.6%
Class 10	0.1%
Class 11	0.0%
Class 12	0.0%
Class 13	0.0%

Hourly truck traffic distribution
by period beginning:

Midnight	2.3%	Noon	5.9%
1:00 am	2.3%	1:00 pm	5.9%
2:00 am	2.3%	2:00 pm	5.9%
3:00 am	2.3%	3:00 pm	5.9%
4:00 am	2.3%	4:00 pm	4.6%
5:00 am	2.3%	5:00 pm	4.6%
6:00 am	5.0%	6:00 pm	4.6%
7:00 am	5.0%	7:00 pm	4.6%
8:00 am	5.0%	8:00 pm	3.1%
9:00 am	5.0%	9:00 pm	3.1%
10:00 am	5.9%	10:00 pm	3.1%
11:00 am	5.9%	11:00 pm	3.1%

Traffic Growth Factor

Vehicle Class	Growth Rate	Growth Function
Class 4	4.0%	Linear
Class 5	4.0%	Linear
Class 6	4.0%	Linear
Class 7	4.0%	Linear
Class 8	4.0%	Linear
Class 9	4.0%	Linear
Class 10	4.0%	Linear
Class 11	4.0%	Linear
Class 12	4.0%	Linear
Class 13	4.0%	Linear

Traffic -- Axle Load Distribution Factors

Level 1: Site Specific

Traffic -- General Traffic Inputs

Mean wheel location (inches from the lane marking):	18
Traffic wander standard deviation (in):	10
Design lane width (ft):	12.14

Number of Axles per Truck

Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.57	0.43	0.00	0.00
Class 5	2.00	0.00	0.00	0.00
Class 6	1.00	1.00	0.00	0.00
Class 7	1.00	1.00	0.00	0.00
Class 8	3.16	0.12	0.00	0.00
Class 9	1.91	1.55	0.00	0.00
Class 10	1.00	1.67	0.33	0.00
Class 11	0.00	0.00	0.00	0.00
Class 12	0.00	0.00	0.00	0.00
Class 13	0.00	0.00	0.00	0.00

Axle Configuration

Average axle width (edge-to-edge) outside dimensions,ft):	8.5
Dual tire spacing (in):	12

Axle Configuration

Tire Pressure (psi) :	120

Average Axle Spacing

Tandem axle(psi):	51.6
Tridem axle(psi):	49.2
Quad axle(psi):	49.2

Climate

icm file:	C:\DG2002\Projects\LOSP-Interpolated.icm
Latitude (degrees.minutes)	43.35047
Longitude (degrees.minutes)	-77.8977
Elevation (ft)	259.186
Depth of water table (ft)	-1

Structure--Design Features

HMA E* Predictive Model:	NCHRP 1-37A viscosity based model.
HMA Rutting Model coefficients:	NCHRP 1-37A coefficients
Endurance Limit (microstrain):	None (0 microstrain)

Structure--Layers

Layer 1 -- Asphalt concrete

Material type:	Asphalt concrete
Layer thickness (in):	1

General Properties

General

Reference temperature (F°):	77

Volumetric Properties as Built

Effective binder content (%):	11
Air voids (%):	11.1
Total unit weight (pcf):	148
Poisson's ratio:	0.23 (user entered)

Thermal Properties

Thermal conductivity asphalt (BTU/hr-ft-F°):	0.67

Heat capacity asphalt (BTU/lb-F°): 0.23

Asphalt Mix

Cumulative % Retained 3/4 inch sieve: 0
Cumulative % Retained 3/8 inch sieve: 0
Cumulative % Retained #4 sieve: 16
% Passing #200 sieve: 1

Asphalt Binder

Option: Conventional penetration grade
Viscosity Grade: Pen 85-100
A: 10.8232 (correlated)
VTS: -3.621 (correlated)

Thermal Cracking Properties

Average Tensile Strength at 14ºF: 343.8
Mixture VMA (%): 22.1
Aggreagate coeff. thermal contraction (in./in.): 0.000005
Mix coeff. thermal contraction (in./in./ºF): 0.000013

Load Time (sec)	Low Temp. -4ºF (1/psi)	Mid. Temp. 14ºF (1/psi)	High Temp. 32ºF (1/psi)
1	2.27E-07	4.57E-07	6.97E-07
2	2.52E-07	5.38E-07	8.99E-07
5	2.89E-07	6.67E-07	1.26E-06
10	3.21E-07	7.85E-07	1.62E-06
20	3.56E-07	9.23E-07	2.09E-06
50	4.08E-07	1.14E-06	2.93E-06
100	4.53E-07	1.35E-06	3.78E-06

Layer 2 -- Asphalt concrete

Material type: Asphalt concrete
Layer thickness (in): 2.1

General Properties

General
Reference temperature (F°): 77

Volumetric Properties as Built
Effective binder content (%): 11
Air voids (%): 8.8
Total unit weight (pcf): 148

Poisson's ratio: 0.4 (user entered)

Thermal Properties

Thermal conductivity asphalt (BTU/hr-ft-F°):	0.67
Heat capacity asphalt (BTU/lb-F°):	0.23

Asphalt Mix

Cumulative % Retained 3/4 inch sieve:	14
Cumulative % Retained 3/8 inch sieve:	47
Cumulative % Retained #4 sieve:	65
% Passing #200 sieve:	3

Asphalt Binder

Option:	Conventional penetration grade
Viscosity Grade	Pen 85-100
A	10.8232 (correlated)
VTS:	-3.621 (correlated)

Layer 3 -- Asphalt concrete

Material type:	Asphalt concrete
Layer thickness (in):	4.6

General Properties

General

Reference temperature (F°):	77

Volumetric Properties as Built

Effective binder content (%):	11
Air voids (%):	7.3
Total unit weight (pcf):	148

Poisson's ratio: 0.39 (user entered)

Thermal Properties

Thermal conductivity asphalt (BTU/hr-ft-F°):	0.67
Heat capacity asphalt (BTU/lb-F°):	0.23

Asphalt Mix

Cumulative % Retained 3/4 inch sieve:	19
Cumulative % Retained 3/8 inch sieve:	36
Cumulative % Retained #4 sieve:	50
% Passing #200 sieve:	4

Asphalt Binder

Option:	Conventional penetration grade
Viscosity Grade	Pen 85-100
A	10.8232 (correlated)
VTS:	-3.621 (correlated)

Layer 4 -- Crushed gravel

Unbound Material:	Crushed gravel
Thickness(in):	12

Strength Properties

Input Level:	Level 3
Analysis Type:	ICM inputs (ICM Calculated Modulus)
Poisson's ratio:	0.35
Coefficient of lateral pressure,Ko:	0.5
Modulus (input) (psi):	25000

ICM Inputs

Gradation and Plasticity Index

Plasticity Index, PI:	1
Liquid Limit (LL)	16
Compacted Layer	Yes
Passing #200 sieve (%):	9.3
Passing #40	14.2
Passing #4 sieve (%):	35.3
D10(mm)	0.1003
D20(mm)	0.984
D30(mm)	3.057
D60(mm)	15.24
D90(mm)	34.03

Sieve	Percent Passing
0.001mm	
0.002mm	
0.020mm	
#200	9.3
#100	
#80	11.8
#60	
#50	
#40	14.2
#30	
#20	
#16	
#10	24.9
#8	
#4	35.3
3/8"	47.9
1/2"	53.8
3/4"	66.9
1"	77
1 1/2"	94.1
2"	100
2 1/2"	
3"	100
3 1/2"	
4"	

Calculated/Derived Parameters

Maximum dry unit weight (pcf):	125.9 (derived)
Specific gravity of solids, Gs:	2.83 (user input)
Saturated hydraulic conductivity (ft/hr):	0.1887 (derived)
Optimum gravimetric water content (%):	8.3 (derived)
Calculated degree of saturation (%):	58.2 (calculated)

Soil water characteristic curve parameters: Default values

Parameters	Value
a	3.2085
b	1.6135
c	0.69419
Hr.	118.6

Layer 5 -- A-2-4

Unbound Material:	A-2-4
Thickness(in):	Semi-infinite

Strength Properties

Input Level:	Level 3
Analysis Type:	ICM inputs (ICM Calculated Modulus)
Poisson's ratio:	0.35
Coefficient of lateral pressure,Ko:	0.5
Modulus (input) (psi):	21500

ICM Inputs

Gradation and Plasticity Index

Plasticity Index, PI:	5
Liquid Limit (LL)	19
Compacted Layer	Yes
Passing #200 sieve (%):	6.4
Passing #40	63
Passing #4 sieve (%):	98
D10(mm)	0.1691
D20(mm)	0.2391
D30(mm)	0.2733
D60(mm)	0.4083
D90(mm)	1.57

Sieve	Percent Passing
0.001mm	
0.002mm	
0.020mm	
#200	6.4
#100	
#80	11
#60	
#50	
#40	63
#30	
#20	
#16	
#10	95
#8	
#4	98
3/8"	100
1/2"	100
3/4"	100
1"	100
1 1/2"	100
2"	100
2 1/2"	
3"	100
3 1/2"	
4"	

Calculated/Derived Parameters

Maximum dry unit weight (pcf):	126.9 (derived)
Specific gravity of solids, Gs:	2.74 (user input)
Saturated hydraulic conductivity (ft/hr):	0.005052 (derived)
Optimum gravimetric water content (%):	7.8 (derived)
Calculated degree of saturation (%):	61.4 (calculated)

Soil water characteristic curve parameters: Default values

Parameters	Value
a	2.6125
b	3.3672
c	1.0517
Hr.	164

Distress Model Calibration Settings - Flexible

AC Fatigue	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	0.007566
k2	3.9492
k3	1.281
AC Rutting	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	-3.35412
k2	1.5606
k3	0.4791
Standard Deviation Total Rutting (RUT):	0.24*POWER(RUT,0.8026)+0.001
Thermal Fracture	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	1.5
Std. Dev. (THERMAL):	0.1468 * THERMAL + 65.027
CSM Fatigue	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
k1	1
k2	1
Subgrade Rutting	Level 3: NCHRP 1-37A coefficients (nationally calibrated values)
Granular:	
k1	2.03
Fine-grain:	
k1	1.35
AC Cracking	
AC Top Down Cracking	
C1 (top)	7
C2 (top)	3.5
C3 (top)	0
C4 (top)	1000
Standard Deviation (TOP)	200 + 2300/(1+exp(1.072-2.1654*log(TOP+0.0001)))

AC Bottom Up Cracking

C1 (bottom)	1
C2 (bottom)	1
C3 (bottom)	0
C4 (bottom)	6000
Standard Deviation (TOP)	1.13+13/(1+exp(7.57-15.5*log(BOTTOM+0.0001)))

CSM Cracking

C1 (CSM)	1
C2 (CSM)	1
C3 (CSM)	0
C4 (CSM)	1000
Standard Deviation (CSM)	CTB*1

IRI

IRI HMA Pavements New

C1(HMA)	40
C2(HMA)	0.4
C3(HMA)	0.008
C4(HMA)	0.015

IRI HMA/PCC Pavements

C1(HMA/PCC)	40.8
C2(HMA/PCC)	0.575
C3(HMA/PCC)	0.0014
C4(HMA/PCC)	0.00825

Figure C-2: 360802 MEPDG Input Summary

Appendix D – Construction Photos

Figure D-1: Subgrade Preparation Looking East - Section 360801 to 360802

Figure D-2: Trenching to Remove Moisture from Base/Subgrade Material during Construction of Section 360801

Figure D-3: FWD Testing and Fine Grading of Aggregate Base Looking West - Section 360802 to 360801

Figure D-4: Tack Coat Applied to Finished Aggregate Base Looking West – Section 360802 to 360801

D-5: Placement of Asphalt Base Layer – Section 360801 Driving Lane (Blaw-Knox model CPF-200 AP87 Paver)

D-6: Compaction of Asphalt Base Layer (Tampon RS-188A Model VC80 Double-Drum Vibratory Roller)

Figure D-7: Obtaining Asphalt Samples for Laboratory Analysis and Shipment to the FHWA-LTPP Materials Research Library (MRL)

Figure D-8: Asphalt Batch Plant - Genesee LeRoy Stone Corp., Stafford, NY

Figure D-9: Asphalt Batch Plant – Iroquois Rock Products, Brockport, NY

Figure D-10: Construction Complete – Looking East towards Section 360801 from the Start of Paving at the End of PCC Pavement

Appendix E – Site Assessment and Data Collection Photos

Figure E-1: Weigh-in-Motion (WIM) Installed at SPS-8 Project

Figure E-2: Photo of High Severity Centerline Longitudinal Crack with Associated Cracking (360801)

Figure E-3: Photo of Multiple Cracks in Vicinity of Station 1+00 (360801)

Figure E-4: Photo of Mid-Lane Longitudinal with Associated Cracking (360801)

Figure E-5: Photo of Moderate Severity Alligator Crack in Outer Wheel Path (360801)

Figure E-6: Photo of High Severity Distress between Section 360801 and 360802

Figure E-7: Photo of Multiple Random Cracking at Station 0+00 (360802)

Figure E- 8: Photo at Location of Water Utility – Signs of Leakage (360802)

Figure E-9: Photo of Low Severity Alligator Cracks in Wheel Paths (360802)

Figure E-10: Photo of High Severity Cracking/Ravelling from End of Section towards Core Sample Locations Station 5+00 (360802)

Figure E-11: Photo of Median, Curb and Left Lane Pavement (360801)

Figure E-12: Photo of Shoulder with Turf Grade Higher Than AC (360801)

Figure E-13: Pavement Quality Indicator (PQI) Density Data Collection

Figure E-14: Falling Weight Deflectometer (FWD) Data Collection

Appendix F – Coring and Core Photos

Figure F-1: Core Location Marking at a Midlane Longitudinal Crack (360801)

Figure F-2: NYSDOT coring - 100mm and 150mm Cores

Figure F-3: 100mm Cores Set Out for Examination and Condition Assessment

Figure F-4: 100mm Cores at Partial Transverse Crack (360801)

Figure F-5: 100mm Cores at Multiple Inner Wheel Path Longitudinal with Associated Cracking (360801)

Figure F-6: 100mm Cores at Alligator Cracking from Centerline towards Inner Wheel Path (360801)

Figure F-7: 100mm Core at Low Severity Longitudinal Crack in Midlane (360801)

Figure F-8: 100mm Cores at Alligator Cracks in Outer Wheel Path (360801)

Figure F-9: Marks Indentifying Location for Cores in Outer Wheel Path (360802)

Figure F-10: 100mm Cores at Location of Wheel Path Longitudinal and Associated Cracking (360802)

Figure F-11: 100mm Cores at Transverse Crack (360802)

Figure F-12: 100mm Cores at Low Severity Longitudinal Crack in Wheel Path (360802)

Figure F-13: 150mm Cores at Station 1+00 (360801)

Figure F-14: 150mm Cores at Station 3+50 (360801)

Figure F-15: 150mm Cores at Station 5+00 (360801)

Figure F-16: 150mm Cores at Station 3+00 (360802)

Figure F-17: 150mm Cores Set Number 2 at Station 2+50 (360801)

Figure F-18: 150mm Cores Set Number 2 at Station 4+00 (360801)

Figure F-19: 150mm Cores Set Number 2 Station 2+50 (360802)

Figure F-20: 150mm Cores Set Number 2 Station 4+25 (360802)

Appendix G – Drilling and Sampling Photos

Figure G-1: Split-Spoon Sampling

Figure G-2: Split-Spoon Sample Material

Figure G-3: Packaging and Labeling of Sample Material for Moisture Determination

Figure G-4: Performing the DCP Test

Appendix H – Split Spoon Sampling Sheets

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP REGION NA
STATE NY
SHRP ASSIGNED ID 0801

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — FIELD SET NO. 4

LOG OF BORE HOLE (A-Type)

DCG SHEET: 03

DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 1 OF 7
BORING DATE 05-21-08 LOCATION: STATION 1+01.5 BORE HOLE NUMBER: C7
BORE HOLE SIZE: 6 (inch Diam.) OFFSET 6 feet from °/s

Scale (Inches)	Strata Changed (Inches)	Sample Number (1)	# Blows (2) 6"	6"	6"	Ref? Y/N (3)	DLR (Inches) (4)	IOP (5)	Material Description	Material Code
	0.9"	-	-	-	-	-	-	-	AC-SURFACE	1
	4.9"	-	-	-	-	-	-	-	AC-BINDER	1
10.0	12.8"	-	9	-	-	N	—	—	CRUSHED GRAVEL	304
20.0										
30.0	40.9"	—	11	9	8	N	—	—	COARSE-GRAINED SILTY SAND	214
40.0										
50.0										
60.0										
70.0										
80.0										
90.0										
100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS:

CERTIFIED

Crew Chief, Contractor
Affiliation:

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR
MAY-21-2008
Date

Form S02A/April 1990

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP REGION NA
STATE NY
SHRP ASSIGNED ID 0801

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — *FIELD SET NO.* 4
LOG OF BORE HOLE (A-Type) *DCG SHEET: 03*
DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 2 OF 7
BORING DATE 05-21-08 *LOCATION: STATION* 3+51.5 *BORE HOLE NUMBER:* C23
BORE HOLE SIZE: 6 (inch Diam.) *OFFSET* 3 *feet from °/s*

Scale (Inches)	*Strata Changed (Inches)*	*Sample Number* (1)	*# Blows* (2) 6"	6"	6"	*Ref? Y/N* (3)	*DLR (Inches)* (4)	*IOP* (5)	*Material Description*	*Material Code*
	0.8"	–	–	–	–	–	–	–	AC-SURFACE	1
	4.6"	–	–	–	–	–	–	–	AC-BINDER	1
_10.0_	12.5"	–	16	–	–	N	–	–	CRUSHED GRAVEL	304
_20.0_									COARSE-GRAINED	
_30.0_	40.6"	–	15	13	7	N	–	–	SILTY SAND	214
_40.0_										
_50.0_										
_60.0_										
_70.0_										
_80.0_										
_90.0_										
_100.0_										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS: ______

CERTIFIED ______
Crew Chief, Contractor
Affiliation: ______

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR
MAY-21-~~15~~2008
Date

Form S02A/April 1990

SHRP REGION NA
STATE NY

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP ASSIGNED ID 0801

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — *FIELD SET NO.* 4

LOG OF BORE HOLE (A-Type) *DCG SHEET: 03*

DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 3 OF 7
BORING DATE 05-21-08 *LOCATION: STATION* 3+51.5 *BORE HOLE NUMBER:* C24
BORE HOLE SIZE: 6 (inch Diam.) *OFFSET* 6 *feet from °/s*

Scale (Inches)	*Strata Changed (Inches)*	*Sample Number* (1)	*# Blows* (2) 6"	6"	6"	*Ref? Y/N* (3)	*DLR (Inches)* (4)	*IOP* (5)	*Material Description*	*Material Code*
	0.8"	–	–	–	–	–	–	–	AC-SURFACE	1
	4.5"	–	–	–	–	–	–	–	AC-BINDER	1
10.0	14.3"	–	12	13	–	N	–	–	CRUSHED GRAVEL	304
20.0										
30.0	40.5"	–	11	7	6	N	–	–	COARSE-GRAINED SILTY SAND	214
40.0										
50.0										
60.0										
70.0										
80.0										
90.0										
100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS:

CERTIFIED ____________
Crew Chief, Contractor
Affiliation: ____________

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR
MAY-21-2008
Date

Form S02A/April 1990

SHRP REGION NA
STATE NY

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP ASSIGNED ID 0801

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — *FIELD SET NO.* 4
LOG OF BORE HOLE (A-Type) *DCG SHEET: 03*
DRILLER NYS DOT EQUIPMENT USED DRILL RIG SHEET NUMBER 4 OF 7
BORING DATE 05-21-08 *LOCATION: STATION* 5+00 *BORE HOLE NUMBER:* C33
BORE HOLE SIZE: 6 (inch Diam.) *OFFSET* 3 *feet from °/s*

Scale (Inches)	*Strata Changed (Inches)*	*Sample Number* (1)	*# Blows* (2) 6"	6"	6"	*Ref? Y/N* (3)	*DLR (Inches)* (4)	*IOP* (5)	*Material Description*	*Material Code*
10.0	9.8"	–	12	10	–	N	–	–	CRUSHED GRAVEL	304
20.0 30.0	36.0"	–	13	10	10	N	–	–	COARSE-GRAINED SILTY SAND	214
40.0 50.0 60.0 70.0 80.0 90.0 100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS: * MISSING LAYER # 3 MEASUREMENT, BORE HOLE LOG STARTED FROM AGG. LAYER

CERTIFIED ____________ Crew Chief, Contractor
Affiliation: ____________

VERIFIED AND APPROVED B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR MAY-21-2008
Date

Form S02A/April 1990

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

SHRP REGION NA
STATE NY
STATE CODE 36
SHRP ASSIGNED ID 0801

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — FIELD SET NO. 4

LOG OF BORE HOLE (A-Type)
DCG SHEET: 03

DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 5 OF 7
BORING DATE 05-21-08 LOCATION: STATION 5+00 BORE HOLE NUMBER: C34
BORE HOLE SIZE: 6 (inch Diam.) OFFSET 6 feet from °/s

Scale (Inches)	Strata Changed (Inches)	Sample Number (1)	# Blows (2) 6"	6"	6"	Ref? Y/N (3)	DLR (Inches) (4)	IOP (5)	Material Description	Material Code
	0.8"	–	–	–	–	–	–	–	AC-SURFACE	1
	6.0"	–	–	–	–	–	–	–	AC-BINDER	1
10.0	13.9"	–	12	–	–	N	–	–	CRUSHED GRAVEL	304
20.0									COARSE-GRAINED	
30.0	42.0"	–	14	11	9	N	–	–	SILTY SAND	214
40.0										
50.0										
60.0										
70.0										
80.0										
90.0										
100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. *Refused* - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete *Driving Length To Refusal* column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. *Driving Length To Refusal* - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. *Inches Of Penetration* - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS:

CERTIFIED
Crew Chief, Contractor
Affiliation:

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR
MAY-21-2008
Date

Form S02A/April 1990

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP REGION NA
STATE NY
SHRP ASSIGNED ID 0802

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — FIELD SET NO. 4

LOG OF BORE HOLE (A-Type)
DCG SHEET: 03

DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 6 OF 7
BORING DATE 05-21-08 LOCATION: STATION 3+01 BORE HOLE NUMBER: C44
BORE HOLE SIZE: 6 (inch Diam.) OFFSET 3 feet from °/s

Scale (Inches)	Strata Changed (Inches)	Sample Number (1)	# Blows (2) 6"	6"	6"	Ref? Y/N (3)	DLR (Inches) (4)	IOP (5)	Material Description	Material Code
	1.1"	—	—	—	—	—	—	—	AC-SURFACE	1
	2.8"	—	—	—	—	—	—	—	AC-BINDER	1
10.0	9.3"	—	—	—	—	—	—	—	AC-BASE	1
20.0	18.5"	—	9	6	—	N	—	—	CRUSHED GRAVEL	304
30.0 40.0	44.3"	—	5	5	5	N	—	—	COARSE-GRAINED CLAYEY SAND	216
50.0 60.0 70.0 80.0 90.0 100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the ***REFUSAL*** column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS:

CERTIFIED

Crew Chief, Contractor
Affiliation:

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARD

MONTH-DAY-YEAR
MAY-21-2008
Date

Form S02A/April 1990

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 36
SHRP REGION NA
STATE NY
SHRP ASSIGNED ID D802

LTPP EXPERIMENT SPS-8 ROUTE/HIGHWAY LOSP Lane 1 Direction EB
SAMPLE/TEST: (a) Before Section — (b) After Section — FIELD SET NO. 4

LOG OF BORE HOLE (A-Type)

DCG SHEET: 03
DRILLER NYSDOT EQUIPMENT USED DRILL RIG SHEET NUMBER 7 OF 7
BORING DATE 05-21-08 LOCATION: STATION 3+01 BORE HOLE NUMBER: C45
BORE HOLE SIZE: 6 (inch Diam.) OFFSET 6 feet from °/s

Scale (Inches)	Strata Changed (Inches)	Sample Number (1)	# Blows (2) 6"	6"	6"	Ref? Y/N (3)	DLR (Inches) (4)	IOP (5)	Material Description	Material Code
	1.0"	—	—	—	—	—	—	—	AC-SURFACE	1
	2.8"	—	—	—	—	—	—	—	AC-BINDER	1
10.0	8.1"	—	—	—	—	—	—	—	AC-BASE	1
20.0	21.1"	—	10	7	—	N	—	—	CRUSHED GRAVEL	304
30.0 40.0	42.9"	—	7	5	5	N	—	—	COARSE-GRAINED CLAYEY SAND	216
50.0										
60.0										
70.0										
80.0										
90.0										
100.0										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.
2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.
3. ***Refused*** - If the splitspoon is refused, place a Y in the ***REFUSAL*** column and complete ***Driving Length To Refusal*** column. Refusal is defined as less than 1 inch of penetration with 100 blows.
4. ***Driving Length To Refusal*** - Record penetration to refusal of splitspoon from the top of the pavement surface.
5. ***Inches Of Penetration*** - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS: ____

CERTIFIED ____
Crew Chief, Contractor
Affiliation: ____

VERIFIED AND APPROVED
B. Henderson
SHRP Representative
Affiliation: LTPP-NARO

MONTH-DAY-YEAR
MAY-21-2008
Date

Form S02A/April 1990

Appendix I – DCP Sampling Sheets

******************************** SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ____ OF ____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C4

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 1 + 00 — DEPTH OF ZERO POINT BELOW SURFACE: 130 mm
LATERAL LOCATION (Distance from outside lane marker): 0.76 m

Initial Scale Reading at zero blows 176 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	23	23	5	1	5	50	3.8
2	5	46	23	5	1	5	50	3.8
3	5	69	23	5	1	5	50	3.8
4	5	94	25	5	1	5	50	3.8
5	5	114	20	4	1	4	60	3.8
6	5	141	27	5	1	5	50	3.8
7	5	165	24	5	1	5	50	3.8
8	5	185	20	4	1	4	60	3.8
9	5	211	26	5	1	5	50	3.8
10	5	229	18	4	1	4	60	3.8
11	5	248	19	4	1	4	60	3.8
12	5	272	24	5	1	5	50	13.2
13	5	297	25	5	1	5	50	13.2
14	5	318	21	4	1	4	60	13.2
15	5	341	23	5	1	5	50	13.2
16	5	370	29	6	1	6	40	13.2
17	5	400	30	6	1	6	40	13.2
18	5	434	34	7	1	7	35	13.2
19	5	467	33	7	1	7	35	18.8
20	5	502	35	7	1	7	35	18.8
21	5	538	36	7	1	7	35	18.8
22	5	586	48	10	1	10	20	18.8
23	5	625	39	8	1	8	30	18.8
24	5	658	33	7	1	7	35	12.6
25	5	681	23	5	1	5	50	12.6

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ___ ___ ___ ___ ___ ___ ___ ___
(B) NOTE Moisture data taken from location C6

CERTIFIED ______ — VERIFIED AND APPROVED Brandt Henderson — DATE 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: ______ — *AFFILIATION:* LTPP - NARO

Form T72, June 2006

******************************** **SPS LABORATORY TESTING DATA SHEET** ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C4

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	706	25	5	1	5	50	12.6
27	5	730	24	5	1	5	50	12.6
28	5	761	31	6	1	6	40	12.6
29	5	796	35	7	1	7	35	12.8
30	4	824	28	7	1	7	35	12.8
31		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______

(B) NOTE Moisture data taken from location C6

CERTIFIED ______________________

VERIFIED AND APPROVED Brandt Henderson

DATE 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: ______________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

******************************** SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / JCD
TEST DATE: 21 - May - 20 08

STATE CODE: 36
SHRP ID: 0801
FIELD SET NO.: 4
LOC NO.: C5

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 1 + 00
DEPTH OF ZERO POINT BELOW SURFACE: 127 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 170 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	25	25	5	1	5	50	4.2
2	5	46	21	4	1	4	60	4.2
3	5	65	19	4	1	4	60	4.2
4	5	86	21	4	1	4	60	4.2
5	5	105	19	4	1	4	60	4.2
6	5	121	16	3	1	3	80	4.2
7	5	135	14	3	1	3	80	4.2
8	5	154	19	4	1	4	60	4.2
9	5	171	17	3	1	3	80	4.2
10	5	184	13	3	1	3	80	4.2
11	5	197	13	3	1	3	80	4.2
12	5	214	17	3	1	3	80	10.1
13	5	238	24	5	1	5	50	10.1
14	5	256	18	4	1	4	60	10.1
15	5	275	19	4	1	4	60	16.0
16	5	300	25	5	1	5	50	16.0
17	5	330	30	6	1	6	40	16.0
18	5	360	30	6	1	6	40	16.0
19	5	391	31	6	1	6	40	16.0
20	5	424	33	7	1	7	35	16.0
21	5	459	35	7	1	7	35	16.0
22	5	496	37	7	1	7	35	12.8
23	5	537	41	8	1	8	30	12.8
24	5	590	53	11	1	11	20	12.8
25	5	633	43	9	1	9	25	12.8

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ____ ____ ____ ____ ____ ____ ____ ____
(B) NOTE Moisture data taken from location C7

CERTIFIED ______________________ AFFILIATION: ______________

VERIFIED AND APPROVED Brandt Henderson AFFILIATION: LTPP - NARO

DATE 28-May-2008 dd-mmm-yyyy

Form T72, June 2006

******************************** SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION:	NARO	**STATE CODE:**	36
STATE:	NY	**SHRP ID:**	0801
OPERATOR:	BH / JCD	**FIELD SET NO.:**	4
TEST DATE:	21 - May - 20 08	**LOC NO.:**	C5

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	656	23	5	1	5	50	12.8
27	5	676	20	4	1	4	60	12.8
28	5	700	24	5	1	5	50	12.8
29	5	725	25	5	1	5	50	12.8
30	5	762	37	7	1	7	35	12.8
31	5	830	68	14	1	14	15	12.8
32		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______

(B) NOTE Moisture data taken from location C7

CERTIFIED	VERIFIED AND APPROVED	DATE
	Brandt Henderson	28-May-2008
		dd-mmm-yyyy
AFFILIATION:	*AFFILIATION:* LTPP - NARO	

Form T72 Continuation, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C21

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 3 + 50 DEPTH OF ZERO POINT BELOW SURFACE: 117 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 176 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	35	35	7	1	7	35	3.9
2	5	55	20	4	1	4	60	3.9
3	5	71	16	3	1	3	80	3.9
4	5	83	12	2	1	2	100	3.9
5	5	96	13	3	1	3	80	3.9
6	5	106	10	2	1	2	100	3.9
7	5	121	15	3	1	3	80	3.9
8	5	133	12	2	1	2	100	3.9
9	5	146	13	3	1	3	80	3.9
10	5	159	13	3	1	3	80	3.9
11	5	174	15	3	1	3	80	3.9
12	5	182	8	2	1	2	100	3.9
13	5	189	7	1	1	1	100	3.9
14	5	213	24	5	1	5	50	13.6
15	5	231	18	4	1	4	60	13.6
16	5	243	12	2	1	2	100	13.6
17	5	244	1	0	1	0	100	13.6
18	5	245	1	0	1	0	100	13.6
19	10	246	1	0	1	0	100	13.6
20		**END ***						
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24								
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE ____ ____ ____ ____ ____ ____ ____ ____
(B) NOTE ***REFUSAL - Moisture data taken from location C23**

CERTIFIED ______________________ VERIFIED AND APPROVED Brandt Henderson DATE 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: ______________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ********************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C22

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 3 + 50 DEPTH OF ZERO POINT BELOW SURFACE: 117 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 164 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	26	26	5	1	5	50	4.4
2	5	43	17	3	1	3	80	4.4
3	5	56	13	3	1	3	80	4.4
4	5	71	15	3	1	3	80	4.4
5	5	83	12	2	1	2	100	4.4
6	5	96	13	3	1	3	80	4.4
7	5	114	18	4	1	4	60	4.4
8	5	130	16	3	1	3	80	4.4
9	5	143	13	3	1	3	80	4.4
10	5	161	18	4	1	4	60	4.4
11	5	178	17	3	1	3	80	4.4
12	5	194	16	3	1	3	80	4.4
13	5	209	15	3	1	3	80	4.4
14	5	231	22	4	1	4	60	4.4
15	5	260	29	6	1	6	40	4.4
16	5	286	26	5	1	5	50	8.9
17	5	313	27	5	1	5	50	8.9
18	5	340	27	5	1	5	50	8.9
19	5	365	25	5	1	5	50	8.9
20	5	391	26	5	1	5	50	8.9
21	5	417	26	5	1	5	50	8.9
22	5	442	25	5	1	5	50	8.9
23	5	467	25	5	1	5	50	8.9
24	5	495	28	6	1	6	40	8.9
25	5	522	27	5	1	5	50	15.0

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ____ ____ ____ ____ ____ ____ ____ ____
(B) NOTE Moisture data taken from location C24

CERTIFIED ______________ VERIFIED AND APPROVED Brandt Henderson DATE 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: ______________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / JCD
TEST DATE: 21 - May - 20 08

STATE CODE: 36
SHRP ID: 0801
FIELD SET NO.: 4
LOC NO.: C22

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	549	27	5	1	5	50	15.0
27	5	580	31	6	1	6	40	15.0
28	5	627	47	9	1	9	25	15.0
29	3	680	53	18	1	18	11	15.0
30	3	746	66	22	1	22	9	18.3
31	3	802	56	19	1	19	11	18.3
32	3	819	17	6	1	6	40	18.3
33	3	819	0	0	1	0	100	18.3
34		**END ***						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE *** REFUSAL - Moisture data taken from location C24**

CERTIFIED ____________________

VERIFIED AND APPROVED Brandt Henderson

DATE 28-May-2008
dd-mmm-yyyy

AFFILIATION: ____________________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / JCD
TEST DATE: 21 - May - 20 08

STATE CODE: 36
SHRP ID: 0801
FIELD SET NO.: 4
LOC NO.: C31

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 98.5
DEPTH OF ZERO POINT BELOW SURFACE: 147 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 175 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	20	20	4	1	4	60	4.5
2	5	36	16	3	1	3	80	4.5
3	5	57	21	4	1	4	60	4.5
4	5	73	16	3	1	3	80	4.5
5	5	87	14	3	1	3	80	4.5
6	5	100	13	3	1	3	80	4.5
7	5	114	14	3	1	3	80	4.5
8	5	122	8	2	1	2	100	4.5
9	10	151	29	3	1	3	80	4.5
10	10	195	44	4	1	4	60	4.5
11	5	210	15	3	1	3	80	4.5
12	5	228	18	4	1	4	60	4.5
13	5	252	24	5	1	5	50	4.5
14	5	275	23	5	1	5	50	7.6
15	5	293	18	4	1	4	60	7.6
16	5	305	12	2	1	2	100	7.6
17	5	310	5	1	1	1	100	7.6
18	10	330	20	2	1	2	100	7.6
19	10	354	24	2	1	2	100	7.6
20	10	395	41	4	1	4	60	7.6
21	10	436	41	4	1	4	60	14.2
22	5	458	22	4	1	4	60	14.2
23	5	480	22	4	1	4	60	14.2
24	5	500	20	4	1	4	60	14.2
25	5	511	11	2	1	2	100	14.2

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE
(B) NOTE Moisture data taken from location C33

CERTIFIED

VERIFIED AND APPROVED: Brandt Henderson

DATE: 28-May-2008
dd-mmm-yyyy

AFFILIATION:

AFFILIATION: LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO | STATE CODE: 36
STATE: NY | SHRP ID: 0801
OPERATOR: BH / JCD | FIELD SET NO.: 4
TEST DATE: 21 - May - 20 08 | LOC NO.: C31

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	525	14	3	1	3	80	14.2
27	5	541	16	3	1	3	80	14.2
28	5	561	20	4	1	4	60	14.2
29	5	582	21	4	1	4	60	14.2
30	5	605	23	5	1	5	50	14.2
31	5	629	24	5	1	5	50	14.2
32	5	654	25	5	1	5	50	14.2
33	5	681	27	5	1	5	50	14.2
34	5	709	28	6	1	6	40	14.0
35	5	727	18	4	1	4	60	14.0
36	5	738	11	2	1	2	100	14.0
37	5	755	17	3	1	3	80	14.0
38	5	777	22	4	1	4	60	14.0
39	5	795	18	4	1	4	60	14.0
40	5	809	14	3	1	3	80	14.0
41	3	825	16	5	1	5	50	14.0
42		END						
43								
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______

(B) NOTE Moisture data taken from location C33

CERTIFIED ____________ | VERIFIED AND APPROVED: Brandt Henderson | DATE: 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: ____________ | *AFFILIATION:* LTPP - NARO

Form T72 Continuation, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ______ OF ______

**LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72**

**BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72**

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C32

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 98.5 — DEPTH OF ZERO POINT BELOW SURFACE: 155 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 170 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	10	10	2	1	2	100	4.2
2	5	36	26	5	1	5	50	4.2
3	5	53	17	3	1	3	80	4.2
4	5	64	11	2	1	2	100	4.2
5	5	80	16	3	1	3	80	4.2
6	5	95	15	3	1	3	80	4.2
7	10	106	11	1	1	1	100	4.2
8	10	120	14	1	1	1	100	4.2
9	10	138	18	2	1	2	100	4.2
10	10	158	20	2	1	2	100	4.2
11	10	192	34	3	1	3	80	4.2
12	10	231	39	4	1	4	60	7.7
13	10	250	19	2	1	2	100	7.7
14	10	273	23	2	1	2	100	7.7
15	10	304	31	3	1	3	80	7.7
16	10	327	23	2	1	2	100	7.7
17	10	362	35	4	1	4	60	14.0
18	10	407	45	5	1	5	50	14.0
19	10	455	48	5	1	5	50	14.0
20	10	502	47	5	1	5	50	14.0
21	5	526	24	5	1	5	50	14.0
22	5	552	26	5	1	5	50	14.0
23	5	576	24	5	1	5	50	14.0
24	5	610	34	7	1	7	35	14.0
25	5	636	26	5	1	5	50	11.5

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE Moisture data taken from location C34

CERTIFIED ______________ VERIFIED AND APPROVED Brandt Henderson DATE 28-May-2008 dd-mmm-yyyy

AFFILIATION: ______________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ********************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / JCD
TEST DATE: 21 - May - 20 08

STATE CODE: 36
SHRP ID: 0801
FIELD SET NO.: 4
LOC NO.: C32

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	659	23	5	1	5	50	11.5
27	5	670	11	2	1	2	100	11.5
28	5	678	8	2	1	2	100	11.5
29	5	690	12	2	1	2	100	11.5
30	5	707	17	3	1	3	80	11.5
31	5	729	22	4	1	4	60	11.5
32	5	745	16	3	1	3	80	11.5
33	5	764	19	4	1	4	60	11.5
34	5	776	12	2	1	2	100	11.5
35	5	792	16	3	1	3	80	11.5
36	5	815	23	5	1	5	50	11.5
37	2	830	15	8	1	8	30	11.5
38		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE _____ _____ _____ _____ _____ _____ _____ _____
(B) NOTE Moisture data taken from location C34

CERTIFIED _______________

VERIFIED AND APPROVED Brandt Henderson

DATE 28-May-2008
dd-mmm-yyyy

AFFILIATION: _______________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C1

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 2 +50 DEPTH OF ZERO POINT BELOW SURFACE: 146 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 315 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	7	7	2	1	2	100	
2	3	15	8	3	1	3	80	
3	3	22	7	2	1	2	100	
4	5	32	10	2	1	2	100	
5	5	44	12	2	1	2	100	
6	5	52	8	2	1	2	100	
7	5	65	13	3	1	3	80	
8	10	84	19	2	1	2	100	
9	10	108	24	2	1	2	100	
10	10	122	14	1	1	1	100	
11	10	141	19	2	1	2	100	
12	10	182	41	4	1	4	60	
13	10	226	44	4	1	4	60	
14	10	265	39	4	1	4	60	
15	10	299	34	3	1	3	80	
16	10	352	53	5	1	5	50	
17	5	392	40	8	1	8	30	
18	5	425	33	7	1	7	35	
19	5	455	30	6	1	6	40	
20	5	488	33	7	1	7	35	
21	5	519	31	6	1	6	40	
22	5	547	28	6	1	6	40	
23	5	568	21	4	1	4	60	
24	6	595	27	5	1	5	50	
25	5	621	26	5	1	5	50	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE ________________________

CERTIFIED ____________ VERIFIED AND APPROVED Brandt Henderson DATE 7-Oct-2008 dd-mmm-yyyy

AFFILIATION: ____________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** *******************************

SHEET # ______ OF ______

**LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72**

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C1

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	657	36	7	1	7	35	
27	4	685	28	7	1	7	35	
28								
29		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE ____

CERTIFIED ________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008
dd-mmm-yyyy

AFFILIATION: ________________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ********************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C3

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 2 + 50 — DEPTH OF ZERO POINT BELOW SURFACE: 147 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 307 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	23	23	8	1	8	30	
2	3	35	12	4	1	4	60	
3	3	48	13	4	1	4	60	
4	3	60	12	4	1	4	60	
5	3	67	7	2	1	2	100	
6	5	83	16	3	1	3	80	
7	5	100	17	3	1	3	80	
8	5	114	14	3	1	3	80	
9	10	144	30	3	1	3	80	
10	10	178	34	3	1	3	80	
11	10	219	41	4	1	4	60	
12	10	261	42	4	1	4	60	
13	10	305	44	4	1	4	60	
14	5	338	33	7	1	7	35	
15	5	370	32	6	1	6	40	
16	5	403	33	7	1	7	35	
17	5	437	34	7	1	7	35	
18	5	470	33	7	1	7	35	
19	5	496	26	5	1	5	50	
20	5	521	25	5	1	5	50	
21	5	553	32	6	1	6	40	
22	5	583	30	6	1	6	40	
23	5	614	31	6	1	6	40	
24	5	664	50	10	1	10	20	
25	2	693	29	15	1	15	14	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE
(B) NOTE

CERTIFIED — VERIFIED AND APPROVED: Brandt Henderson — DATE: 7-Oct-2008 (dd-mmm-yyyy)

AFFILIATION: ______ — *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO | **STATE CODE:** 36
STATE: NY | **SHRP ID:** 0801
OPERATOR: AL / JCD | **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 | **LOC NO.:** C5

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 00 DEPTH OF ZERO POINT BELOW SURFACE: 155 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 323 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	13	13	4	1	4	60	
2	3	22	9	3	1	3	80	
3	3	28	6	2	1	2	100	
4	5	37	9	2	1	2	100	
5	5	45	8	2	1	2	100	
6	5	54	9	2	1	2	100	
7	5	61	7	1	1	1	100	
8	5	68	7	1	1	1	100	
9	10	79	11	1	1	1	100	
10	10	98	19	2	1	2	100	
11	10	115	17	2	1	2	100	
12	10	138	23	2	1	2	100	
13	10	164	26	3	1	3	80	
14	10	192	28	3	1	3	80	
15	10	213	21	2	1	2	100	
16	10	242	29	3	1	3	80	
17	10	272	30	3	1	3	80	
18	10	304	32	3	1	3	80	
19	10	329	25	3	1	3	80	
20	10	372	43	4	1	4	60	
21	5	394	22	4	1	4	60	
22	5	415	21	4	1	4	60	
23	5	436	21	4	1	4	60	
24	5	460	24	5	1	5	50	
25	5	480	20	4	1	4	60	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE ____________________

CERTIFIED ____________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008 (dd-mmm-yyyy)

AFFILIATION: ____________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** *******************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: AL / JCD
TEST DATE: 07 - Oct - 20 08

STATE CODE: 36
SHRP ID: 0801
FIELD SET NO.: 5
LOC NO.: C5

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	5	498	18	4	1	4	60	
27	5	520	22	4	1	4	60	
28	5	547	27	5	1	5	50	
29	5	572	25	5	1	5	50	
30	5	601	29	6	1	6	40	
31	5	629	28	6	1	6	40	
32	5	657	28	6	1	6	40	
33	4	677	20	5	1	5	50	
34								
35		**END**						
36								
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE _____ _____ _____ _____ _____ _____ _____ _____
(B) NOTE ______________________________

CERTIFIED ______________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008
dd-mmm-yyyy

AFFILIATION: ______________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** *******************************

SHEET # ______ OF ______

**LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72**

**BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72**

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0801
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C7

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 00 DEPTH OF ZERO POINT BELOW SURFACE: 145 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 298 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	13	13	4	1	4	60	
2	3	21	8	3	1	3	80	
3	3	35	14	5	1	5	50	
4	5	37	2	0	1	0	100	
5	5	43	6	1	1	1	100	
6	10	57	14	1	1	1	100	
7	10	80	23	2	1	2	100	
8	10	97	17	2	1	2	100	
9	10	119	22	2	1	2	100	
10	10	139	20	2	1	2	100	
11	10	166	27	3	1	3	80	
12	10	187	21	2	1	2	100	
13	10	219	32	3	1	3	80	
14	5	235	16	3	1	3	80	
15	5	244	9	2	1	2	100	
16	5	249	5	1	1	1	100	
17	5	257	8	2	1	2	100	
18	5	257	0	0	1	0	100	
19	10	259	2	0	1	0	100	
20	10	269	10	1	1	1	100	
21	10	281	12	1	1	1	100	
22	10	307	26	3	1	3	80	
23	10	322	15	2	1	2	100	
24	10	344	22	2	1	2	100	
25	10	361	17	2	1	2	100	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE Long test - Very hard subgrade or rock

CERTIFIED ____________________ VERIFIED AND APPROVED Brandt Henderson DATE 7-Oct-2008 (dd-mmm-yyyy)

AFFILIATION: ____________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO | **STATE CODE:** 36
STATE: NY | **SHRP ID:** 0801
OPERATOR: AL / JCD | **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 | **LOC NO.:** C7

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	10	378	17	2	1	2	100	
27	10	404	26	3	1	3	80	
28	10	444	40	4	1	4	60	
29	10	486	42	4	1	4	60	
30	10	532	46	5	1	5	50	
31	10	577	45	5	1	5	50	
32	5	602	25	5	1	5	50	
33	5	625	23	5	1	5	50	
34	5	649	24	5	1	5	50	
35	5	674	25	5	1	5	50	
36	5	702	28	6	1	6	40	
37								
38		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______
(B) NOTE Long test - Very hard subgrade or rock

CERTIFIED ____________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008 (dd-mmm-yyyy)

AFFILIATION: ____________________

AFFILIATION: LTPP - NARO

Form T72 Continuation, June 2006

********************************* SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0802
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C42

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 2 + 99.5 DEPTH OF ZERO POINT BELOW SURFACE: 231 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 179 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	21	21	4	1	4	60	5.8
2	5	38	17	3	1	3	80	5.8
3	5	59	21	4	1	4	60	5.8
4	5	81	22	4	1	4	60	5.8
5	5	113	32	6	1	6	40	5.8
6	5	140	27	5	1	5	50	5.8
7	5	175	35	7	1	7	35	5.8
8	5	219	44	9	1	9	25	5.8
9	5	260	41	8	1	8	30	5.8
10	5	328	68	14	1	14	15	11.5
11	3	396	68	23	1	23	9	11.5
12	3	446	50	17	1	17	12	13.8
13	3	488	42	14	1	14	15	13.8
14	3	541	53	18	1	18	11	13.8
15	3	566	25	8	1	8	30	19.0
16	3	589	23	8	1	8	30	19.0
17	3	619	30	10	1	10	20	19.0
18	3	658	39	13	1	13	16	19.7
19	3	698	40	13	1	13	16	19.7
20	3	741	43	14	1	14	15	19.7
21	3	808	67	22	1	22	9	19.7
22		**END**						
23								
24								
25								

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE _____ _____ _____ _____ _____ _____ _____ _____
(B) NOTE Moisture data taken from location C44

CERTIFIED _______________ VERIFIED AND APPROVED Brandt Henderson DATE 28-May-2008 dd-mmm-yyyy

AFFILIATION: _______________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

*********************************** SPS LABORATORY TESTING DATA SHEET *********************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0802
OPERATOR: BH / JCD — **FIELD SET NO.:** 4
TEST DATE: 21 - May - 20 08 — **LOC NO.:** C43

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 2 + 99.5 DEPTH OF ZERO POINT BELOW SURFACE: 224 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 171 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	26	26	5	1	5	50	5.3
2	5	46	20	4	1	4	60	5.3
3	5	62	16	3	1	3	80	5.3
4	5	79	17	3	1	3	80	5.3
5	5	98	19	4	1	4	60	5.3
6	5	114	16	3	1	3	80	5.3
7	5	144	30	6	1	6	40	5.3
8	5	172	28	6	1	6	40	5.3
9	5	201	29	6	1	6	40	5.3
10	5	237	36	7	1	7	35	5.3
11	5	281	44	9	1	9	25	5.3
12	5	334	53	11	1	11	20	5.3
13	5	382	48	10	1	10	20	9.9
14	5	426	44	9	1	9	25	9.9
15	5	467	41	8	1	8	30	19.0
16	5	506	39	8	1	8	30	19.0
17	5	563	57	11	1	11	20	19.0
18	3	597	34	11	1	11	20	16.8
19	3	626	29	10	1	10	20	16.8
20	3	657	31	10	1	10	20	16.8
21	3	724	67	22	1	22	9	16.8
22	3	775	51	17	1	17	12	16.8
23	3	812	37	12	1	12	18	18.5
24		**END**						
25								

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE _____ _____ _____ _____ _____ _____ _____ _____
(B) NOTE Moisture data taken from location C45

CERTIFIED ________________

VERIFIED AND APPROVED: Brandt Henderson

DATE: 28-May-2008 (dd-mmm-yyyy)

AFFILIATION: __________ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: AL / JCD
TEST DATE: 07 - Oct - 20 08

STATE CODE: 36
SHRP ID: 0802
FIELD SET NO.: 5
LOC NO.: C9

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 1 + 50
DEPTH OF ZERO POINT BELOW SURFACE: 224 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 405 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	15	15	5	1	5	50	
2	3	30	15	5	1	5	50	
3	3	43	13	4	1	4	60	
4	3	55	12	4	1	4	60	
5	5	72	17	3	1	3	80	
6	5	95	23	5	1	5	50	
7	5	116	21	4	1	4	60	
8	5	140	24	5	1	5	50	
9	5	179	39	8	1	8	30	
10	5	211	32	6	1	6	40	
11	5	256	45	9	1	9	25	
12	5	281	25	5	1	5	50	
13	5	329	48	10	1	10	20	
14	5	388	59	12	1	12	18	
15	3	418	30	10	1	10	20	
16	3	442	24	8	1	8	30	
17	3	468	26	9	1	9	25	
18	3	486	18	6	1	6	40	
19	3	509	23	8	1	8	30	
20	3	537	28	9	1	9	25	
21	3	562	25	8	1	8	30	
22	3	578	16	5	1	5	50	
23	3	589	11	4	1	4	60	
24	3	595	6	2	1	2	100	
25		**END**						

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ____ ____ ____ ____ ____ ____ ____ ____
(B) NOTE ______________________

CERTIFIED ______________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008
dd-mmm-yyyy

AFFILIATION: ______________

AFFILIATION: LTPP - NARO

Form T72, June 2006

********************************* **SPS LABORATORY TESTING DATA SHEET** *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0802
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C11

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 1 + 50 — DEPTH OF ZERO POINT BELOW SURFACE: 221 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 405 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	23	23	8	1	8	30	
2	3	39	16	5	1	5	50	
3	5	63	24	5	1	5	50	
4	5	85	22	4	1	4	60	
5	5	110	25	5	1	5	50	
6	5	132	22	4	1	4	60	
7	5	158	26	5	1	5	50	
8	5	189	31	6	1	6	40	
9	5	203	14	3	1	3	80	
10	5	221	18	4	1	4	60	
11	5	247	26	5	1	5	50	
12	5	261	14	3	1	3	80	
13	5	281	20	4	1	4	60	
14	5	284	3	1	1	1	100	
15	5	285	1	0	1	0	100	
16	5	285	0	0	1	0	100	
17	5	285	0	0	1	0	100	
18	5	285	0	0	1	0	100	
19								
20		**REFUSAL**						
21								
22								
23								
24								
25								

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE
(B) NOTE

CERTIFIED — VERIFIED AND APPROVED — DATE

Brandt Henderson — 7-Oct-2008
dd-mmm-yyyy

AFFILIATION: ______ *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET ********************************

SHEET # ______ OF ______

**LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72**

**BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72**

LTPP REGION: NARO — **STATE CODE:** 36
STATE: NY — **SHRP ID:** 0802
OPERATOR: AL / JCD — **FIELD SET NO.:** 5
TEST DATE: 07 - Oct - 20 08 — **LOC NO.:** C12

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 1+ 51.5 — DEPTH OF ZERO POINT BELOW SURFACE: 225 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 404 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	3	18	18	6	1	6	40	
2	3	29	11	4	1	4	60	
3	3	44	15	5	1	5	50	
4	3	58	14	5	1	5	50	
5	3	73	15	5	1	5	50	
6	3	87	14	5	1	5	50	
7	5	113	26	5	1	5	50	
8	5	137	24	5	1	5	50	
9	5	163	26	5	1	5	50	
10	5	192	29	6	1	6	40	
11	5	227	35	7	1	7	35	
12	5	268	41	8	1	8	30	
13	5	317	49	10	1	10	20	
14	5	361	44	9	1	9	25	
15	5	400	39	8	1	8	30	
16	5	436	36	7	1	7	35	
17	5	478	42	8	1	8	30	
18	5	532	54	11	1	11	20	
19	5	576	44	9	1	9	25	
20	5	596	20	4	1	4	60	
21								
22		**END**						
23								
24								
25								

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE
(B) NOTE

CERTIFIED — VERIFIED AND APPROVED: Brandt Henderson — DATE: 7-Oct-2008 (dd-mmm-yyyy)

AFFILIATION: ______ — *AFFILIATION:* LTPP - NARO

Form T72, June 2006

********************************** SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / TW
TEST DATE: 07 - Oct - 20 08

STATE CODE: 36
SHRP ID: 0802
FIELD SET NO.: 5
LOC NO.: C13

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 25
DEPTH OF ZERO POINT BELOW SURFACE: 225 mm
LATERAL LOCATION (Distance from outside lane marker): 0.91 m

Initial Scale Reading at zero blows 406 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	24	24	5	1	5	50	
2	5	49	25	5	1	5	50	
3	5	73	24	5	1	5	50	
4	5	92	19	4	1	4	60	
5	5	109	17	3	1	3	80	
6	5	126	17	3	1	3	80	
7	5	142	16	3	1	3	80	
8	5	162	20	4	1	4	60	
9	5	174	12	2	1	2	100	
10	5	199	25	5	1	5	50	
11	3	216	17	6	1	6	40	
12	3	229	13	4	1	4	60	
13	3	252	23	8	1	8	30	
14	3	271	19	6	1	6	40	
15	3	297	26	9	1	9	25	
16	3	322	25	8	1	8	30	
17	3	359	37	12	1	12	18	
18	1	369	10	10	1	10	20	
19	1	379	10	10	1	10	20	
20	1	390	11	11	1	11	20	
21	1	404	14	14	1	14	15	
22	1	415	11	11	1	11	20	
23	1	427	12	12	1	12	18	
24	1	439	12	12	1	12	18	
25	1	454	15	15	1	15	14	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS
(A) CODE ____ ____ ____ ____ ____ ____ ____ ____
(B) NOTE ________________________________

CERTIFIED ____________________

VERIFIED AND APPROVED Brandt Henderson

DATE 7-Oct-2008
dd-mmm-yyyy

AFFILIATION: ____________

AFFILIATION: LTPP - NARO

Form T72, June 2006

******************************** SPS LABORATORY TESTING DATA SHEET ******************************

SHEET # ______ OF ______

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION:	NARO	**STATE CODE:**	36
STATE:	NY	**SHRP ID:**	0802
OPERATOR:	BH / TW	**FIELD SET NO.:**	5
TEST DATE:	07 - Oct - 20 08	**LOC NO.:**	C13

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	1	469	15	15	1	15	14	
27	1	484	15	15	1	15	14	
28	1	501	17	17	1	17	12	
29	1	517	16	16	1	16	13	
30	1	534	17	17	1	17	12	
31	1	552	18	18	1	18	11	
32	1	574	22	22	1	22	9	
33								
34		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE ______ ______ ______ ______ ______ ______ ______ ______

(B) NOTE ______________________________

CERTIFIED	VERIFIED AND APPROVED	DATE
	Brandt Henderson	7-Oct-2008
		dd-mmm-yyyy
AFFILIATION:	*AFFILIATION:* LTPP - NARO	

Form T72 Continuation, June 2006

1.

********************************* SPS LABORATORY TESTING DATA SHEET *******************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72

BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION: NARO
STATE: NY
OPERATOR: BH / TW
TEST DATE: 07 - Oct - 20 08

STATE CODE: 36
SHRP ID: 0802
FIELD SET NO.: 5
LOC NO.: C15

HAMMER WEIGHT: [X] 8-Kg [ ] 4.6-Kg
LOCATION STATION: 4 + 25
DEPTH OF ZERO POINT BELOW SURFACE: 220 mm
LATERAL LOCATION (Distance from outside lane marker): 1.83 m

Initial Scale Reading at zero blows 383 mm

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
1	5	29	29	6	1	6	40	
2	5	47	18	4	1	4	60	
3	5	61	14	3	1	3	80	
4	5	74	13	3	1	3	80	
5	5	87	13	3	1	3	80	
6	5	102	15	3	1	3	80	
7	5	120	18	4	1	4	60	
8	5	136	16	3	1	3	80	
9	5	149	13	3	1	3	80	
10	5	167	18	4	1	4	60	
11	3	181	14	5	1	5	50	
12	3	192	11	4	1	4	60	
13	3	202	10	3	1	3	80	
14	3	211	9	3	1	3	80	
15	3	221	10	3	1	3	80	
16	3	240	19	6	1	6	40	
17	3	264	24	8	1	8	30	
18	3	280	16	5	1	5	50	
19	3	294	14	5	1	5	50	
20	3	312	18	6	1	6	40	
21	3	337	25	8	1	8	30	
22	3	367	30	10	1	10	20	
23	3	397	30	10	1	10	20	
24	3	427	30	10	1	10	20	
25	3	455	28	9	1	9	25	

Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE
(B) NOTE

CERTIFIED

VERIFIED AND APPROVED: Brandt Henderson

DATE: 7-Oct-2008
dd-mmm-yyyy

AFFILIATION:

AFFILIATION: LTPP - NARO

Form T72, June 2006

*********************************** SPS LABORATORY TESTING DATA SHEET *********************************

SHEET # _____ OF _____

LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
PENETRATION RATE OF THE DYNAMIC CONE PENETROMETER
LAB DATA SHEET T72
Continuation
BASE/SUBGRADE SOILS
LTPP TEST DESIGNATION: UG14, SS14/LTPP PROTOCOL P72

LTPP REGION:	NARO	**STATE CODE:**	36
STATE:	NY	**SHRP ID:**	0802
OPERATOR:	BH / TW	**FIELD SET NO.:**	5
TEST DATE:	07 - Oct - 20 08	**LOC NO.:**	C15

III- SUMMARY OF RESULTS

Read No	Number of blows	Scale Reading (mm)	Penetration between readings (mm)	Penetration per blow (mm)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Moisture (%)
26	3	492	37	12	1	12	18	
27	3	537	45	15	1	15	14	
28	1	552	15	15	1	15	14	
29	1	570	18	18	1	18	11	
30	1	597	27	27	1	27	7	
31								
32		**END**						
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Note: If additional rows are needed, please use continuation data sheet.

IV - COMMENTS

(A) CODE _____ _____ _____ _____ _____ _____ _____ _____
(B) NOTE

CERTIFIED	VERIFIED AND APPROVED	DATE
	Brandt Henderson	7-Oct-2008
		dd-mmm-yyyy
AFFILIATION:	*AFFILIATION:* LTPP - NARO	

Form T72 Continuation, June 2006

Appendix J – Ground Penetrating Radar Layer Profiles

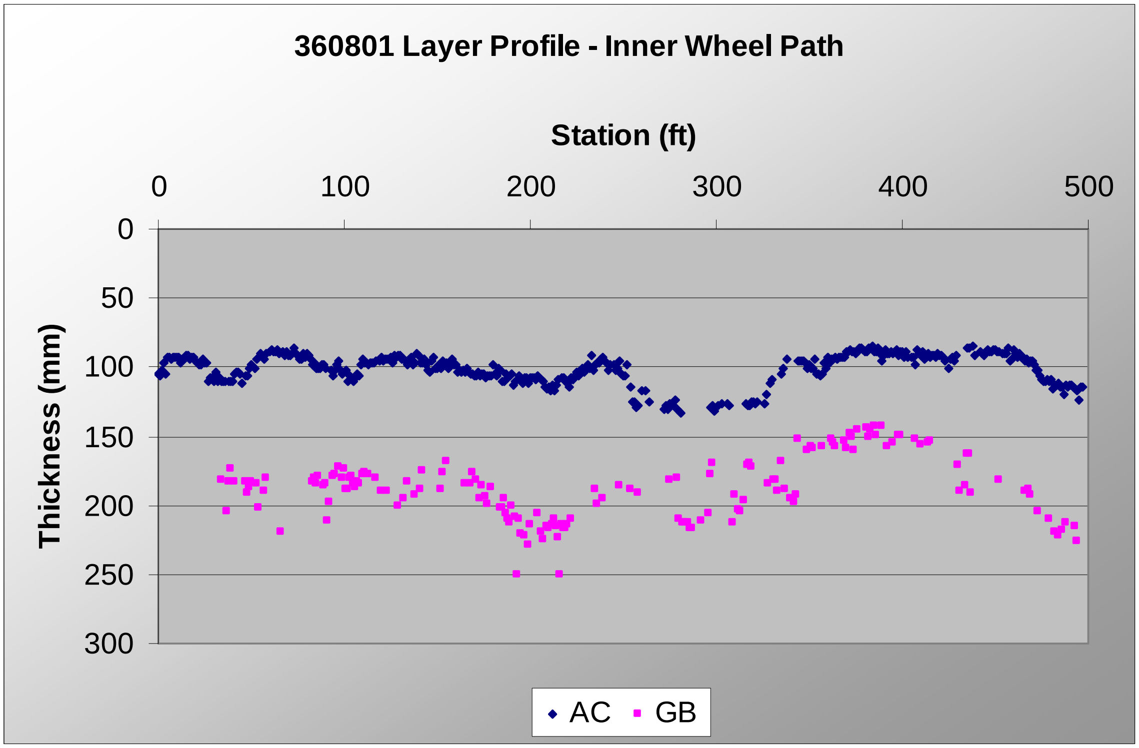

Figure J-1: 360801 IWP GPR Layer Profile

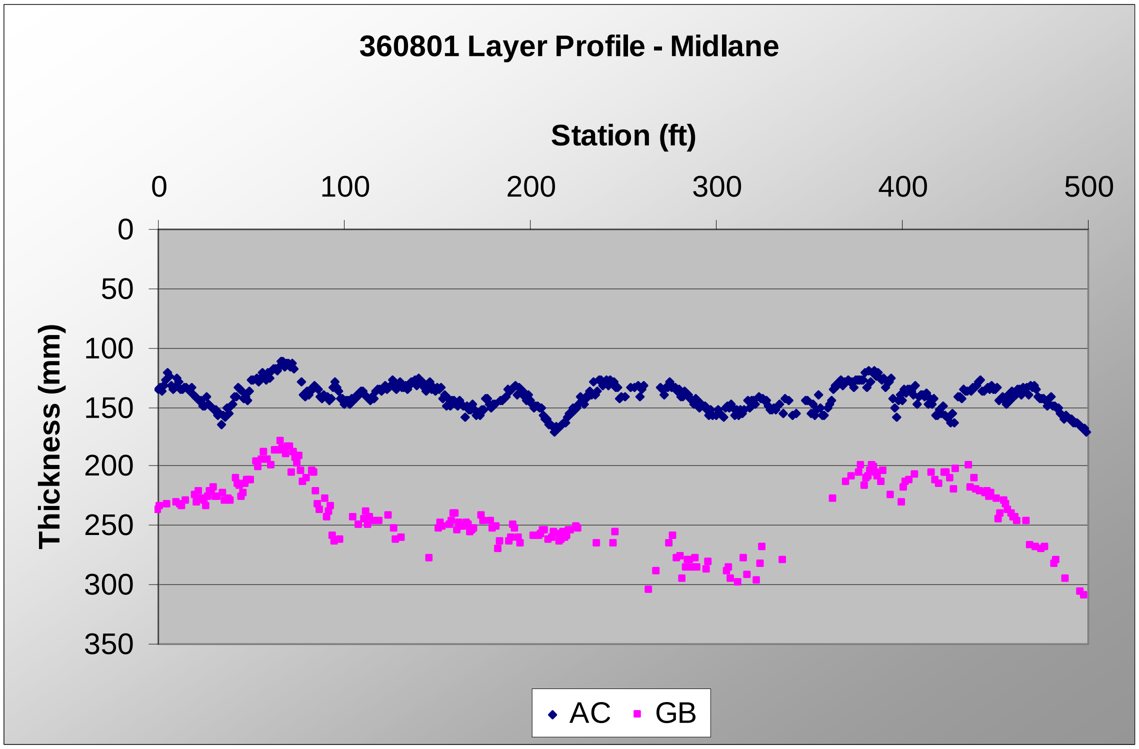

Figure J-2: 360801 Midlane GPR Layer Profile

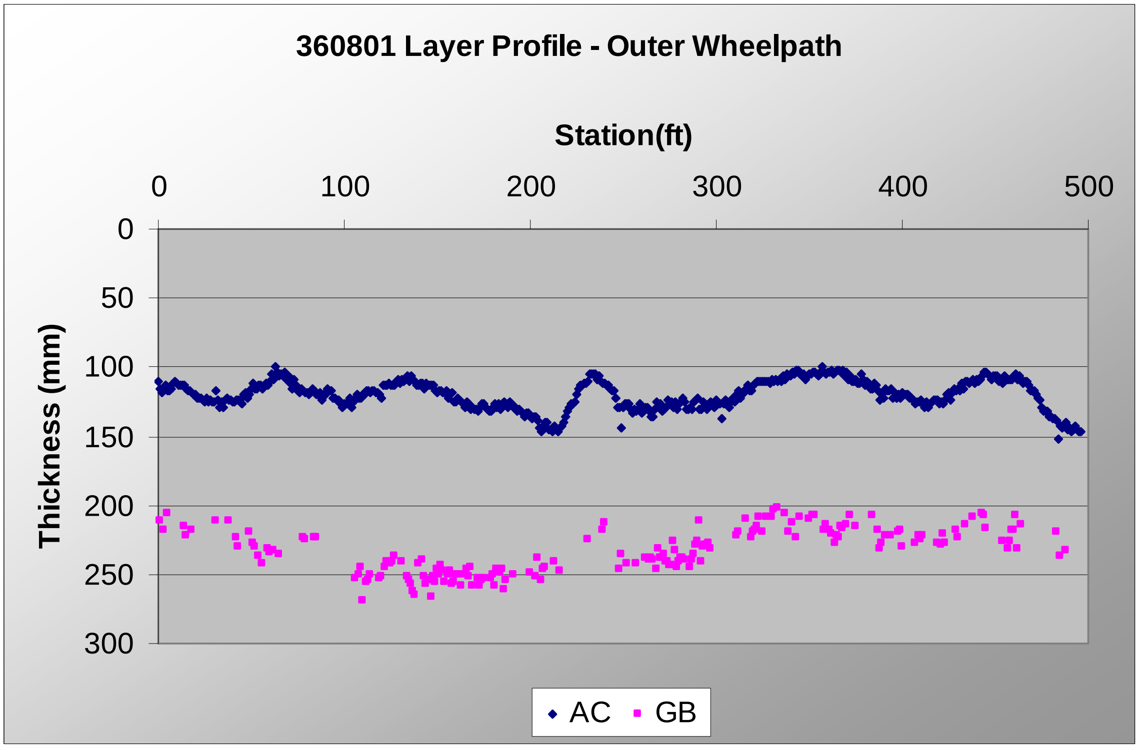

Figure J-3: 360801 OWP GPR Layer Profile

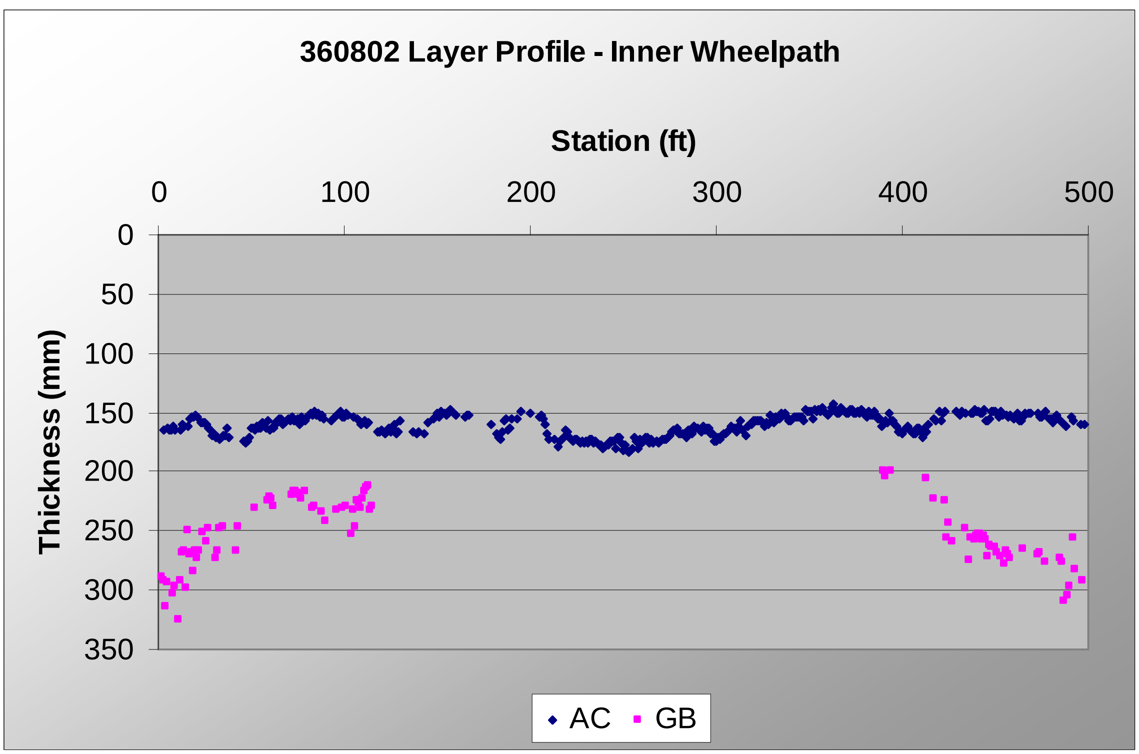

Figure J-4: 360802 IWP GPR Layer Profile

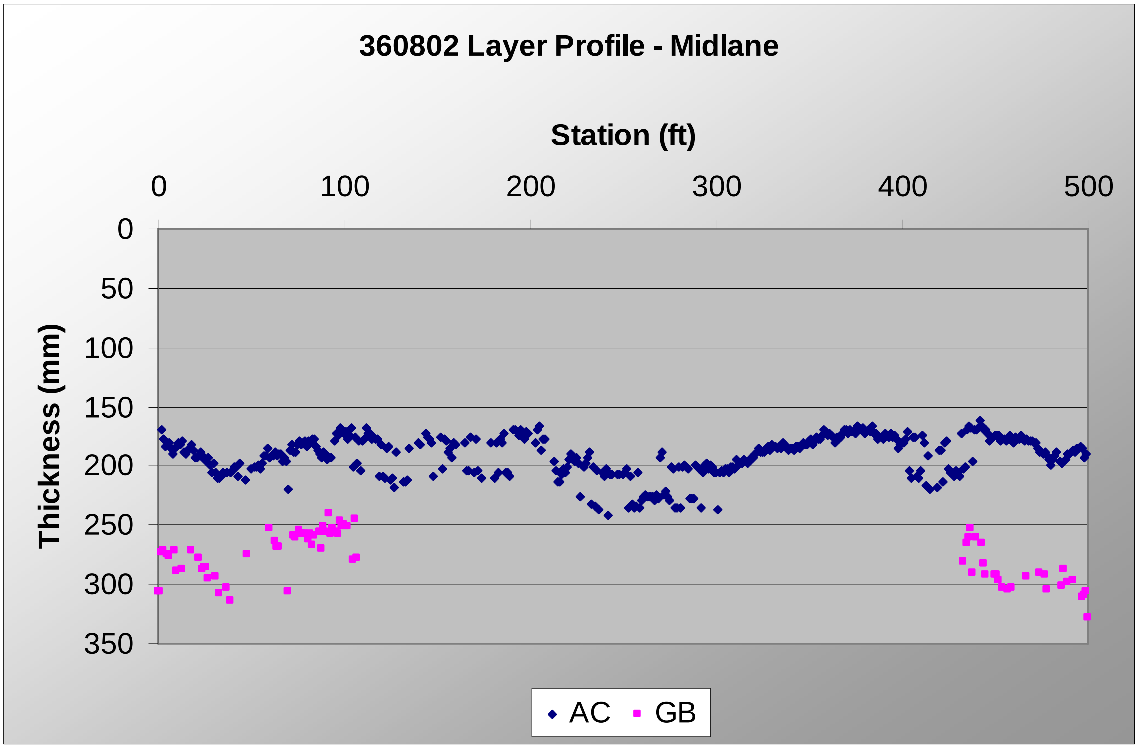

Figure J-5: 360802 Midlane GPR Layer Profile

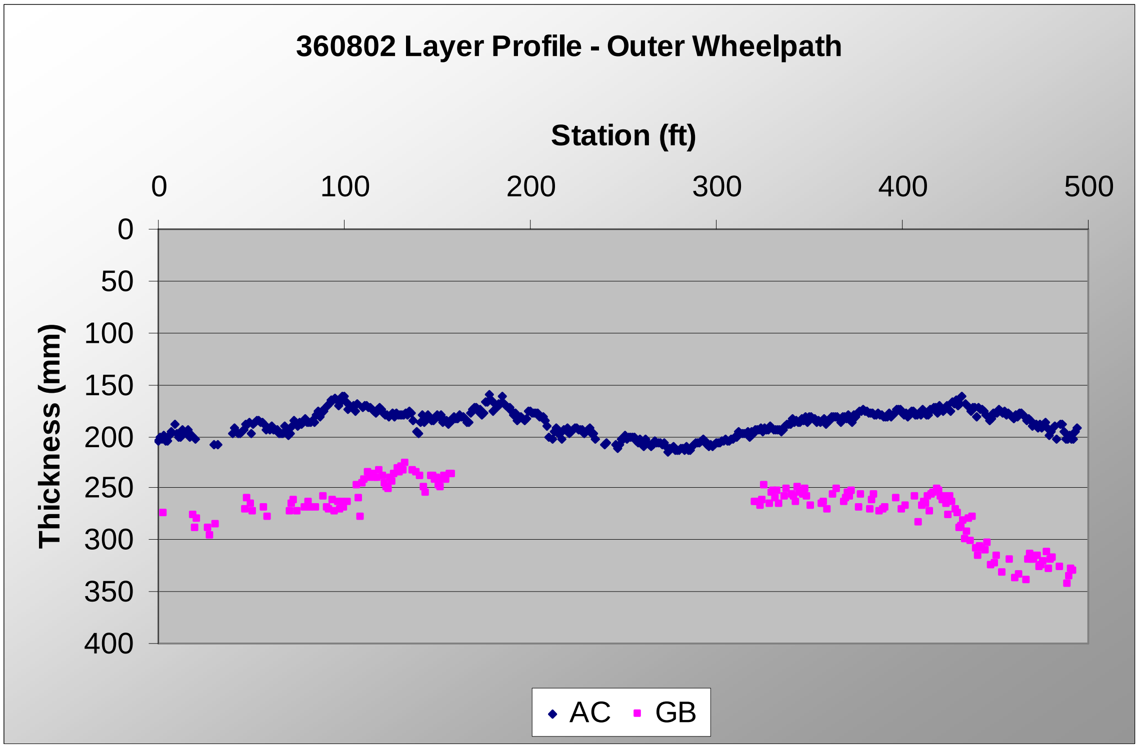

Figure J-6: 360802 OWP GPR Layer Profile

Appendix K – FWD Data Analysis Historical Plots

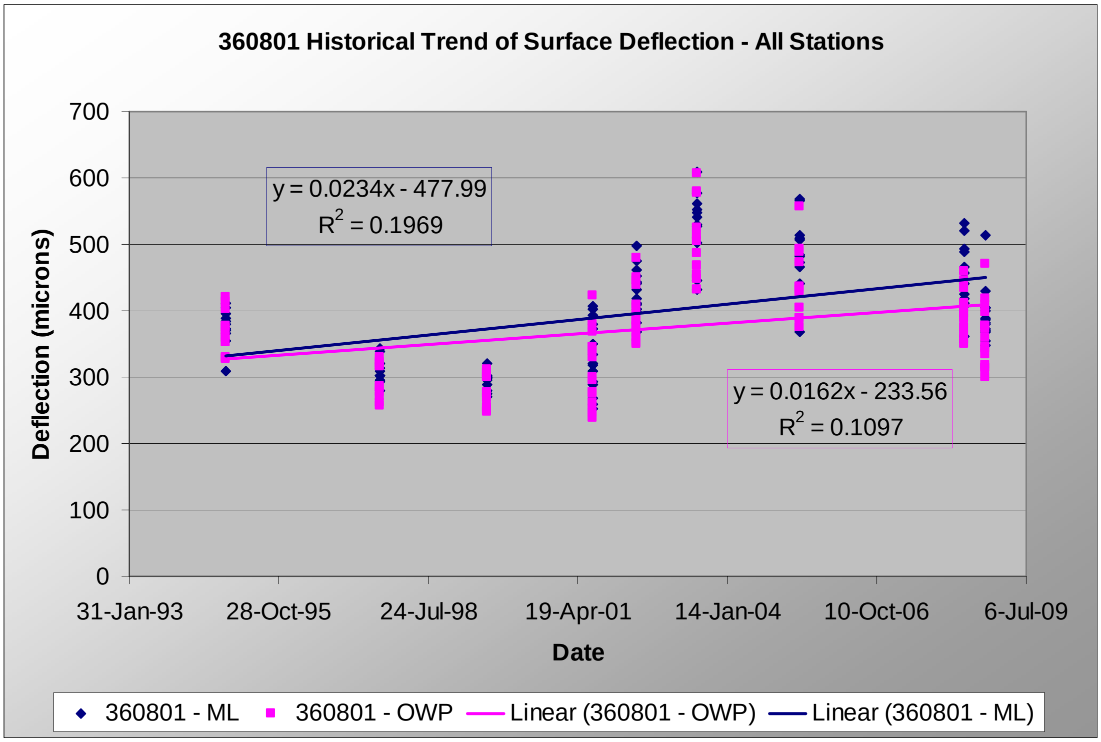

Figure K-1: Historical Trend Surface Deflections (360801)

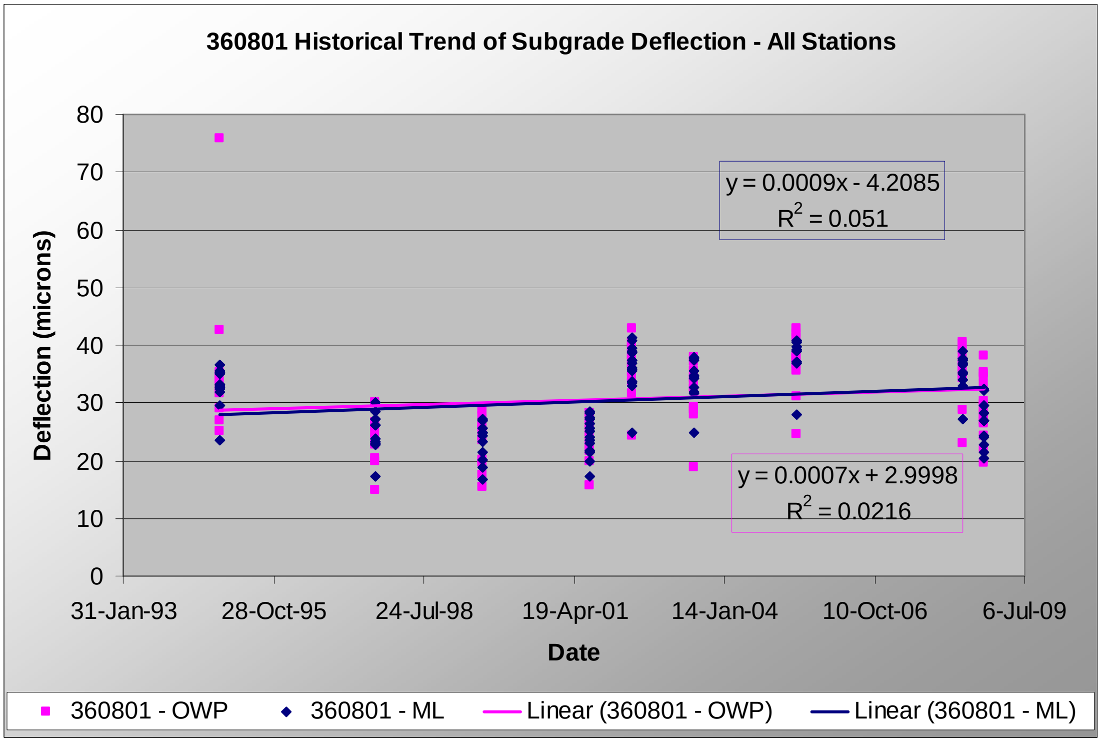

Figure K-2: Historical Trend of Subgrade Deflections (360801)

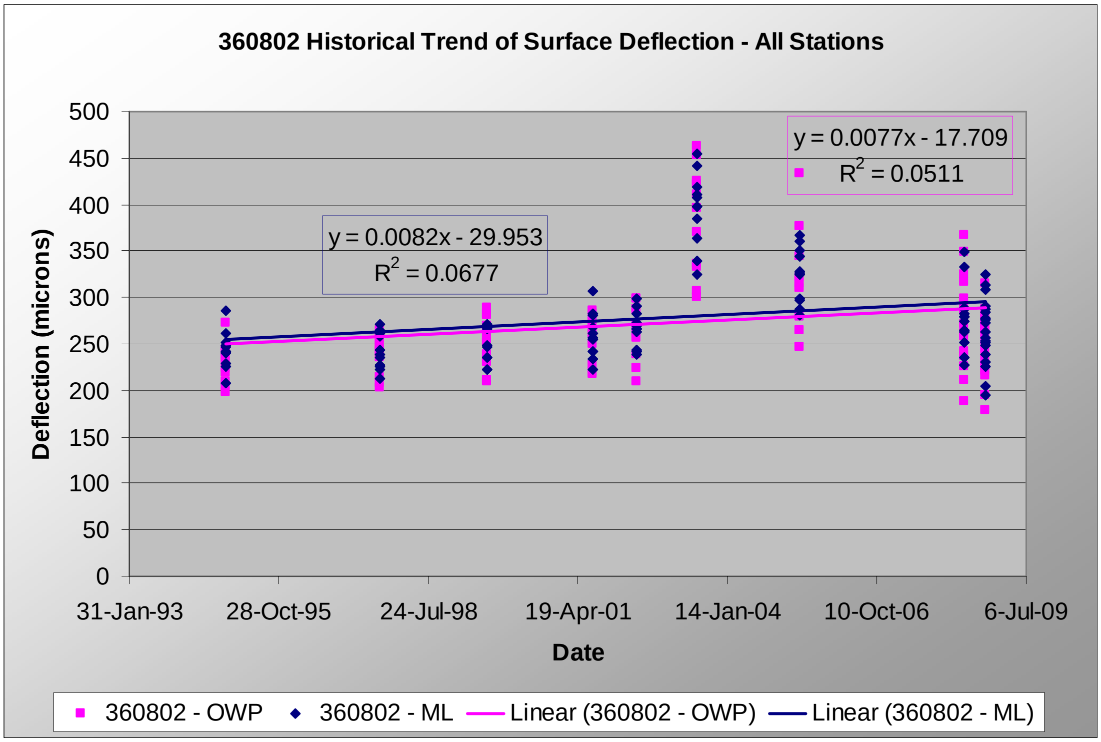

Figure K-3: Historical Trend of Surface Deflections (360802)

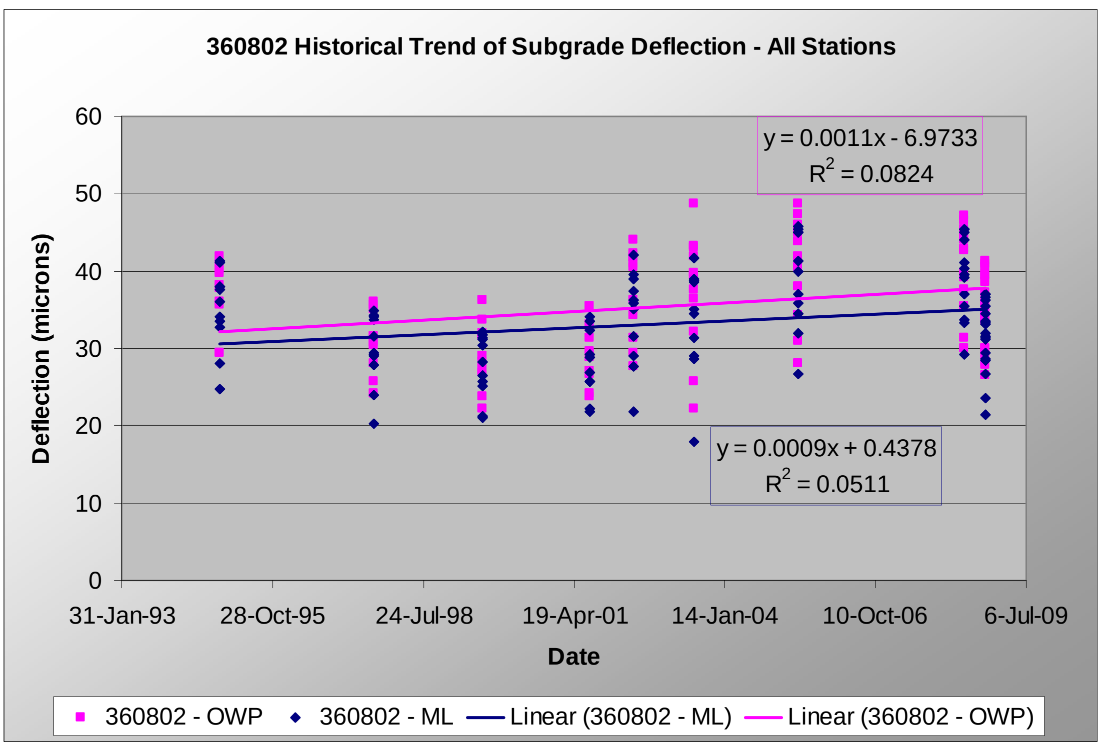

Figure K-4: Historical Trend of Subgrade Deflections (360802)

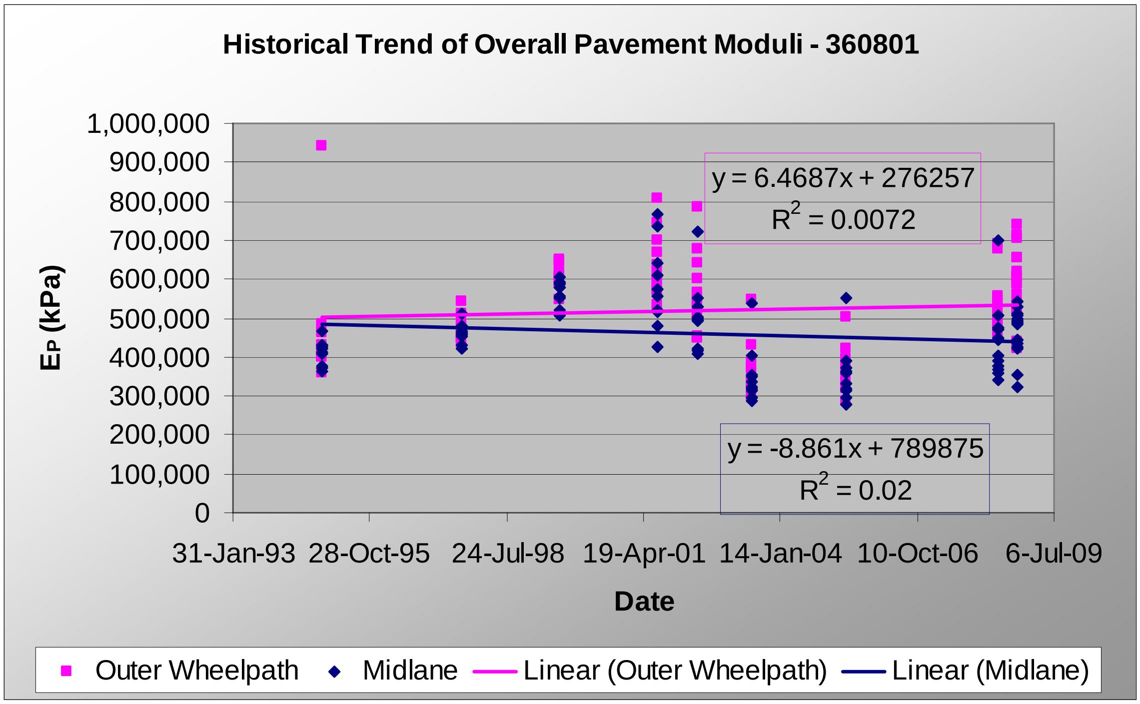

Figure K-5: Historical Trend of Pavement Resilient Moduli (360801)

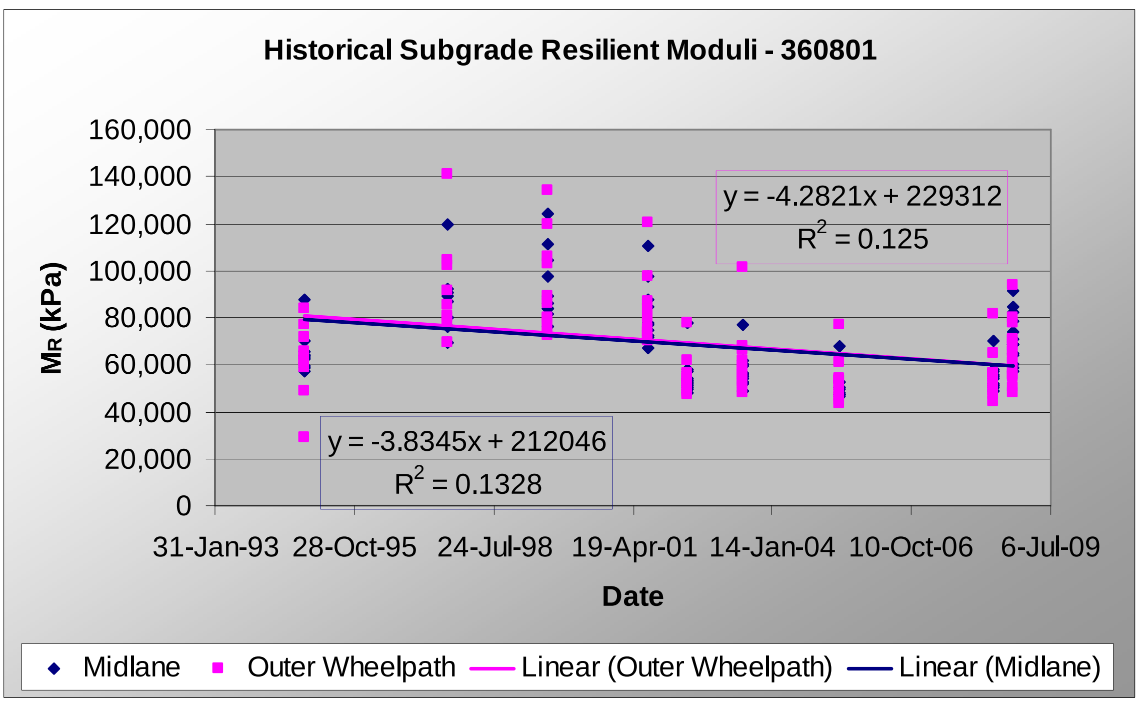

Figure K-6: Historical Trend of Subgrade Resilient Moduli (360801)

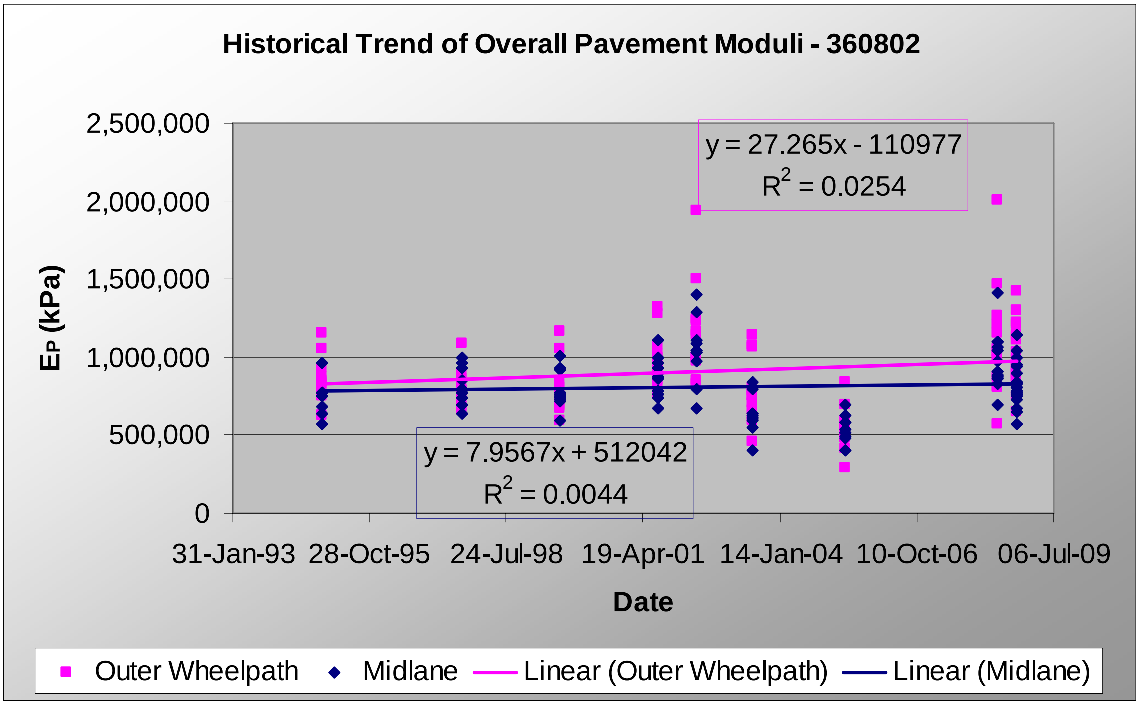

Figure K-7: Historical Trend of Pavement Resilient Moduli (360802)

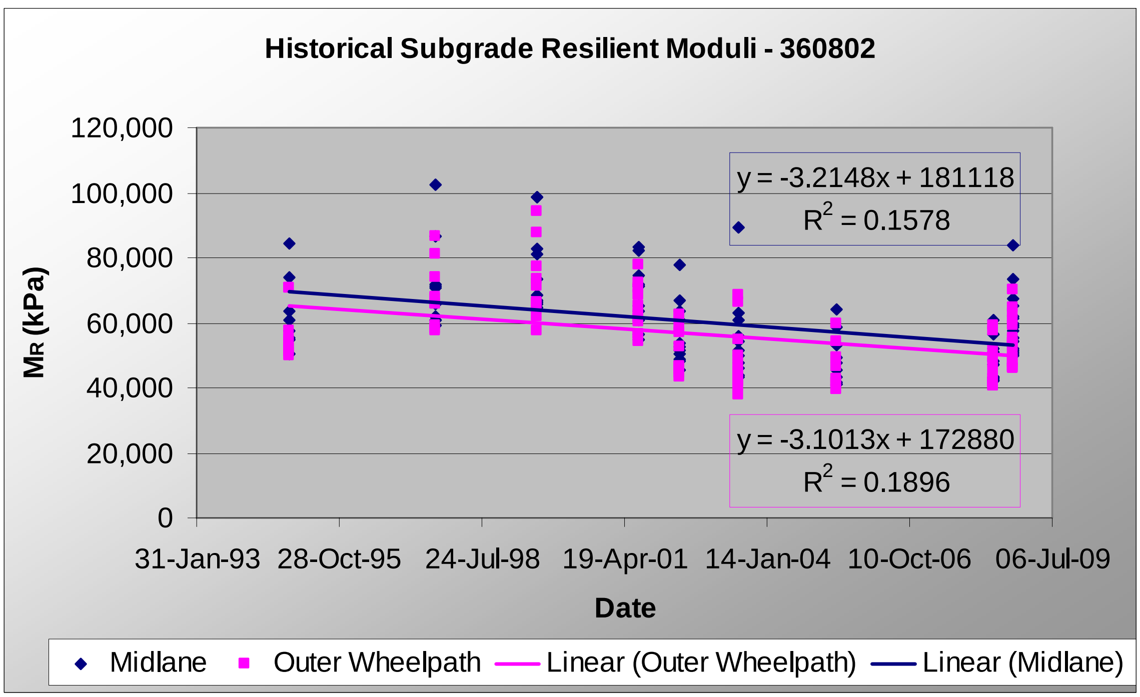

Figure K-8: Historical Trend of Subgrade Resilient Moduli (360802)

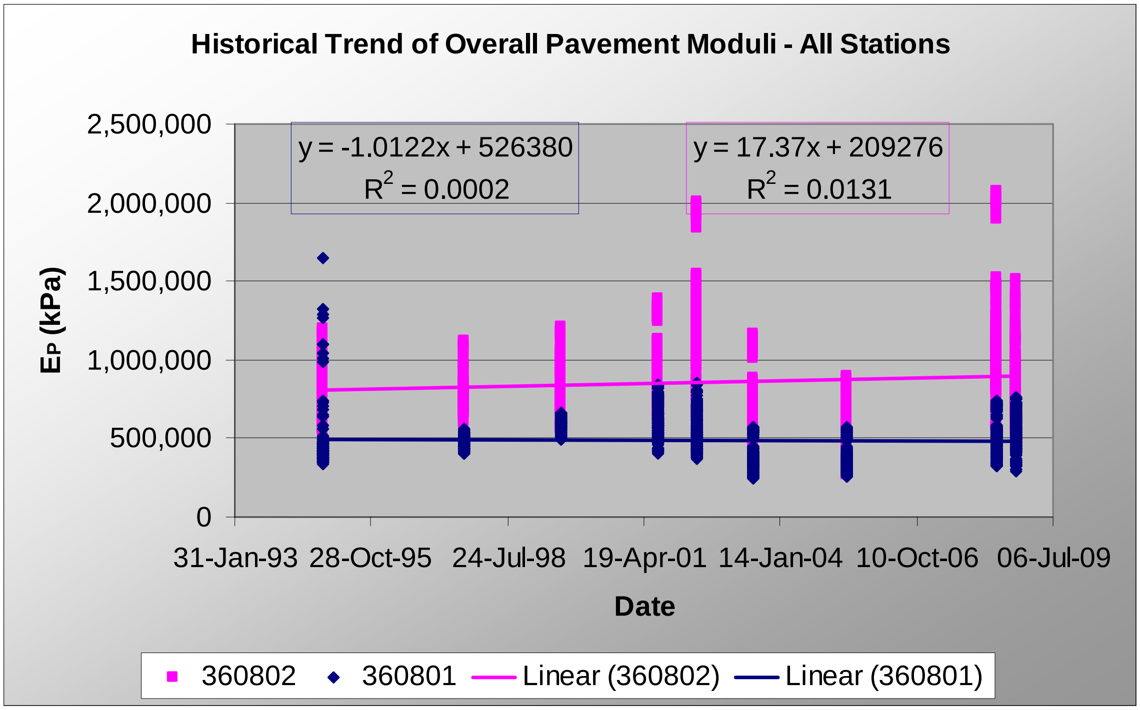

Figure K-9: Comparing Historical Trends in Overall Pavement Resilient Moduli

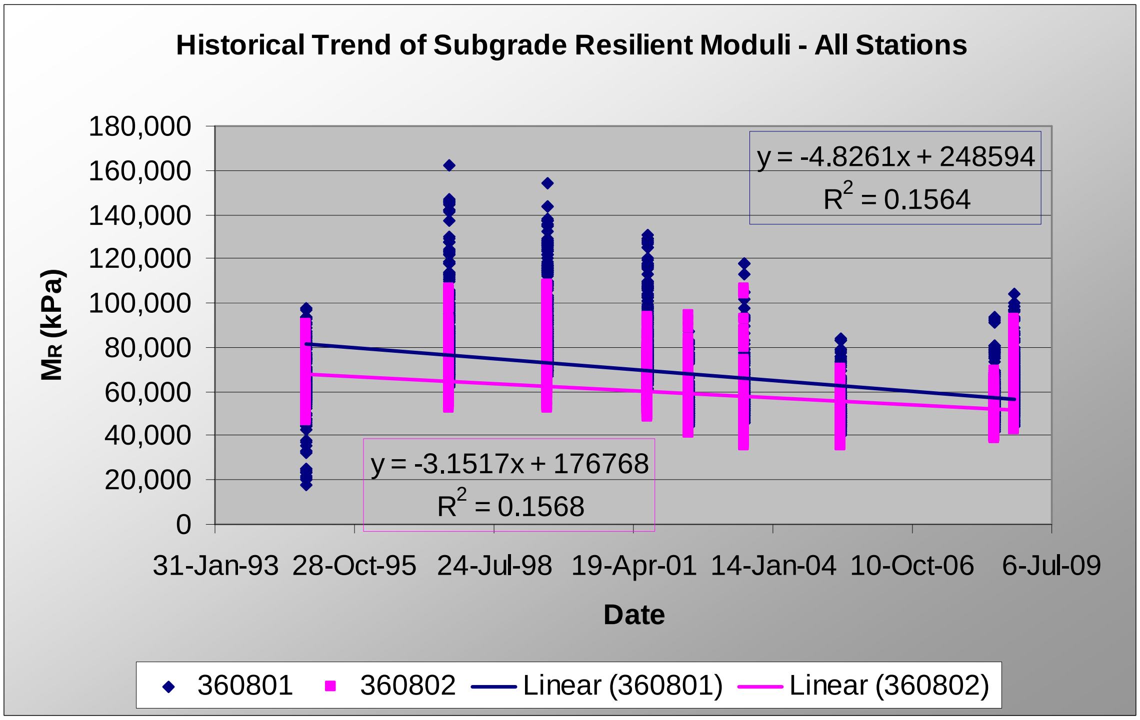

Figure K-10: Comparing Trends in Subgrade Resilient Moduli

Appendix L – Manual Distress Historical Plots

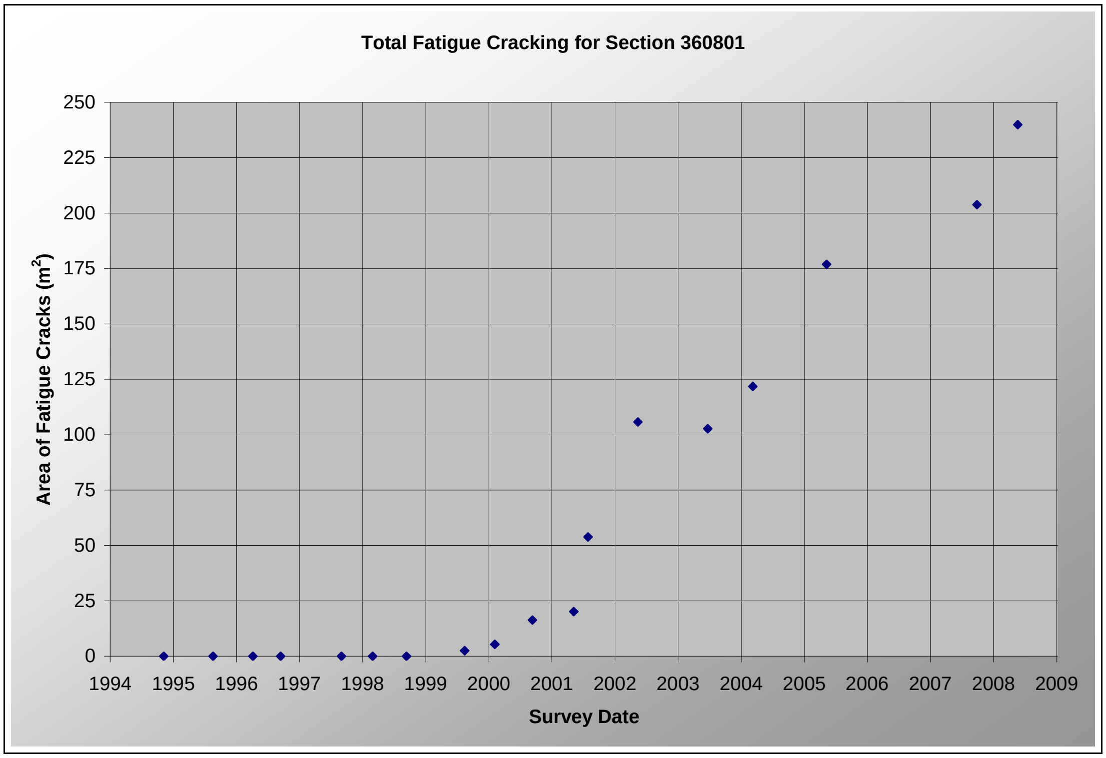

Figure L-1: Historical Trend in Fatigue (360801)

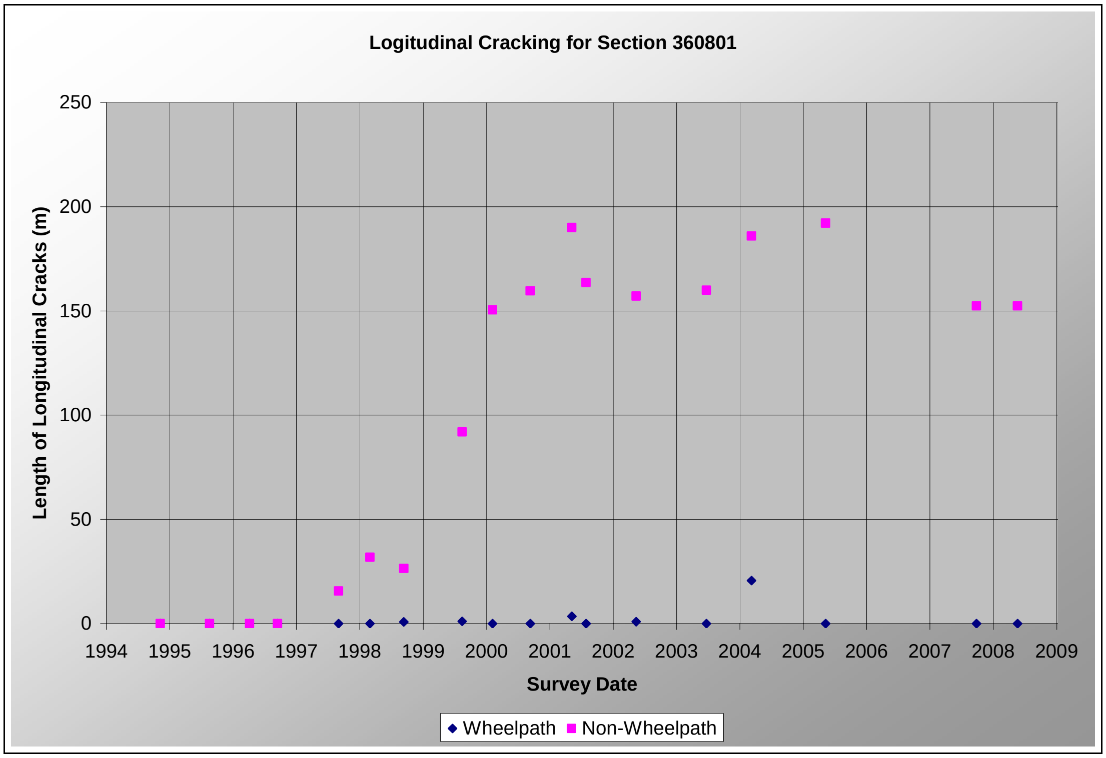

Figure L-2: Historical Trend in Longitudinal Cracking (360801)

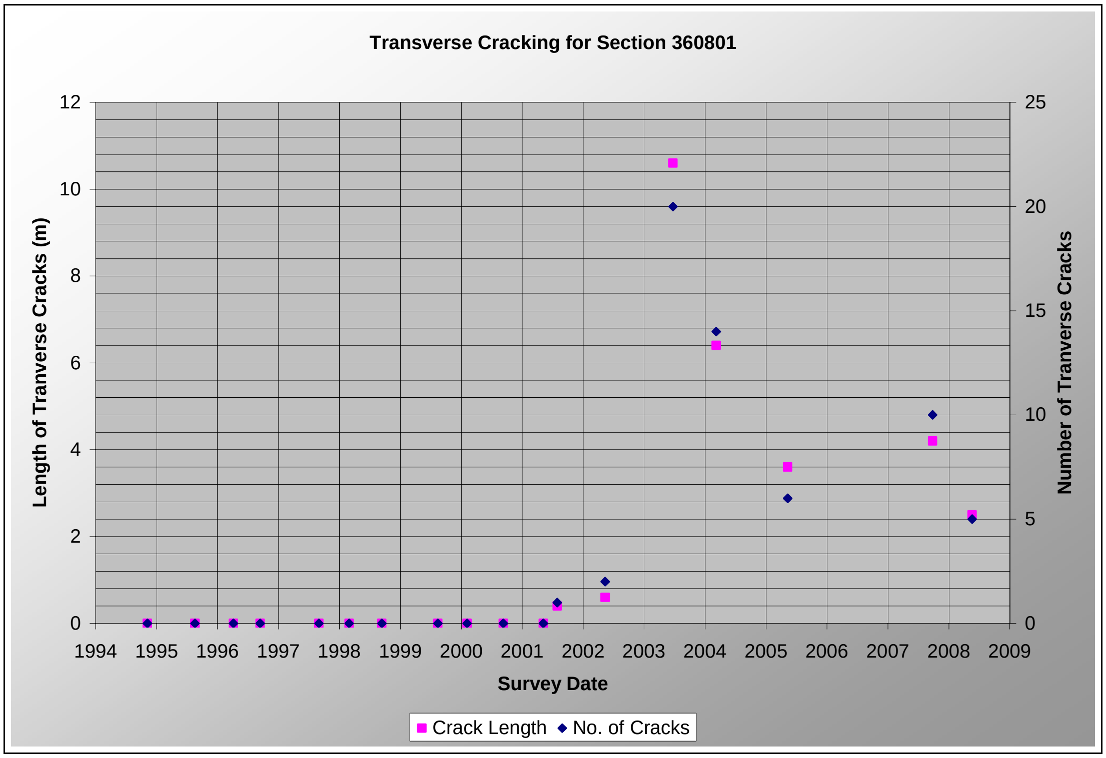

Figure L-3: Historical Trend in Transverse Cracking (360801)

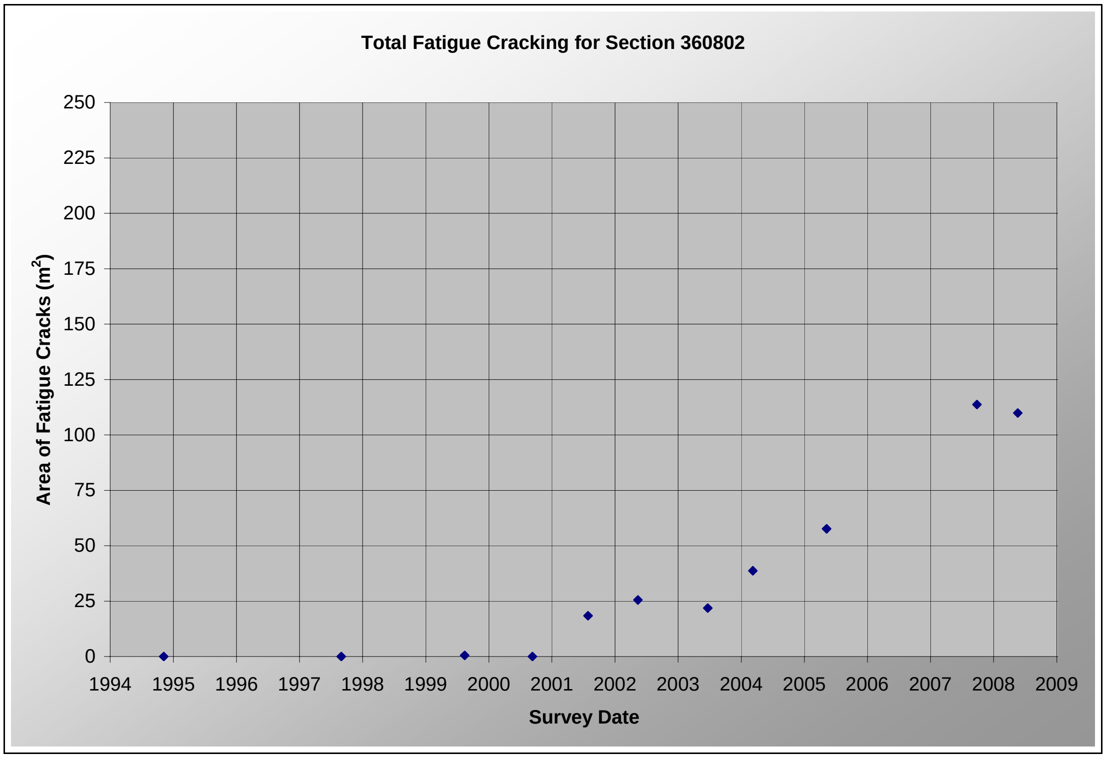

Figure L-4: Historical Trend in Fatigue Cracking (360802)

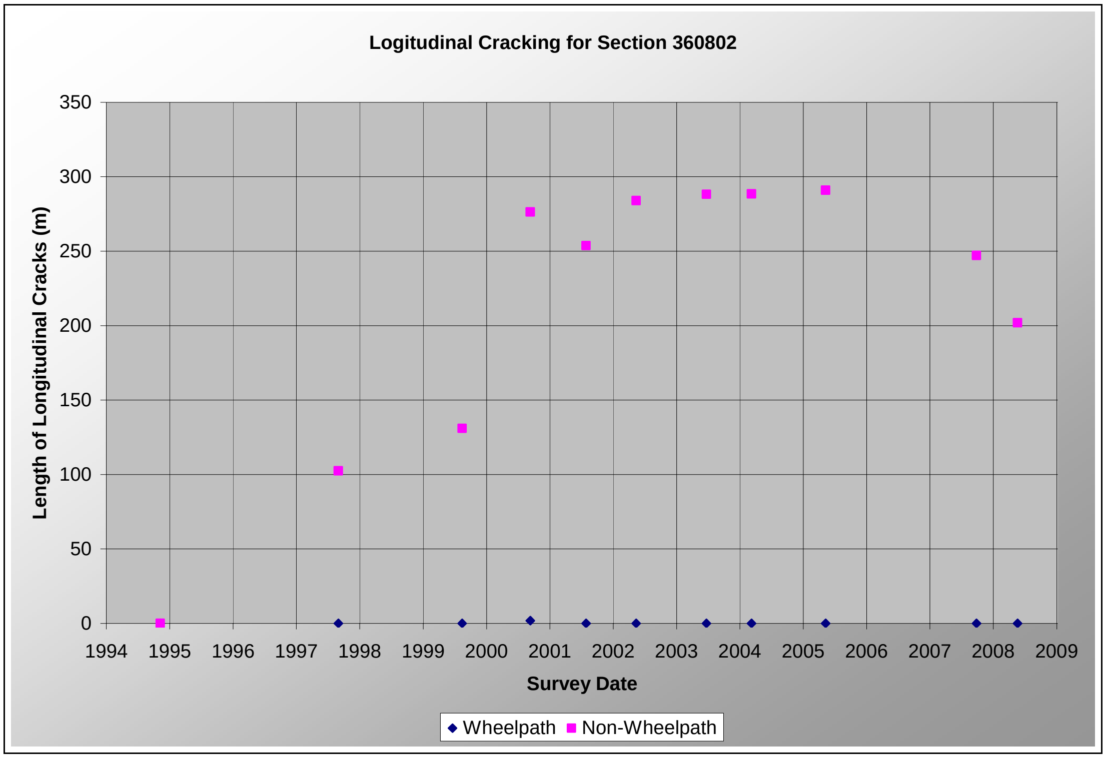

Figure L-5: Historical Trend in Longitudinal Cracking (360802)

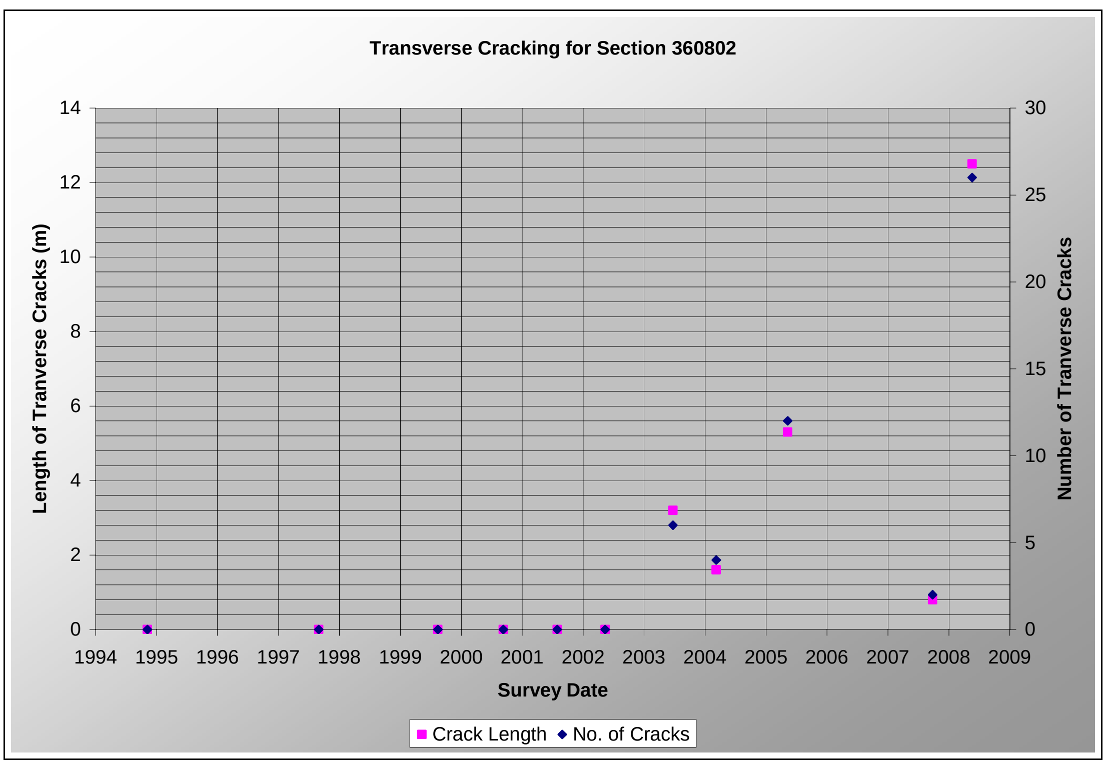

Figure L-6: Historical Trend in Transverse Cracking (360802)