BC Ministry of Transportation and Infrastructure
South Coast Region

ISSUED FOR USE

PAVEMENT STRENGTH TESTING AND EVALUATION
HIGHWAY 7 & 7B - LKI SEGMENTS 2730 AND 2715
PITT MEADOWS / PORT COQUITLAM, BC

V13101493.002

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EXECUTIVE SUMMARY

The British Columbia Ministry of Transportation and Infrastructure (MoTI) retained the services of EBA Engineering Consultants Ltd. (EBA) to conduct pavement strength testing on Highways 7 and 7B in Pitt Meadows and Port Coquitlam, B.C. The purpose of the investigation was to identify areas of pavement strength deficiency within these sections of highway, and assist the MoTI with its pavement rehabilitation plans.

The primary objective of the investigation was to determine current roadway strength by Falling Weight Deflectometer (FWD) testing. EBA also collected asphalt thickness information (asphalt probes and cores) to complement the analysis of the FWD data. RPMS data collected in 2005 and 2007 by EBA was also reviewed as part of this assignment.

EBA's site investigations and subsequent analysis support the MoTI's preferred rehabilitation options, the details of which are discussed in this report.

Highway 7 Rehabilitation Options:

Based on the information discussed herein and EBA's general understanding of the MoTI's requirements at this time, the recommended rehabilitation options for this section of Highway 7 are as follows:

Option A: **50 mm Overlay All Lanes** – Overlay roadway sections where indicated roadway structural deficiencies warrant the addition of more pavement structure.

Option B: **75 mm Mill and Inlay / Defer Rehabilitation** – Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated, as well as provide regular maintenance to all other areas to preserve the current roadway condition.

Option C: **50/75 mm Mill and Inlay** – 75mm Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated; 50mm Mill and Inlay in all other areas to extend roadway service life.

The sections of Highway 7 considered suitable for each rehabilitation option are provided in Section 7.1 of this report.

Highway 7B Rehabilitation Options:

Based on the information discussed herein and EBA's general understanding of the MoTI's requirements at this time, the recommended rehabilitation strategy for this section of Highway 7B is as follows:

- **Localized 50 mm Mill and Inlay** – Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated, as well as provide regular maintenance to all other areas to preserve the current roadway condition.

- **50 mm Mill and Inlay** – Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated.
- **100 mm Mill and Inlay** – Mill and Inlay roadway sections where moderate strengthening and roadway distress levels are indicated.
- **Defer Rehabilitation** – Defer Rehabilitation in areas with low pavement distress levels and the structural requirements for the roadway design life are presently met.
- **Deep Patch Repairs** – Repair areas showing high severity fatigue-type distresses resulting in localized deteriorated or failed pavement structure.

The sections of Highway 7B considered suitable for each rehabilitation option are provided in Section 7.2 of this report.

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1.0 INTRODUCTION

1.1 PURPOSE

This report presents the results of a pavement strength data collection and analysis assignment undertaken by EBA Engineering Consultants Ltd. (EBA) for the British Columbia Ministry of Transportation and Infrastructure (MoTI) on Highways 7 and 7B in Pitt Meadows and Port Coquitlam, B.C.

The MoTI requested that EBA provide Falling Weight Deflectometer (FWD) testing and associated analysis to determine the strength of the existing pavement in support of the development of possible rehabilitation options.

1.2 SCOPE OF SERVICES

The scope of services was provided in a Work Plan prepared by EBA dated October 21, 2009 and included:

- Conducting a review and summary of relevant MoTI Roadway Pavement Management System (RPMS) data from 2005 and 2007 data collection years;
- Coordinating suitable traffic control and lane closure permits;
- Conducting FWD testing at a suitable test interval in all travel directions;
- Determination of asphalt pavement thicknesses;
- Determination of the design Equivalent Single Axle Loads (ESALs);
- Analysis of the FWD and pavement thickness data collected;
- Coordinating a site visit with the MoTI to discuss results, as well as identify any particular concerns the MoTI would like addressed in the investigation; and
- Preparation of this report summarizing the data and results of the analysis.

1.3 GENERAL CONDITIONS

This report is subject to EBA's General Conditions, a copy of which is provided in Appendix A.

1.4 AUTHORIZATION TO PROCEED

Authorization to carry out this assignment was provided via email by Mr. Salem Bahamdun, P.Eng., on October 22, 2009, as part of the MoTI's "As and When" Consulting Services Contract No. 156CS0602.

2.0 BACKGROUND INFORMATION

2.1 PROJECT LOCATION

As requested by the MoTI, two Highway sections (Highway 7 and Highway 7B) were evaluated as part of this project.

The section of Highway 7 evaluated extends from Dewdney Trunk Road to approximately 0.35 km west of Harris Road, in Pitt Meadows, BC. This section of Highway 7 is located within the MoTI's Lane Kilometre Inventory (LKI) Segment 2730 and extends from LKI 6.56 to LKI 8.66. This section of roadway consists of three travel lanes in both the eastbound and westbound directions (six travel lanes total), divided by a concrete Jersey barrier. Roadway drainage is provided by an open ditch located along both the north and south sides of the roadway alignment. Traffic on this section of Highway 7 consists of both passenger and commercial transport vehicles.

The section of Highway 7B evaluated extends from the east abutment of the Coquitlam River Bridge to the CP Railway Underpass, in Port Coquitlam, BC. This section of Highway 7B is located within the MoTI's LKI Segment 2715 and extends from LKI 2.45 to LKI 8.17. This section of roadway consists of two travel lanes in both the eastbound and westbound directions (four travel lanes total). The two travel directions are divided throughout the project length by a combination of concrete Jersey barrier (most frequent), concrete median, and painted median. The majority of the each travel direction is bound on the outside shoulder by a concrete Jersey barrier, with small sections of concrete and asphalt curb and gutter. Roadway drainage is primarily provided by an open ditch located along both the north and south sides of the roadway alignment. Traffic on this section of Highway 7B consists of both passenger and commercial transport vehicles.

The general alignment of for both project roadways is shown in Figure 1.

2.2 CLIMATE

According to the C-SHRP Environmental Zones plan, the project roadways are located in a Wet-No-Freeze environmental zone. The area has an average annual precipitation of about 1900 mm. Mean daily temperature ranges from 16°C in the summer to 3.7°C in the winter (10.5°C annual mean temperature). However, temperature extremes may reach as high as 35°C in the summer and drop as low as –18.3°C in the winter (Environment Canada, Canadian Climate Normals). Table 1 shows climate data from weather station ID #1101155, located on Burnaby Mountain at an elevation of 137 m above mean sea level and 13 km west of the project site.

TABLE 1: CLIMATE DATA			
Weather Station Name (Number)	Average Annual Precipitation (mm)	Summer and Winter Mean Temperature (°C)	Extreme Temperature (°C)
Burnaby Mountain (ID# 1101155)	1900	3.7 to 16.0	-18.3 to 35.0

- Reference: Environmental Canada, climate Normals (1971 – 2000)

This area is subject to a freezing index of 250°C-days (Canadian Foundation Engineering Manual). This corresponds to a 1 in 20-year frost depth on the order of 0.6 m.

2.3 TRAFFIC DATA

Traffic count information for both project highway sections was obtained from the MoTI's Traffic Data Program. The MoTI's Traffic Data Program monitors traffic volumes throughout the province at a variety of permanent and short count collection sites. This information is collected with the intent to support planning, design, construction, and operation of the Ministry road network.

2.3.1 Highway 7 Traffic Data

Annual Average Daily Traffic (AADT) data for the year 2007 was provided for reporting site Pitt Meadows (Station 16-865EW). This station provided eastbound and westbound traffic count information approximately 0.580 km west of Harris Road, within the project limits.

An annual growth rate of 1.5% was estimated from the historic MoTI traffic data as well as anticipated increased adjacent land use. This growth rate was applied to the 2007 AADT in estimating design 2009 AADT values of 33,824 and 35,414 for the eastbound and westbound directions respectively.

The MoTI's Traffic Data Program did not provide daily vehicle length distribution data for the year 2007. Light and heavy truck traffic information was obtained from the BC MoTI's Lower Mainland Truck Freight Study (1999). An estimated 8.0% commercial truck traffic was combined with gross vehicle weight (GVW) maximums as specified by the MoTI in determining an average weighted truck factor of 1.0 ESALs / truck.

Lane specific traffic volume distributions estimated that 70% of the commercial traffic travelled in the outside lane, 50% of the commercial traffic travelled in the centre lane, and 20% of the commercial traffic travelled in the inside lane. As a result, lane split values of 0.7, 0.5, and 0.2 were used to estimate the number ESALs in the outside, centre, and inside lanes respectively.

The cumulative ESALs for a 20 year design period are shown in Table 2.

TABLE 2: HIGHWAY 7 20-YEAR DESIGN ESALS

Direction	Lane	2009 AADT	Percent Commercial	Truck Factor	Lane Split	Growth Rate	Design Period	ESALs / Design Lane
Eastbound	Inside	33,824	8%	1.0	0.2	1.5	20	4.6E+06
	Centre	33,824	8%	1.0	0.5	1.5	20	11.4E+06
	Outside	33,824	8%	1.0	0.7	1.5	20	16.0E+06
Westbound	Inside	35,414	8%	1.0	0.2	1.5	20	4.8E+06
	Centre	35,414	8%	1.0	0.5	1.5	20	12.0E+06
	Outside	35,414	8%	1.0	0.7	1.5	20	16.7E+06

The design ESALs noted in Table 2 were used in the analysis of FWD data for Highway 7.

2.3.2 Highway 7B Traffic Data

Annual Average Daily Traffic (AADT) data for the year 2007 was provided for reporting site 16-171EW. This station provided eastbound and westbound traffic count information for Highway 7B (Mary Hill Bypass) approximately 0.8 km west of United Boulevard, 0.2 km west of the project limits.

An annual growth rate of 1.5% was estimated from the historic MoTI traffic data as well as anticipated increased adjacent land use. This growth rate was applied to the 2007 AADT in estimating design 2009 AADT values of 27,905 and 26,412 for the eastbound and westbound directions respectively.

The MoTI's Traffic Data Program did not provide daily vehicle length distribution data for the year 2007. Light and heavy truck traffic information was obtained from the BC MoTI's Lower Mainland Truck Freight Study (1999). An estimated 10.0% commercial truck traffic was combined with gross vehicle weight (GVW) maximums as specified by the MoTI in determining an average weighted truck factor of 1.0 ESALs / truck.

Lane specific traffic volume distributions estimated that 85% of the commercial traffic travelled in the outside lane and 50% of the commercial traffic travelled in the inside lane. As a result, lane split values of 0.85 and 0.5 were used to estimate the number ESALs in the outside and inside lanes respectively.

The cumulative ESALs for a 20 year design period are shown in Table 3.

TABLE 3: HIGHWAY 7B 20-YEAR DESIGN ESALS

Direction	Lane	2009 AADT	Percent Commercial	Truck Factor	Lane Split	Growth Rate	Design Period	ESALs / Design Lane
Eastbound	Inside	27,905	10%	1.0	0.5	1.5	20	1.18E+07
	Outside	27,905	10%	1.0	0.85	1.5	20	2.00E+07
Westbound	Inside	26,412	10%	1.0	0.5	1.5	20	1.12E+07
	Outside	26,412	10%	1.0	0.85	1.5	20	1.90E+07

The design ESALs noted in Table 3 were used in the analysis of FWD data for Highway 7B.

2.4 RPMS DATA

Pavement condition data collected in 2005 and 2007 was obtained from the MoTI Roadway Pavement Management System (RPMS). Data elements that were compiled and plotted included average IRI (International Roughness Index), average mean rut depths, maximum rut depths, PDI (Pavement Distress Index), and fatigue crack PDI.

Surface RPMS condition was measured continuously using a vehicle-based event keyboard. Distress data was reported in 50 m segments. All linear referencing was provided by a vehicle-based DMI. Surface distress segments were GPS tagged. IRI data were collected and referenced using a FHWA Class II profiler. Rut data were collected and referenced using a laser-based 11 sensor rut bar. Both IRI and Rut data were reported at 50 m intervals. Linear referencing was provided by a vehicle-based DMI and referenced to GPS coordinates.

The RPMS data includes information regarding the extent and severity of 9 different pavement distresses: Longitudinal Wheel Track Rutting (LWT), Longitudinal Joint Cracks (LJC), Pavement Edge Cracking (PEC), Alligator Cracking (AC), Transverse Cracking (TC), Meandering Longitudinal Cracking (MLC), Potholes, Bleeding, and Distortion. From these data the Pavement Distress Index (PDI), and fatigue crack PDI were calculated for each 50 m segment.

A primary component in the determining the roadway's current structural capacity is the assessment of existing pavement conditions. Quantifying the type, amount, severity, and location of surface distresses can assist in identifying areas of structural deficiency. Furthermore, comparing RPMS data from two separate collection years provides insight to the roadways rate of structural deterioration and reduction in load carrying capacity.

2.4.1 Highway 7 RPMS Data Review

2007 RPMS data indicated maximum rut depths ranging between 2 and 29 mm with an overall average rut depth of 4 mm. Within this section of roadway 100% of the rutted areas measure less than 10 mm which corresponds to a roadway classified as having low severity rutting.

The IRI data correspond to the riding comfort experienced by the road user. The 2007 RPMS data indicated IRI values ranging between 1.01 and 4.40 m/km with an overall average IRI of 1.75 m/km. Within this section of roadway, approximately 73% of the roadway IRI measured less than 2.0 m/km, with 99% of the measured IRI less than 3.8 m/km. These values classify this roadway as having a relatively smooth pavement surface providing a pleasant, comfortable, and safe ride along the majority of the roadway length.

Pavement distress data produced PDI values ranging between 1.5 and 10.0. The overall average PDI for this Section was 8.3. Within this section of roadway, approximately 85% of PDI values measured greater than 7.0, with 98% of the roadways PDI greater than 7.0. These values classify this roadway as being in good to fair condition.

EBA reviewed the data used to calculate the PDI, and specifically the contribution of fatigue cracking was analyzed. With the non-fatigue related data removed, the PDI would vary between 3.7 and 10.0, with an average value of 9.1. Comparing PDI and fatigue crack PDI values indicates that that fatigue type distresses (edge cracking, longitudinal wheel track cracking, and alligator cracking) are a minor contributor to the roadways overall distress level.

2005/2007 RPMS Data Comparison

EBA also reviewed the MoTI's 2005 RPMS data. Comparing IRI, Rut, and PDI values from two consecutive RPMS data collection years can potentially provide insight to the roadways overall rate of deterioration.

Average IRI, maximum rut, PDI and fatigue PDI values are summarized in Table 4.

TABLE 4: 2005 / 2007 RPMS COMPARISON

LKI Station	Average IRI (m / km)		Average Max Rut (mm)		Average PDI		Average Fatigue PDI	
	2005	2007	2005	2007	2005	2007	2005	2007
LKI 6.56 – LKI 8.66	1.71	1.75	3.0	4.0	8.6	8.3	9.4	9.1

In general, differences in 2005 and 2007 RPMS data are representative of reasonable rate of deterioration for this section of roadway. 2005 and 2007 RPMS data for Highway 7 has also been plotted, and can be found in Figure 2.

2.4.2 Highway 7B RPMS Data Review

2007 RPMS data was provided for the eastbound outside travel lane. The project roadway has been divided into two sections (east and west of Pitt River Road – LKI 5.40).

LKI 2.40 to LKI 5.40

RPMS data indicated maximum rut depths ranging between 3 and 31 mm with an overall average rut depth of 6 mm. Within this section of roadway, approximately 93% of the rutted areas measure less than 10 mm, with approximately 98% of the measured rut depths less than 20 mm. The density and severity of rutting present corresponds to a roadway classified as having low severity rutting.

The IRI data correspond to the riding comfort experienced by the road user. The 2007 RPMS data indicated IRI values ranging between 0.97 and 4.20 m/km with an overall average IRI of 1.48 m/km. Within this section of roadway, approximately 95% of the roadway IRI measured less than 2.0 m/km, with 100% of the measured IRI less than 3.8 m/km. These values classify this roadway as having a smooth pavement surface providing a pleasant, comfortable, and safe ride.

Pavement distress data produced PDI values ranging between 6.3 and 10.0. The overall average PDI for this Section was 8.9. Within this section of roadway, approximately 97% of PDI values measured greater than 7.0, with 100% of the roadways PDI greater than 6.2. These values classify this roadway as being in good condition.

EBA reviewed the data used to calculate the PDI, and specifically the contribution of fatigue cracking was analyzed. With the non-fatigue related data removed, the PDI would vary between 7.9 and 10.0, with an average value of 9.6. Comparing PDI and fatigue crack PDI values indicates that that fatigue type distresses (edge cracking, longitudinal wheel track cracking, and alligator cracking) are a minor contributor to the roadways overall distress level.

LKI 5.40 to LKI 8.20

RPMS data indicated maximum rut depths ranging between 4 and 33 mm with an overall average rut depth of 14 mm. Within this section of roadway, approximately 45% of the rutted areas measure less than 10 mm, with approximately 82% of the measured rut depths less than 20 mm. The density and severity of rutting present corresponds to a roadway classified as having low to medium severity rutting.

The 2007 RPMS data indicated IRI values ranging between 0.90 and 4.14 m/km with an overall average IRI of 2.06 m/km. Within this section of roadway, approximately 63% of the roadway IRI measured less than 2.0 m/km, with 97% of the measured IRI less than 3.8 m/km. These values classify this roadway as having a relatively smooth pavement surface, overall providing a pleasant, comfortable, and safe ride.

Pavement distress data produced PDI values ranging between 2.0 and 10.0. The overall average PDI for this Section was 6.8. Within this section of roadway, approximately 55% of PDI values measured greater than 7.0, with 82% of the roadways PDI greater than 7.0. Generally, PDI values less than 7.0 indicate a pavement surface with three of four predominant types of distress of varying severity and density, and would therefore qualify as a potential candidate for rehabilitation. These values classify this roadway as being in fair to good condition.

EBA reviewed the data used to calculate the PDI, and specifically the contribution of fatigue cracking was analyzed. With the non-fatigue related data removed, the PDI would vary between 3.7 and 10.0, with an average value of 8.6. Comparing PDI and fatigue crack PDI values indicates that that fatigue type distresses (edge cracking, longitudinal wheel track cracking, and alligator cracking) are a significant contributor to the roadways overall distress level.

2005/2007 RPMS Data Comparison

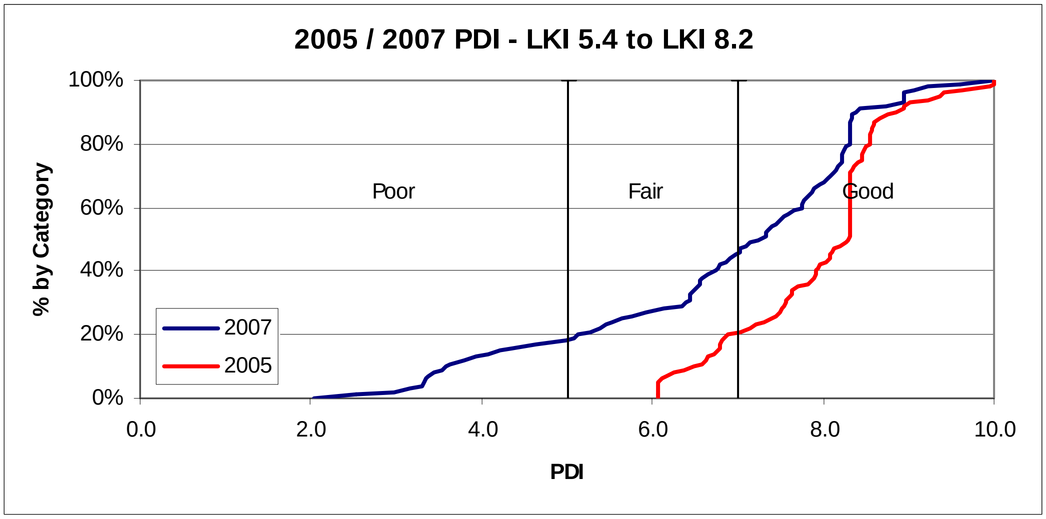
EBA also reviewed the MoTI's 2005 RPMS data. Comparing IRI, Rut, and PDI values from two consecutive RPMS data collection years can potentially provide insight to the roadways overall rate of deterioration.

Average IRI, maximum rut, PDI and fatigue PDI values are summarized in Table 4.

TABLE 5: 2005 / 2007 RPMS COMPARISON

LKI Station	Average IRI (m / km)		Average Max Rut (mm)		Average PDI		Average Fatigue PDI	
	2005	2007	2005	2007	2005	2007	2005	2007
LKI 2.40 – LKI 5.40	1.45	1.48	5.8	6.7	8.8	8.9	9.6	9.6
LKI 5.40 – LKI 8.20	1.88	2.06	9.4	13.5	7.9	6.8	9.8	8.6

In general, differences in 2005 and 2007 RPMS data are representative of reasonable rate of deterioration for this section of roadway. There is however, there is indication of a increased rate in pavement distress values, and indicated by comparing 2005 and 2007 PDI values, between LKI 5.4 to LKI 8.2. Within this area, the overall percentage of poor pavement condition increased from 0% to 19% between 2005 and 2007. In addition, the percentage of fair pavement condition increased from 20% to 45% between 2005 and 2007. A statistical comparison showing the percentage of PDI severity by category (poor, fair, or good condition) of the 2005 and 2007 RPMS data can be seen below.



This increase in roadway PDI may be indicative of a weakening pavement structure. The rate of deterioration suggests that rehabilitation of this area may be required. 2005 and 2007 RPMS data for Highway 7B has also been plotted, and can be found in Figure 3.

3.0 SITE INVESTIGATION

A site investigation including asphalt pavement thickness measurements and strength testing by FWD was completed between November 11, 2009 and November 12, 2009.

3.1 PAVEMENT THICKNESS EVALUATION

A pavement thickness evaluation was completed on all travel lanes within the project limits for both Highway 7 and Highway 7B. Asphalt concrete pavement (ACP) thickness was measured by completing asphalt probes using a hand-held hammer drill, and asphalt cores. Asphalt prove thickness measurements were collected at approximately 500 m intervals. At each location the pavement-base layer interface was identified, and the pavement thickness was measured. Asphalt thickness values for each roadway have been reported to the nearest 5 mm, and are considered accurate to ± 10 mm. A total of 70 individual asphalt probe thicknesses were taken between the two project Highways.

A summary of the asphalt thickness results are shown in Tables 5 and 6 for Highways 7 and 7B respectively. A complete list of all asphalt thicknesses are presented in Appendix B.

TABLE 6: HIGHWAY 7 ASPHALT THICKNESS MEASUREMENTS					
Direction	Lane	Asphalt Thickness (mm)			
		Maximum	Minimum	Average	Standard Deviation
Eastbound	Inside	135	145	140	4.1
	Centre	135	140	140	2.9
	Outside	145	155	150	4.1
Westbound	Inside	130	140	135	4.1
	Centre	135	140	135	2.9
	Outside	135	140	140	2.5

TABLE 6: HIGHWAY 7B ASPHALT THICKNESS MEASUREMENTS					
Direction	Lane	Asphalt Thickness (mm)			
		Maximum	Minimum	Average	Standard Deviation
Eastbound	Inside	115	175	140	15.6
	Outside	90	170	135	19.6
Westbound	Inside	100	145	120	12.7
	Outside	100	155	125	19.4

EBA also completed an asphalt coring program on both project Highways. The purpose of this coring program was a quality assurance check on the results determined from the hand-held hammer drill method.

Core sites were selected within the outside travel lanes at locations that were considered to provide a general representation of the ACP thickness across each site. At each core location, a hammer-drill hole was first drilled, and the ACP thickness measured. This was then followed by coring the ACP with the core centred on hammer-drill hole. The core thickness was then measured, and compared to the ACP thickness determined by the hammer-drill. Results from the coring program are shown in Tables 7 and 8 for Highways 7 and 7B respectively.

TABLE 7: HIGHWAY 7 ACP CORE THICKNESSES

Direction	Lane	LKI Station (km)	ACP Probe Thickness (mm)	ACP Core Thickness (mm)
Eastbound	Outside	7.00	155	148
Eastbound	Outside	8.00	150	143
Westbound	Outside	7.00	140	140
Westbound	Outside	8.00	135	131

TABLE 8: HIGHWAY 7B ACP CORE THICKNESSES

Direction	Lane	LKI Station (km)	ACP Probe Thickness (mm)	ACP Core Thickness (mm)
Eastbound	Outside	4.0	100	91
Eastbound	Outside	6.5	110	102
Westbound	Outside	4.0	90	80
Westbound	Outside	6.5	130	128

A total of eight 100mm diameter ACP cores were extracted. All core locations were backfilled with quick set concrete.

The ACP core thicknesses were within the accuracy of the asphalt probes. The ACP cores measured on average 5 – 10 mm less than the ACP probes.

3.2 FWD TESTING PROGRAM

The roadway was tested using a Dynatest Model 8000 FWD with 9 active sensors. The FWD used for testing in this assignment was calibrated at the SHRP test facility in Denver, Colorado in March 2009. A total of 162 and 298 locations were tested for Highway 7 and 7B respectively. Testing included target FWD drop weights of 26 kN, 40 kN, and 54 kN. The second drop at 40 kN is intended to simulate the deflection caused by an 80 kN (18,000 lbs) single axle load.

FWD testing was conducted in all travel lanes. Testing was completed at 50m spacing in the outside lanes, and 100m spacing in the centre and inside lanes. Traffic control was arranged by EBA and provided by ALLL Traffic Control and Safety Systems of Richmond, BC.

4.0 FWD ANALYSIS AND METHODOLOGY

AASHTO flexible pavement design methodology, outlined in the Guide for Design of Pavement Structures (1993), was used for the analysis of FWD data.

The design parameters required by the AASHTO method and used in the analysis of the FWD test data are summarized in Table 9.

TABLE 9: AASHTO PAVEMENT DESIGN INPUTS

Criteria	Value	Rationale
Reliability	85%	Based on engineering judgment, the roadway classification, 20-year design ESALs, and MoTI practice.
Serviceability		In accordance with generally accepted pavement engineering principles and AASHTO practice. (MoTI Technical Circular T-04/01)
Initial Serviceability Index (Pi)	4.2	
Terminal Serviceability Index (Pt)	2.5	
Serviceability Loss (□ PSI)	1.7	
Overall Standard Deviation (So)	0.45	
Resilient Modulus Reduction Factor	0.33	This factor is required to adjust the back-calculated subgrade resilient modulus to be consistent with the values used to represent the AASHO Road Test subgrade.

The 20-year design ESALs used in the analysis were based on the analysis of MoTI traffic data and are presented in Tables 2 and 3.

The Asphalt Concrete Pavement (ACP) thicknesses used in the analysis were based on an average thickness information from the test hole locations as presented in Tables 5 and 6.

Determination of subsurface soil and road base thickness and characteristics were not within the scope of this investigation. Therefore, an assumed underlying granular structure of 600 mm was used in the analysis. The assumed ACP and granular base and sub-base course thickness values are consistent with MoTI Technical Circular T-01/04 for a Type A (High Volume) roadway on a soil subgrade. MoTI Technical Circular T-01/04 for high volume roadways on soil subgrade indicates that pavement design standards for Type “A” roadways with traffic volumes greater that 1,000,000 ESALs call for 300 mm of crushed base course (CBC) over 300 mm of select granular sub-base (SGSB).

The analysis of the pavement structures for the subject road was conducted using DAPAv99 (Design and Analysis of Pavements using AASHTO) software developed by EBA. The software analyzes FWD data in accordance with the methodology outlined in the AASHTO Guide for Design of Pavement Structure and provides point-by-point analysis of each FWD test location.

The output consists of back-calculated Subgrade Resilient Modulus (Mr), Pavement Modulus (Ep), and pavement strengthening requirement presented as an equivalent thickness of ACP in millimetres.

Subgrade and Pavement Moduli, as well as the roadway Structural Number would vary if the actual existing base and sub-base thickness was different than the thickness used in the analysis. Of these three parameters, the roadway structural number is the most sensitive to layer thickness.

5.0 RESULTS

EBA has provided back calculated pavement and subgrade moduli for the project sections. EBA has also provided strengthening results based on 20-year design ESALs in accordance with Technical Circular T-01/04. Typical analysis periods for new construction is 20 years; however, the design life of the initial rehabilitation or resurfacing treatments is generally limited to 15 years or less.

5.1 HIGHWAY 7 RESULTS

In general, analysis of the FWD data indicated that the majority of the roadway has sufficient strength (strengthening requirements < 5 mm), with the exception of the westbound centre lane, where an average strengthening requirement of 50 mm has been determined. Pavement strengthening requirements (20-year design ESALs) for Highway 7 are summarized in Table 10.

TABLE 10: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Strengthening Results (mm)		
			Minimum	Maximum	Average
Eastbound	Inside	LKI 6.60 - LKI 8.70	0	20	<5
	Centre	LKI 6.60 - LKI 8.71	0	52	<5
	Outside	LKI 6.60 - LKI 8.72	0	49	<5
Westbound	Inside	LKI 6.60 - LKI 8.73	0	0	<5
	Centre	LKI 6.60 - LKI 8.74	0	147	50
	Outside	LKI 6.60 - LKI 8.75	0	36	<5

Pavement Modulus (E_P), Subgrade Modulus (M_r), and Effective Pavement Structural Number (SN_{EFF}) were also determined in the analysis are included in Appendix C. Graphical representation of Ep, Mr, and AASHTO strengthening requirements are presented in Figures 4 and 5.

5.2 HIGHWAY 7B RESULTS

To facilitate the development of potential rehabilitation option, the project roadway has been divided into two apparent homogeneous sections (east and west of Pitt River Road – LKI 5.40).

In general, analysis of the FWD data indicated that the majority of the inside travel lanes are structurally sufficient (strengthening requirements < 5mm) along the project length. The outside travel lanes between LKI 2.45 and LKI 5.60 generally show minimal strengthening requirements; however, areas of structural deficiency do exist between LKI 5.60 and LKI 8.10. Pavement strengthening requirements (20-year design ESALs) for Highway 7B are summarized in Table 10.

TABLE 11: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Strengthening Results (mm)		
			Minimum	Maximum	Average
Eastbound	Inside	LKI 2.45 - LKI 5.60	0	89	<5
		LKI 5.60 - LKI 8.10	0	54	15
Eastbound	Outside	LKI 2.45 - LKI 5.60	0	94	10
		LKI 5.60 - LKI 8.10	0	150	65
Westbound	Inside	LKI 2.45 - LKI 5.60	0	76	<5
		LKI 5.60 - LKI 8.10	0	65	<5
Westbound	Outside	LKI 2.45 - LKI 5.60	0	112	10
		LKI 5.60 - LKI 8.10	0	99	25

Pavement Modulus (E_P), Subgrade Modulus (M_r), and Effective Pavement Structural Number (SN_{EFF}) were also determined in the analysis are included in Appendix C. Graphical representation of Ep, Mr, and AASHTO strengthening requirements are presented in Figures 6 and 7.

The strengthening requirements found in Tables 10 and 11 do not necessary mean an overlay is the most suitable option for rehabilitation. These values are representative of the strengthening required in an equivalent thickness of new asphalt pavement.

6.0 MEETINGS

A Pavement Rehabilitation and Options meeting was held on November 28, 2009 with the MoTI, at which time a preliminary analysis of the data, as well as potential rehabilitation options were discussed.

Following this meeting the MoTI requested additional information concerning localized areas requiring large strengthening requirement on Highway 7B. These strengthening requirements "spikes" were defined as any test location where the strengthening requirement exceeds 25mm. Based on this criterion, a table was created referencing test lane and station to each "spike", and was then provided to the MoTI for use. A copy of this table can be found in Appendix D for reference.

7.0 REHABILITATION OPTIONS

7.1 HIGHWAY 7 REHABILITATION OPTIONS

Based on the information discussed herein and EBA's general understanding of the MoTI's requirements at this time, the recommended rehabilitation options for this section of Highway 7 are as follows:

Option A: **50 mm Overlay All Lanes** – Overlay roadway sections where indicated roadway structural deficiencies warrant the addition of more pavement structure.

Option B: **75 mm Mill and Inlay / Defer Rehabilitation** – Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated, as well as provide regular maintenance to all other areas to preserve the current roadway condition.

Option C: **50/75 mm Mill and Inlay** – 75mm Mill and Inlay roadway sections where modest strengthening and roadway distress levels are indicated; 50mm Mill and Inlay in all other areas to extend roadway service life.

Option A: 50 mm Overlay All Lanes – This rehabilitation strategy includes the addition of 50 mm of new AP to the existing roadway. This option effectively addresses pavement strength deficiencies in the westbound centre lane, and improves the ride quality (while extending the service life) in all other travel lanes.

Thin overlays (~ 50 mm) can be viewed more as surface treatments, and will slow the rate of pavement deterioration. For pavements deficient in structural rigidity, such as in the westbound centre lane, thin overlays may not offer effective reflective crack control. Strain concentration in the overlay, particularly in the vicinity of pre-existing surface distresses, can increase the new overlay's susceptibility to the reoccurrence of surface distresses due to reflective cracking. Reflection cracking has a considerable influence on the life of the overlay, reducing the pavements serviceability, and often requiring maintenance such as patching and crack sealing earlier in the pavements design life.

As with Mill and Inlay strategies, Overlays are also effective at reducing roadway long-wave surface distortions such as heaves or swells, in turn, improving the overall ride quality of the roadway. Overlays also provide a modest remedy to low severity rutting.

It should be noted that an overlay will increase the overall ACP thickness providing an increased pavement structure. Thicker ACP will postpone the reoccurrence of surface distresses, but it will not be able to completely prevent the resurfacing of cracks. Areas where surface distresses are present that are not treated prior to overlay will have a higher susceptibility to reflective type cracking.

Option B: 75 mm Mill and Inlay/Defer Rehabilitation – This rehabilitation strategy includes the removal and replacement of the top 75 mm of ACP. The mill and inlay component of this strategy will addresses strengthening issues in the westbound outside lane, and well as preserve the pavement service life in the other travel lanes with regular routine maintenance.

Replacing the top portion of the deteriorated of distressed pavement structure with new ACP will provide a majority of the required strengthening within the roadway sections identified below. In addition, the removal of a portion of the existing AP often improves the overall pavement performance due to the removal of surface distresses, and therefore reduces the likelihood of reflective cracking. Reflection cracking can have a considerable influence on the life of a new ACP. Deteriorated reflection cracks detract from a pavement's serviceability and often require ongoing frequent maintenance. Therefore, the removal of surface distresses is considered advantageous to long term life of the pavement.

In addition to mitigating the reoccurrence of surface distresses, a Mill and Inlay strategy is also effective at reducing roadway long-wave surface distortions such as heaves or swells, in turn, improving the overall ride quality of the roadway. Milling the ACP surface is also effective at treating low severity rutting.

This strategy also includes deferring pavement rehabilitation in lanes with minimal strengthening requirements at this time. In areas where roadway surface distress levels are of low frequency and severity, and pavement strengthening requirements are minimal, the roadway design life can be extended with routine maintenance. A regular crack sealing and patching program will improve the pavement serviceability, and defer higher cost rehabilitation.

This option is an ongoing process, and requires that the pavement surface be inspected at regular intervals. Areas indentified requiring repairs should be addressed promptly to prevent the defect from deteriorating.

Roadway section(s) recommended for this option include:

- All Eastbound Lanes – Defer Rehabilitation
- Westbound Inside and Outside Lanes – Defer Rehabilitation
- Westbound Centre Lane – Mill and Inlay 75 mm

This Option is considered a cost-effective strategy for preserving roadway service life while sustaining the ride quality of the pavement surface.

Option C: 50/75 mm Mill and Inlay - This rehabilitation strategy includes the removal and replacement of the top 50 or 75 mm of ACP. This mill and inlay strategy addresses the same issues discussed in Option B, with the exception being that the mill depth will vary across the roadway width as the strengthening requirements dictate. The mill depth recommended for each lane is a function of the determined strengthening requirements. A 75 mm mill depth will not only provide additional strength, but it will also provide additional resistance to the reoccurrence of surface distresses compared to a 50 mm mill and inlay.

Roadway section(s) recommended for this option include:

- All Eastbound Lanes – Mill and Inlay 50 mm
- Westbound Inside and Outside Lanes – Mill and Inlay 50 mm
- Westbound Centre Lane – Mill and Inlay 75 mm

This Option provides a majority of the required strength required in the westbound centre lane, and extends the service life of all other travel lanes.

7.2 HIGHWAY 7B REHABILITATION OPTIONS

Based on the information discussed herein and EBA's general understanding of the MoTI's requirements at this time, the recommended rehabilitation strategy for this section of Highway 7B is summarized in Table 12, and then discussed in more detail below.

TABLE 12: HIGHWAY 7B REHABILITATION OPTIONS

Direction	Lane	LKI Station (km)	Recommended Rehabilitation Option
Eastbound	Inside	LKI 2.45 - LKI 5.60	Defer Rehabilitation
		LKI 5.60 - LKI 8.10	50 mm Mill and Inlay
Eastbound	Outside	LKI 2.45 - LKI 5.60	Defer Rehabilitation
		LKI 5.60 - LKI 8.10	100 mm Mill and Inlay
Westbound	Inside	LKI 2.45 - LKI 5.60	Defer Rehabilitation
		LKI 5.60 - LKI 8.10	Localized 50 mm Mill and Inlay
Westbound	Outside	LKI 2.45 - LKI 5.60	Defer Rehabilitation
		LKI 5.60 - LKI 8.10	50 mm Mill and Inlay

Defer Rehabilitation – This strategy includes deferring pavement rehabilitation at this time. In areas where roadway surface distress levels are of low frequency and severity, and pavement strengthening requirements are minimal, the roadway design life can be extended with routine maintenance. A regular crack sealing and patching program will improve the pavement serviceability, and defer high cost rehabilitation.

This option is an ongoing process, and requires that the pavement surface be inspected at regular intervals. Areas indentified requiring repairs should be addressed promptly to prevent the defect from deteriorating.

Roadway section(s) recommended for this option include:

- LKI 2.50 to LKI 5.50 – All Eastbound and Westbound Lanes

This Option is considered a cost-effective strategy for preserving roadway service life and improving the ride quality of the pavement surface.

50 mm Mill and Inlay - This rehabilitation strategy includes the removal and replacement of the top 50 mm of ACP. Replacing the top portion of the deteriorated of distressed pavement structure with new ACP will provide a majority of the required strengthening within the roadway sections identified below (a ~25 mm net increase in Structural Number). In addition, the removal of a portion of the existing ACP often improves the overall pavement performance due to the removal of surface distresses, and therefore reduces the likelihood of reflective cracking. Reflection cracking can have a considerable influence on the life of a new ACP. Deteriorated reflection cracks detract from a pavement's serviceability and often require ongoing frequent maintenance. Therefore, the removal of surface distresses is considered advantageous to long term life of the pavement.

In addition to mitigating the reoccurrence of surface distresses, a Mill and Inlay strategy is also effective at reducing roadway long-wave surface distortions such as heaves or swells, in turn, improving the overall ride quality of the roadway. Milling the ACP surface is also effective at treating low severity rutting.

Roadway section(s) recommended for this option include:

- LKI 5.50 to LKI 8.50 – Eastbound Inside Lane
- LKI 5.50 to LKI 8.50 – Westbound Outside Lane

This Option, when combined with regular roadway maintenance, provides a majority of the required strength for these sections without an increase in roadway profile elevation generally associated with overlays. Mill and inlay strategies also have minimal impact on adjacent shoulders, curb and gutter, or concrete barriers.

Localized 50 mm Mill and Inlay – A localized mill and inlay addresses the same issues discussed in Option B, with the exception being that it limited to localized areas where a minimal structural deficiency has been identified.

Roadway section(s) recommended for this option include:

- LKI 5.50 to LKI 8.50 – Westbound Inside Lane

From a structural standpoint, the FWD results provide insight when identifying suitable candidates for this strategy. Conducting a limited visual condition survey would provide surface condition (RPMS data does not exist for westbound direction), which could be used in combination with areas identified by the FWD analysis when selecting potential areas for this option.

Areas deferred from this option should continue to receive regular and routine maintenance, including crack sealing, and pothole repair. Continued regular maintenance of theses areas will ensure the long term performance of this section of roadway throughout the remainder of its design life.

100 mm Mill and Inlay – This rehabilitation strategy includes the removal and replacement of the top 100 mm of ACP. Replacing the top portion of the deteriorated of distressed pavement structure with new ACP will provide a majority of the required strengthening within the roadway sections identified below (a ~50mm net increase of new AP).

As discussed in Option B, the removal of a portion of the existing ACP often improves the overall pavement performance due to the removal of surface distresses, and therefore reduces the likelihood of reflective cracking. By increasing the mill depth to 100 mm, additional strength is provided, while improving long term performance by limiting the reoccurrence of surface distresses.

Roadway section(s) recommended for this option include:

- LKI 5.50 to LKI 8.50 – Eastbound Inside Lane
- LKI 5.50 to LKI 8.50 – Westbound Outside Lane

This Option, when combined with regular roadway maintenance, provides a majority of the required strength for these sections.

Deep Patch Repair - The 2005 and 2007 RPMS data identified several areas in the eastbound outside travel lane with moderate to high severity fatigue cracking. Moderate to high severity fatigue "alligator" cracked areas generally indicate a failed pavement structure, which would include the cracked asphalt and an underlying weakening granular base. As such the repair typically requires replacement of the granular base. These areas are considered candidates for localized deep patch repair which requires the full removal of the asphalt pavement and removal of a portion of the underlying granular base to a thickness typically between 300 mm and 450 mm.

Once exposed, the material should also be inspected and tested if necessary to determine if the fines content is too high or drainage capacity is impaired. If the granular material is considered unsatisfactory, the poor quality material is sub-excavated and replaced with new imported crushed granular base course to depths of up to 1m depending on site conditions. The asphalt pavement is then replaced to the same thickness as the adjacent asphalt.

Potential areas for deep patch repairs include localized areas where pavement surface condition has deteriorated to the state where substantial rehabilitation is required. Areas where RPMS data indicated poor PDI values (PDI < 5) would be considered candidates for deep patch repair. Reviewing the RPMS data revealed that in several roadway sections within the project limits, PDI values significantly worsened between 2005 and 2007 data collection cycles, and suggests that the roadways rate of deterioration is largely influenced by the presence of fatigue type distresses.

Analysis of the FWD data identified areas within the above roadway sections requiring large localized strengthening requirements. Typically these areas include strengthening requirements greater than 100 mm. These large "spikes" suggest a failed pavement structure, and should be inspected prior to rehabilitation. Base on the FWD analysis, specific test locations that are potential candidates for deep patch repair are summarized in Table 14.

TABLE 14: HIGHWAY 7B DEEP PATCH REPAIR LOCATIONS			
Direction	Lane	LKI Station (km)	AASHTO Strengthening Requirement (mm)
Eastbound	Outside	6.00	106
		6.30	117
		6.35	150
		6.70	110
		6.75	112
		7.00	106
		7.41	100
		7.90	101

It should be noted that deep patch repairs are costly and require additional traffic control and increase construction delays. As such, the provision should be made to inspect and test the existing granular material in an effort to limit the granular replacement to those areas which most require it. As a minimum the localized repair at the moderate to high severity fatigue cracking sites should involve the full removal and replacement the existing asphalt pavement.

7.3 ASPHALT MIX

The use of a Class 1 Medium Mix as per Section 501 of the MoTI's *2006 Standard Specifications for Highway Construction* is considered appropriate for all rehabilitation options for both Highway 7 and 7B.

8.0 LIMITATIONS OF REPORT

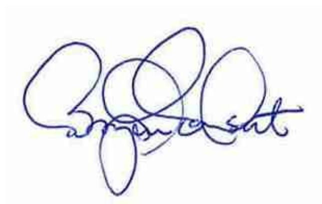
This report and its contents are intended for the sole use of the British Columbia Ministry of Transportation and Infrastructure and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the MoTI, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the General Conditions provided in Appendix A of this report.

9.0 CLOSURE

EBA appreciates the opportunity to be of continued service to the Ministry of Transportation and Infrastructure. We trust the information provided meets your present requirements.

Respectfully submitted,
EBA Engineering Consultants Ltd.

Prepared By:

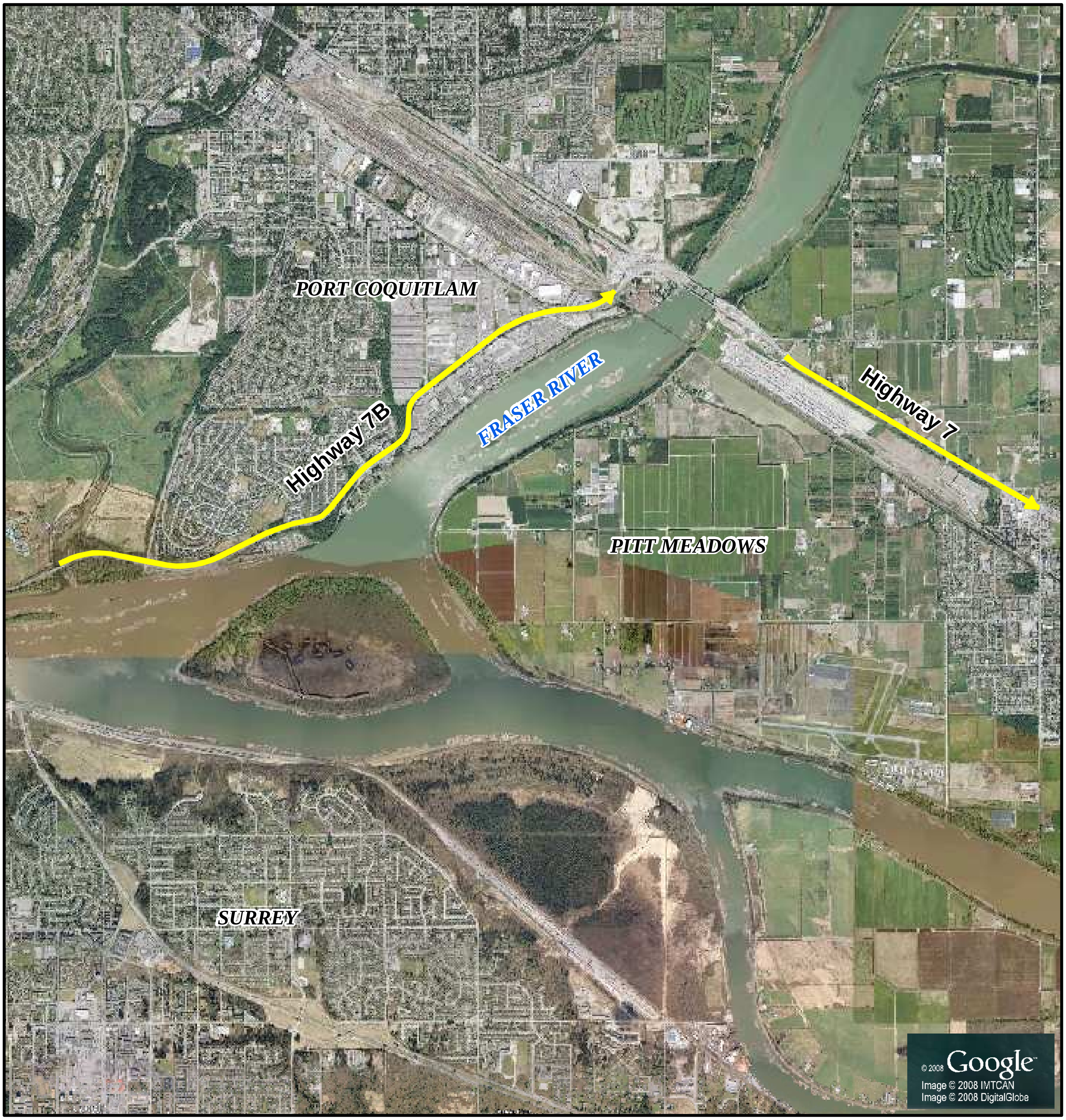


Bryan Palsat, EIT
Pavement Engineer

Reviewed By:

Christian Babuin, P.Eng.
Pavement Engineer

FIGURES



LEGEND

Project Roads

NOTES

Base data source: Road data acquired from BC Ministry of Transportation Road Network Shapefile.

ISSUED FOR USE

BC MINISTRY OF TRANSPORTATION
SOUTH COAST AS & WHEN

SITE LOCATION PLAN
HIGHWAY 7 & HIGHWAY 7B

PROJECTION	DATUM
UTM ZONE 10	NAD83

Scale: 1:50,000

0.7 0.35 0 0.7

Kilometres

FILE NO.
Hwy 7 - 7B - Site Location Plan.mxd

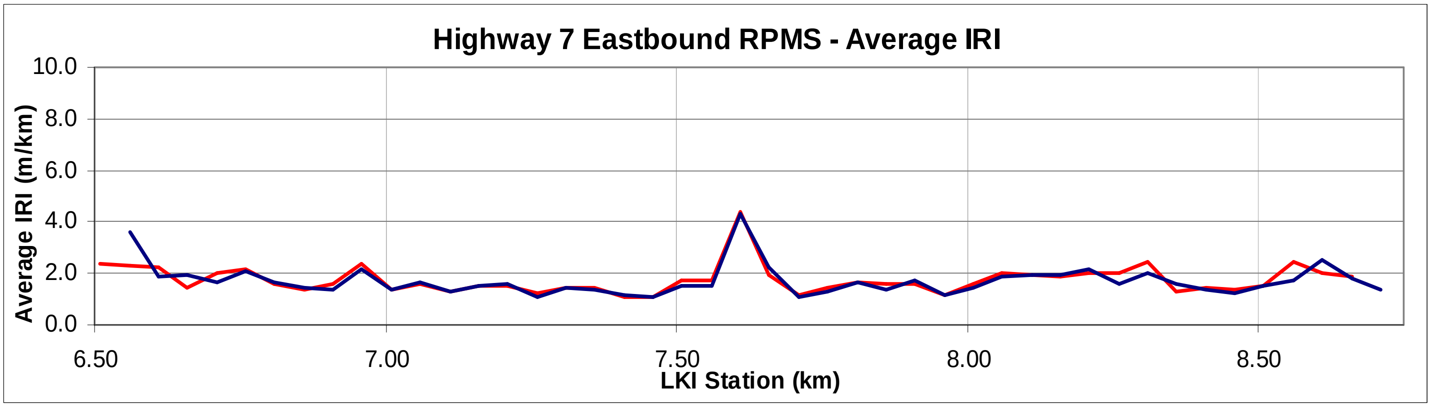
PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0

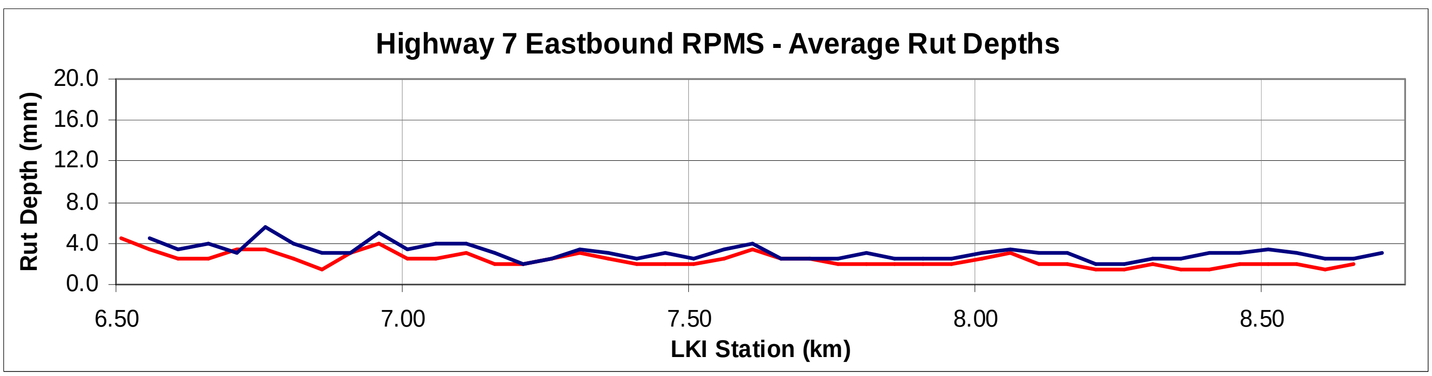
OFFICE	DATE
EBA-VANC	February 2010

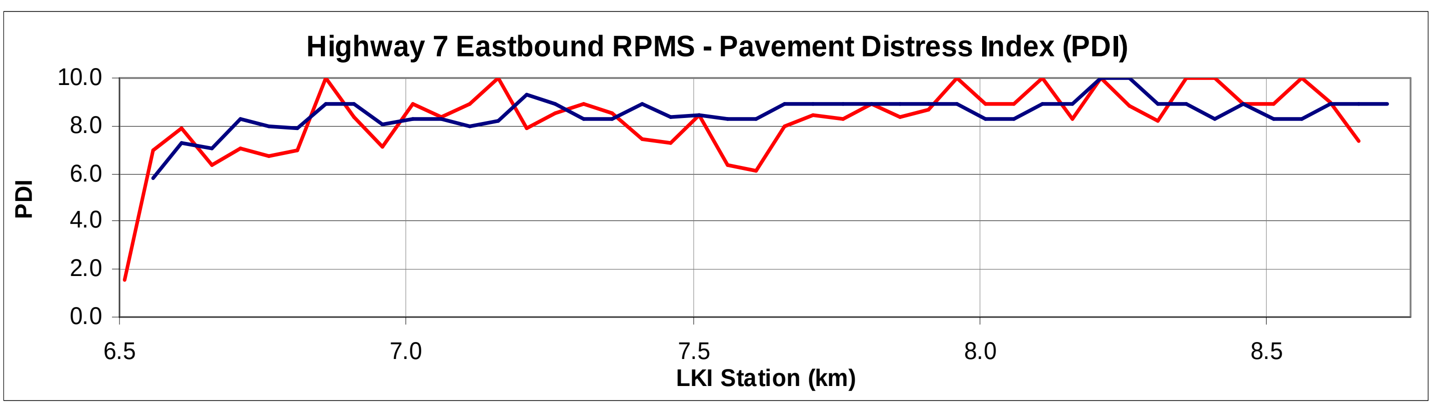
EBA Engineering Consultants Ltd.

Figure 1

Q:\Vancouver\Engineering\V131\Projects\V13101493 - MoT South Coast As and When Pavements\002 - Hwy 7 & 7B\GIS\Hwy 7-7B - Site Location Plan.mxd







LEGEND

- Project Road
- 2007 RPMS
- 2005 RPMS

NOTES

Base data sourceRPMS collected by EBA Engineering Consultants Ltd.

CLIENT

BRITISH COLUMBIA
Ministry of Transportation

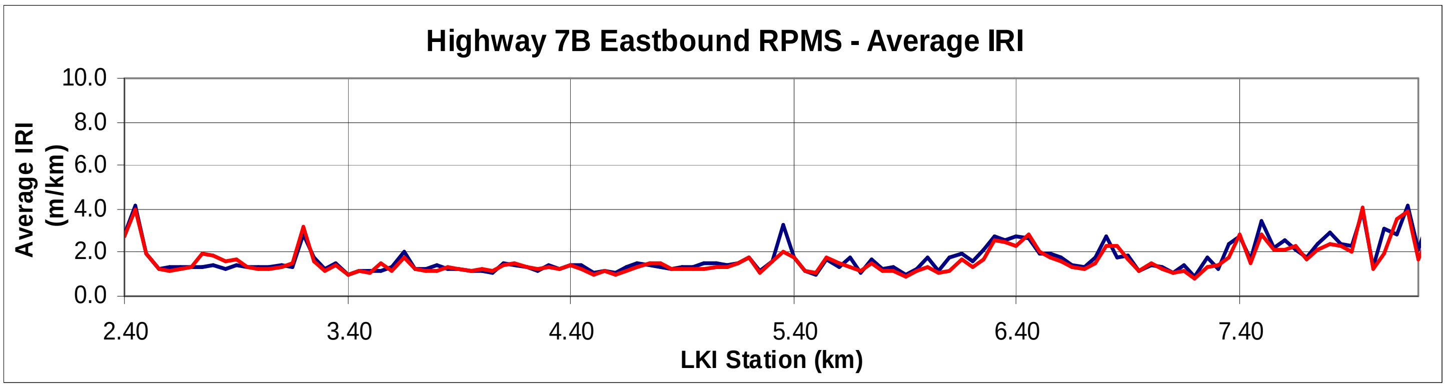
EBA Engineering Consultants Ltd.

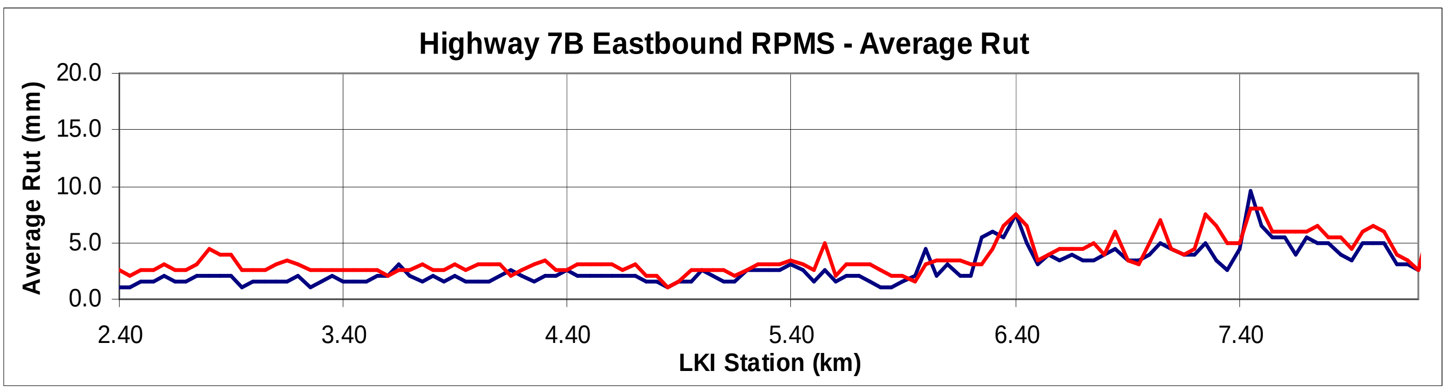
BC MINISTRY OF TRANSPORTATION SOUTH COAST AS AND WHEN

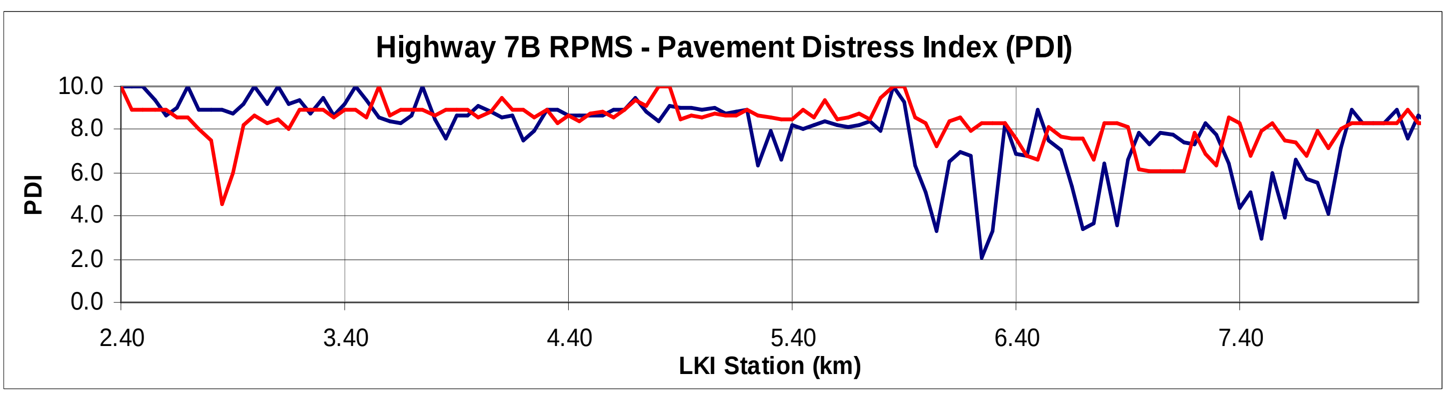
HIGHWAY 7 EASTBOUND RPMS

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0
OFFICE	DATE		
EBA-VANC	February 3, 2010		

Figure 2







LEGEND

- Project Road
- 2005 RPMS
- 2007 RPMS

NOTES

Base data source:FWD Results collected by EBA Engineering Consultants Ltd.

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Ministry of Transportation

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BC MINISTRY OF TRANSPORTATION SOUTH COAST AS AND WHEN

HIGHWAY 7B EASTBOUND RPMS

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0
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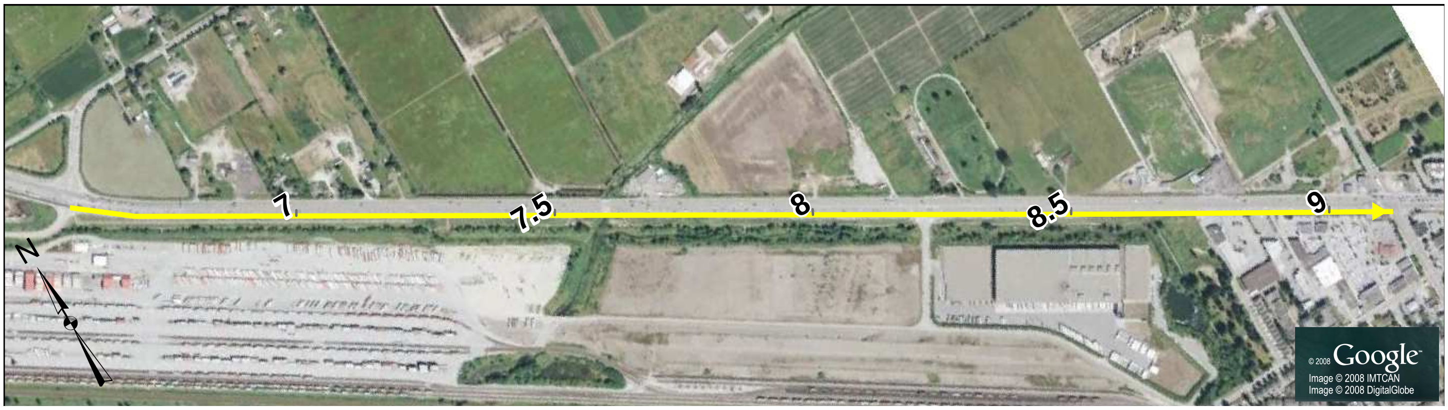
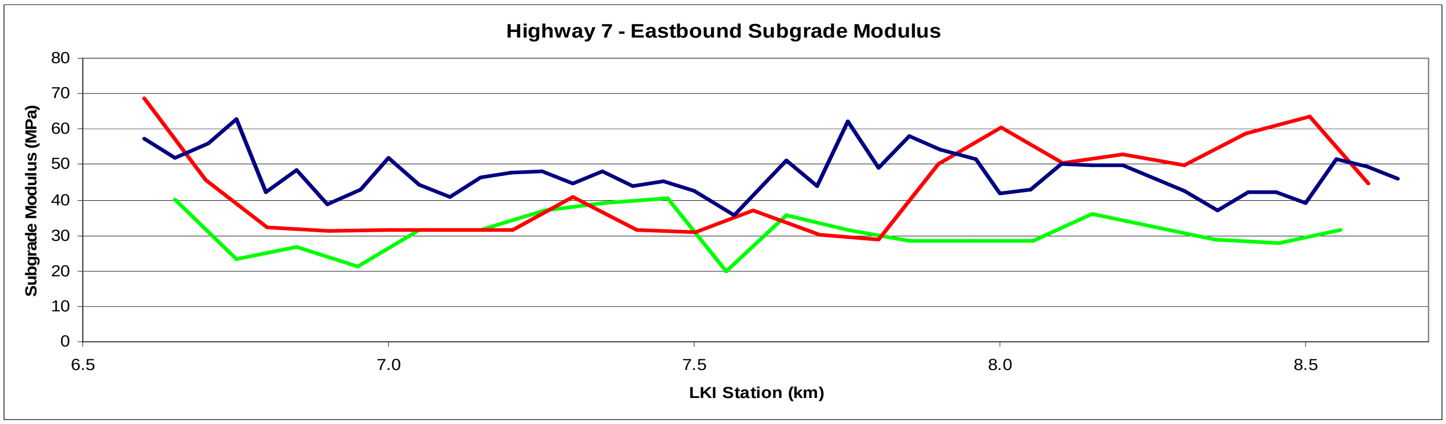
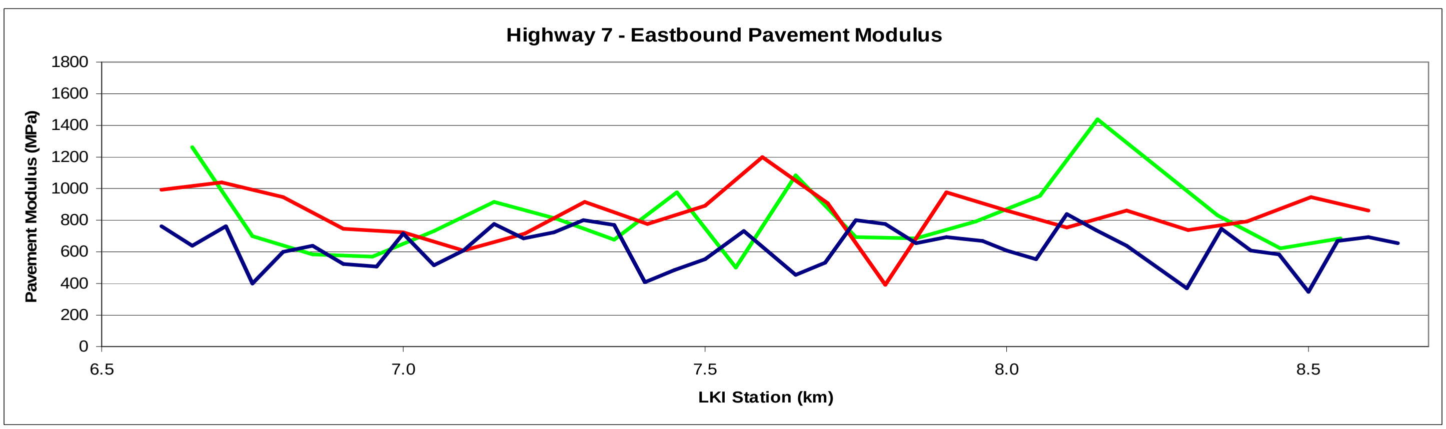
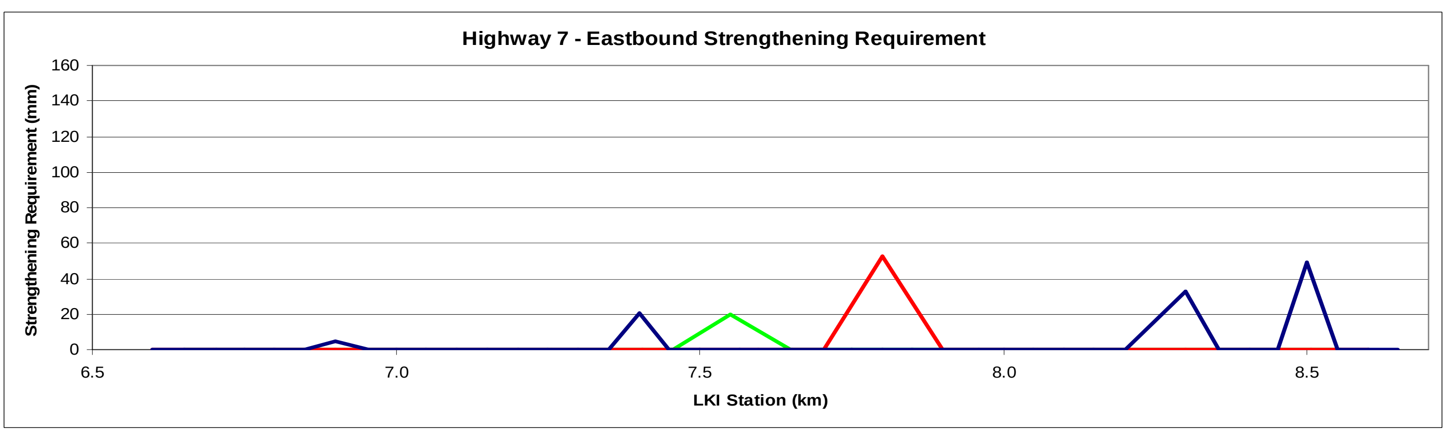
Figure 3









LEGEND

- Project Road
- Inside Lane
- Centre Lane
- Outside Lane

Reliability: 85%
Design ESALs: 4.6E+06 to 18.0E+06
S_O: 0.45
ΔPSI: 1.7

NOTES

Base data source collected from MOT shapefile.

CLIENT

BRITISH COLUMBIA
Ministry of Transportation

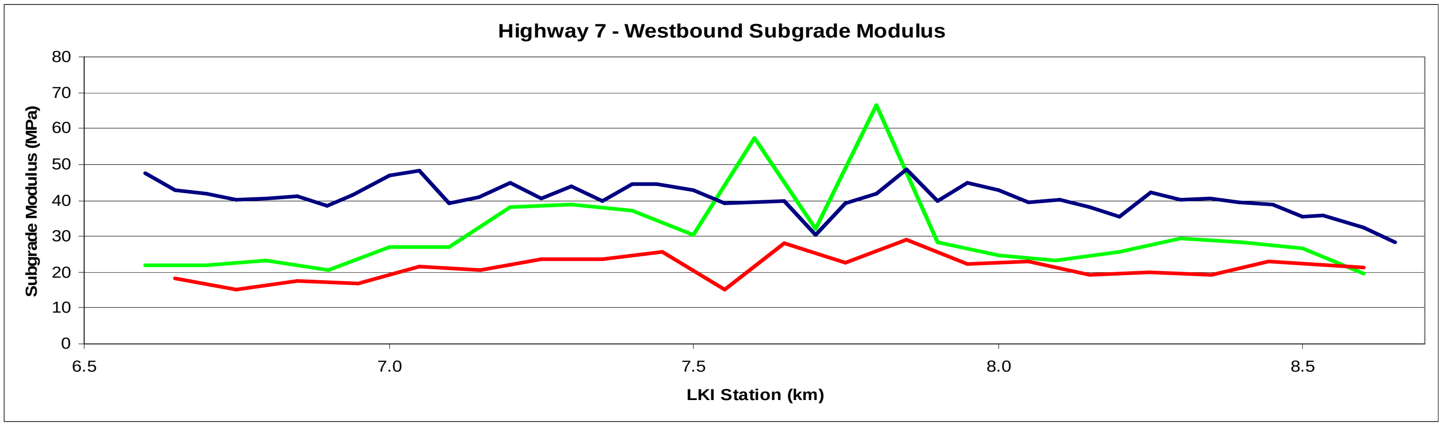
EBA Engineering Consultants Ltd.

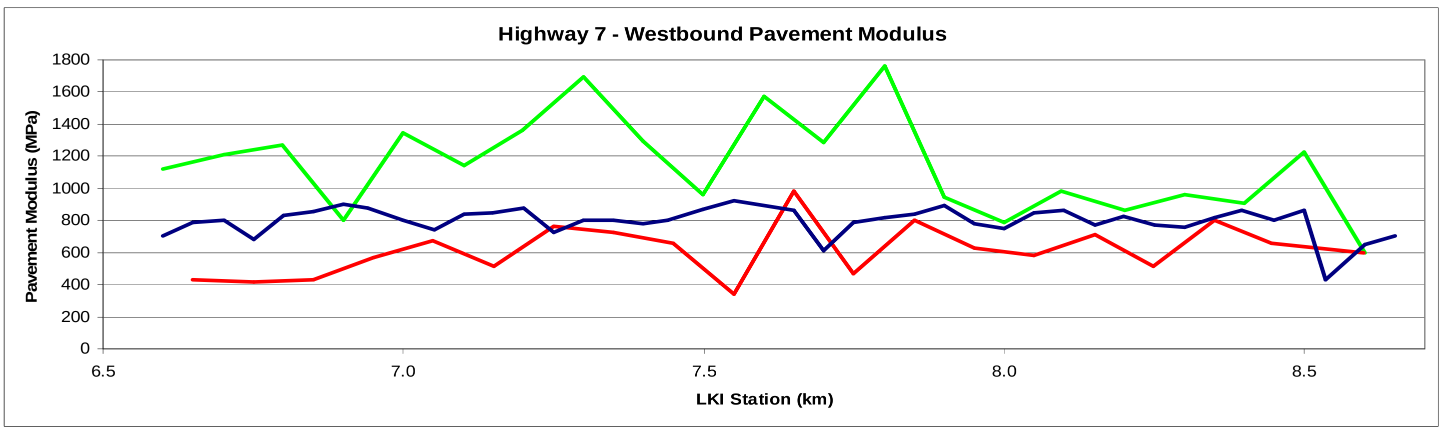
BC MINISTRY OF TRANSPORTATION SOUTH COAST AS AND WHEN

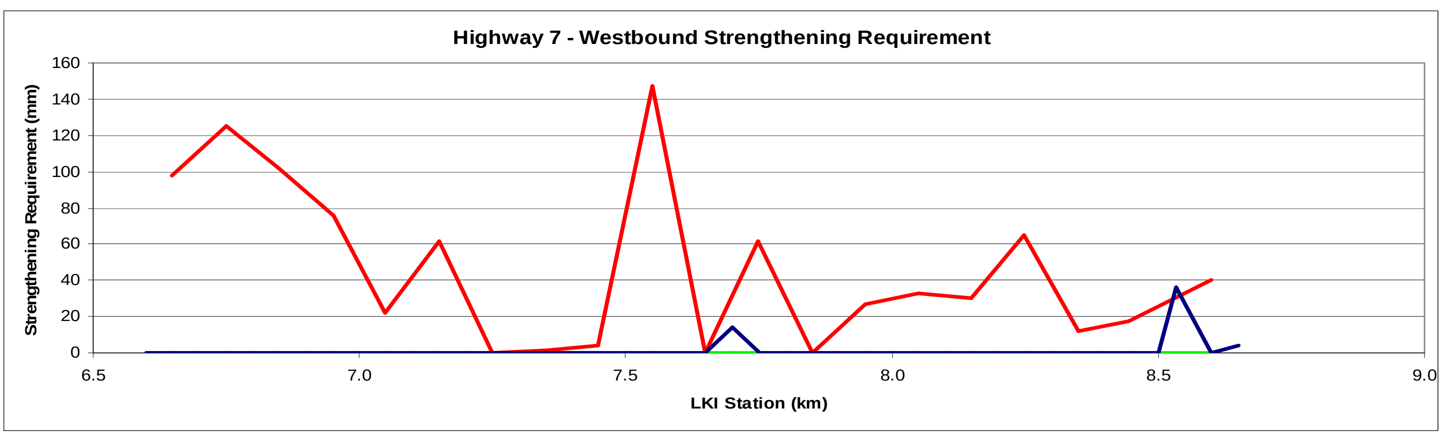
HIGHWAY 7 EASTBOUND STRENGTHENING REQUIREMENT

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0
OFFICE	DATE		
EBA-VANC	February 3, 2010		

Figure 4







LEGEND

- Project Road
- Inside Lane
- Centre Lane
- Outside Lane

Reliability: 85%
Design ESALs: 4.6E+06 to 18.0E+06
S_O: 0.45
ΔPSI: 1.7

NOTES
Base data source collected from MOT shapefile.

CLIENT

British Columbia
Ministry of Transportation

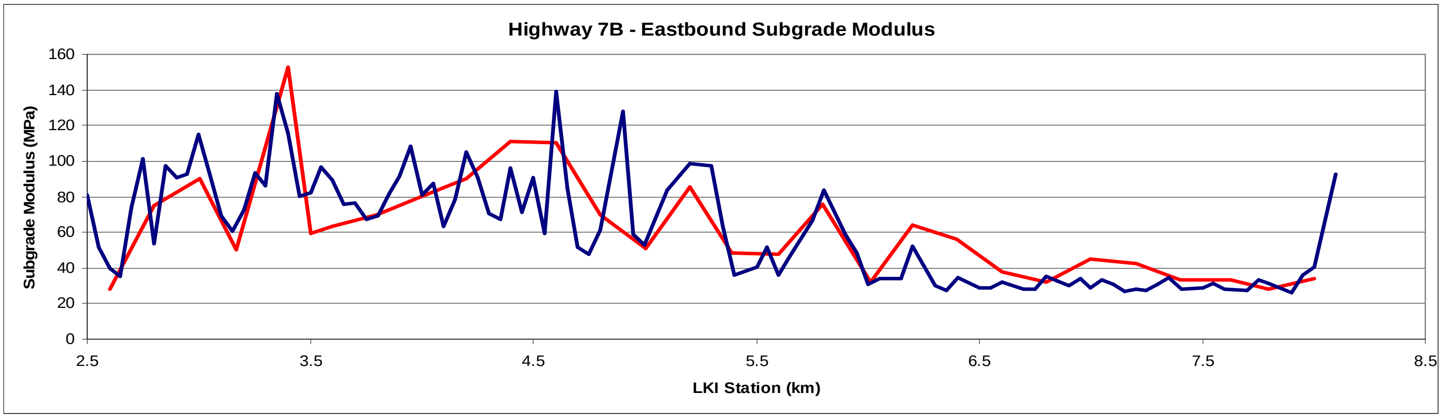
EBA Engineering Consultants Ltd.

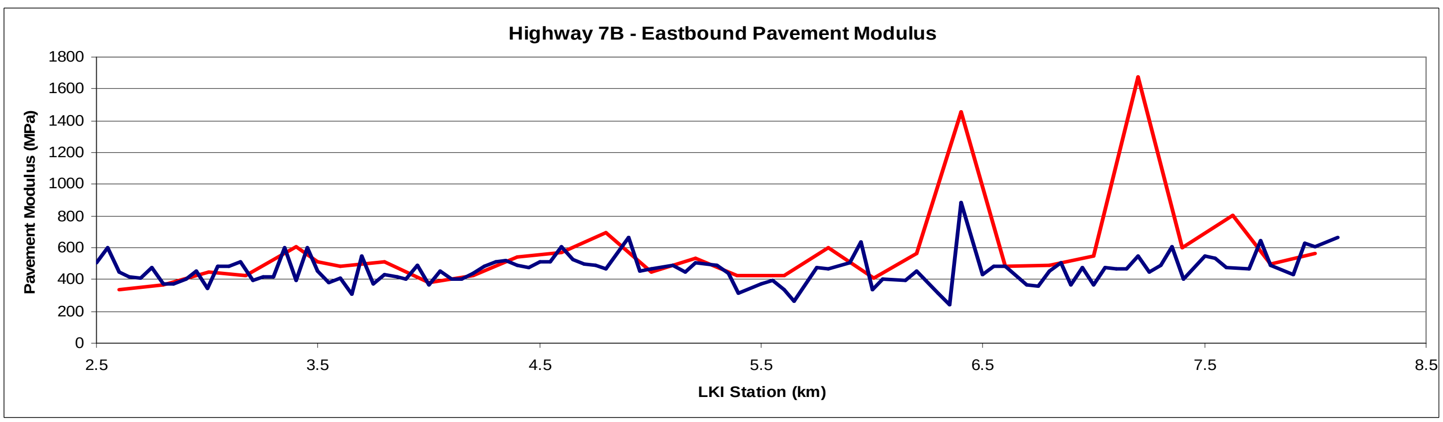
BC MINISTRY OF TRANSPORTATION SOUTH COAST AS AND WHEN

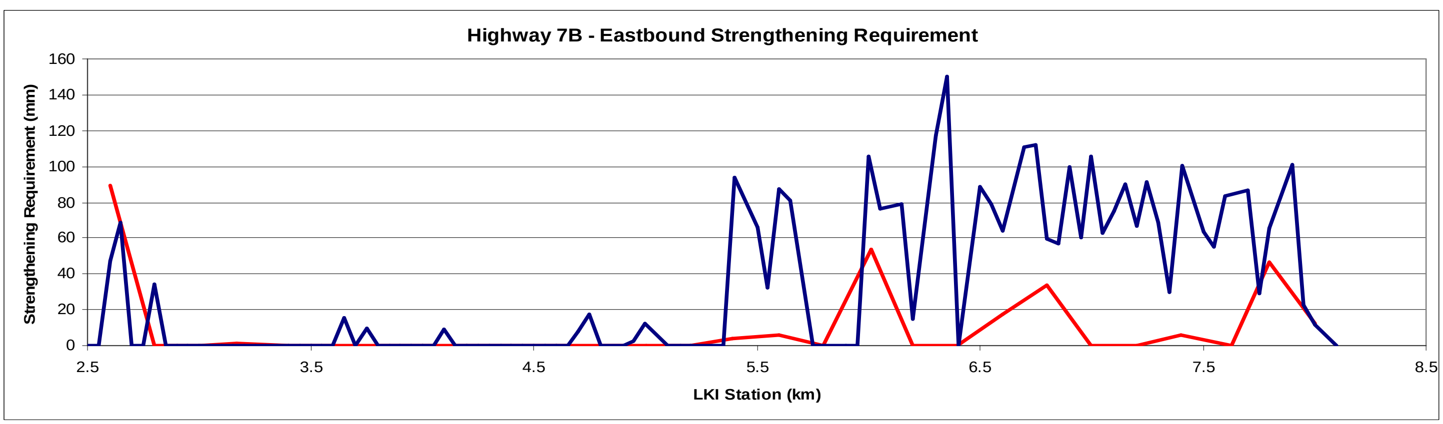
HIGHWAY 7 WESTBOUND STRENGTHENING REQUIREMENT

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0
OFFICE	DATE		
EBA-VANC	February 3, 2010		

Figure 5







LEGEND

- Project Road
- Inside Lane
- Outside Lane

Reliability: 85%
Design ESALs: 11.1E+06 to 20.0E+06
S_O: 0.45
ΔPSI: 1.7

NOTES

Base data source:FWD Results collected by EBA Engineering Consultants Ltd.

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British Columbia
Ministry of Transportation

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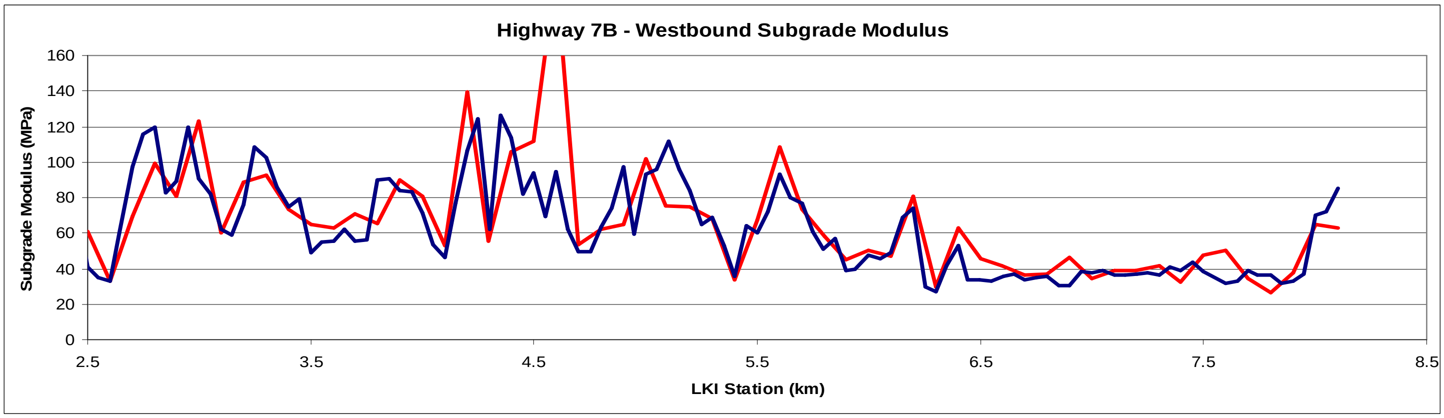
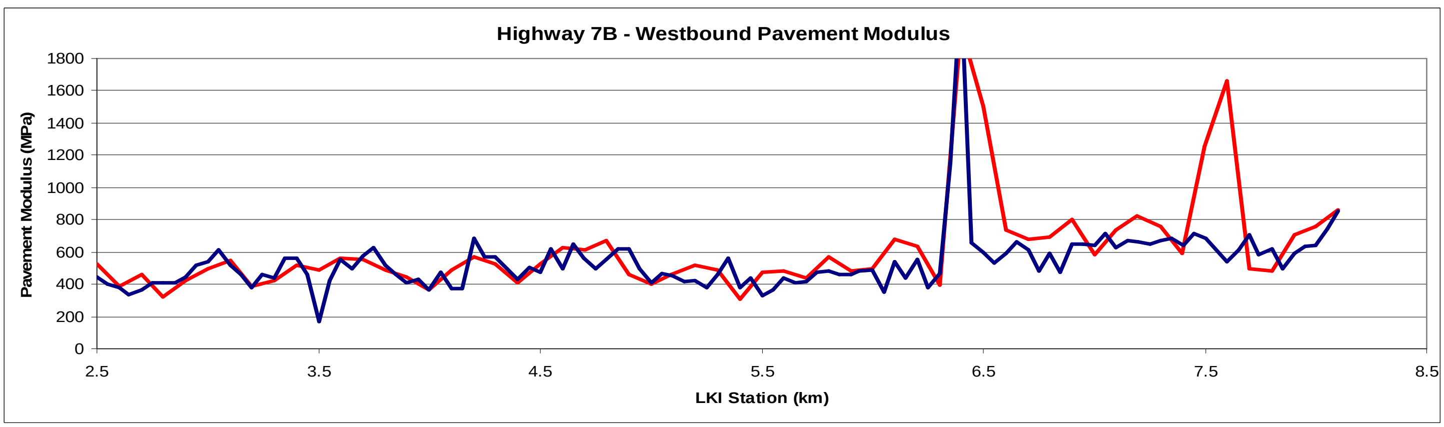
BC MINISTRY OF TRANSPORTATION
SOUTH COAST AS AND WHEN

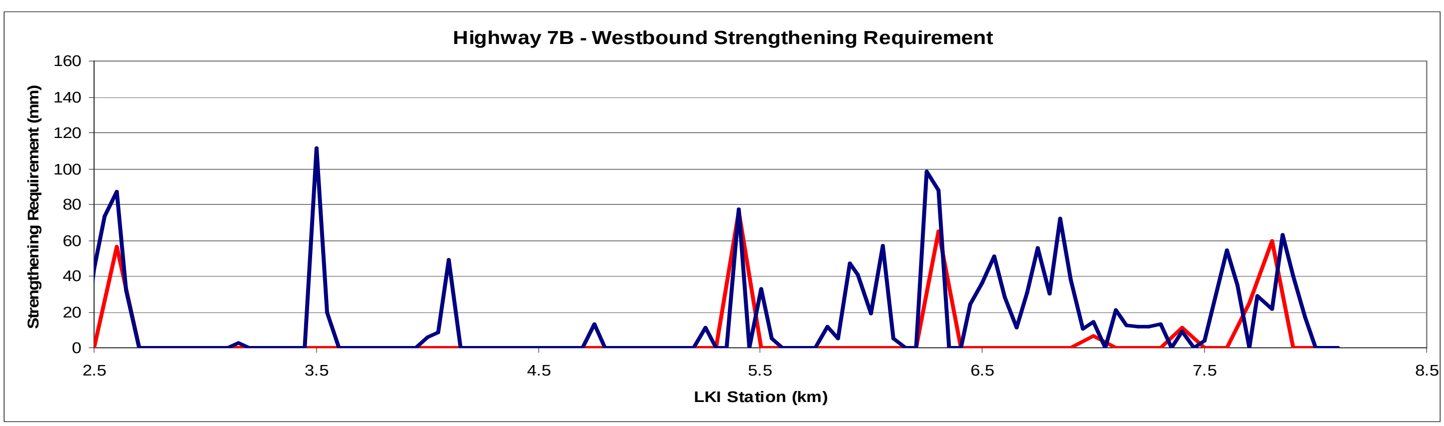
HIGHWAY 7B EASTBOUND STRENGTHENING REQUIREMENT

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0
OFFICE	DATE		
EBA-VANC	February 3, 2010		

Figure 6







LEGEND

- Project Road
- Inside Lane
- Outside Lane

Reliability: 85%
Design ESALs: 11.1E+06 to 20.0E+06
S_O: 0.45
ΔPSI: 1.7

NOTES

Base data sFWD Results collected by EBA Engineering Consultants Ltd..

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BC MINISTRY OF TRANSPORTATION SOUTH COAST AS AND WHEN

HIGHWAY 7B WESTBOUND STRENGTHENING REQUIREMENT

PROJECT NO.	DWN	CKD	REV
V13101493.002	AMF	BP	0

OFFICE	DATE
EBA-VANC	February 3, 2010

Figure 7

APPENDIX A

APPENDIX A GENERAL CONDITIONS

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgemental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

9.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

10.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

11.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

12.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

13.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

14.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

APPENDIX B

APPENDIX B ASPHALT THICKNESS DATA

APPENDIX B: HIGHWAY 7 ACP THICKNESS MEASUREMENTS				
Direction	Lane	Station (LKI)	Probe Thickness (mm)	Core Thickness (mm)
Eastbound	Inside	7.05	145	-
Eastbound	Inside	7.55	140	-
Eastbound	Inside	8.05	140	-
Eastbound	Inside	8.55	135	-
Eastbound	Centre	7.30	140	-
Eastbound	Centre	7.80	135	-
Eastbound	Centre	8.30	135	-
Eastbound	Outside	7.00	155	148
Eastbound	Outside	7.50	145	-
Eastbound	Outside	8.00	150	143
Eastbound	Outside	8.50	150	-
Westbound	Inside	8.30	130	-
Westbound	Inside	7.70	135	-
Westbound	Inside	7.30	140	-
Westbound	Inside	6.70	135	-
Westbound	Centre	8.45	140	-
Westbound	Centre	7.95	140	-
Westbound	Centre	7.45	135	-
Westbound	Centre	6.95	135	-
Westbound	Outside	8.50	140	-
Westbound	Outside	8.00	135	131
Westbound	Outside	7.50	140	-
Westbound	Outside	7.00	140	140

APPENDIX B: HIGHWAY 7B ACP THICKNESS MEASUREMENTS				
Direction	Lane	Station (LKI)	Probe Thickness (mm)	Core Thickness (mm)
Westbound	Inside	8.0	175	-
Westbound	Inside	7.5	140	-
Westbound	Inside	7.0	150	-
Westbound	Inside	6.5	145	-
Westbound	Inside	6.0	140	-
Westbound	Inside	5.5	130	-
Westbound	Inside	5.0	135	-
Westbound	Inside	4.5	135	-
Westbound	Inside	4.0	115	-
Westbound	Inside	3.5	135	-
Westbound	Inside	3.0	125	-
Westbound	Inside	2.5	120	-
Westbound	Outside	8.0	170	-
Westbound	Outside	7.5	150	-
Westbound	Outside	7.0	145	-
Westbound	Outside	6.5	130	128
Westbound	Outside	6.0	145	-
Westbound	Outside	5.5	125	-
Westbound	Outside	5.0	120	-
Westbound	Outside	4.5	135	-
Westbound	Outside	4.0	90	80
Westbound	Outside	3.5	130	-
Westbound	Outside	3.0	130	-
Westbound	Outside	2.5	120	-
Eastbound	Inside	3.0	110	-
Eastbound	Inside	3.4	100	-
Eastbound	Inside	4.0	115	-
Eastbound	Inside	4.4	120	-
Eastbound	Inside	5.0	115	-
Eastbound	Inside	5.4	125	-
Eastbound	Inside	6.0	120	-
Eastbound	Inside	6.4	115	-
Eastbound	Inside	7.0	120	-
Eastbound	Inside	7.4	140	-
Eastbound	Inside	8.0	145	-
Eastbound	Outside	2.5	120	-
Eastbound	Outside	3.0	100	-
Eastbound	Outside	3.5	120	-
Eastbound	Outside	4.0	100	91
Eastbound	Outside	4.5	110	-
Eastbound	Outside	5.0	150	-
Eastbound	Outside	5.5	145	-
Eastbound	Outside	6.0	110	-
Eastbound	Outside	6.5	110	102
Eastbound	Outside	7.0	130	-
Eastbound	Outside	7.5	140	-
Eastbound	Outside	8.0	155	-

APPENDIX C

APPENDIX C FWD DATA

APPENDIX C: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Inside	6.65	40	1264	192	0
Eastbound	Inside	6.75	23	699	157	0
Eastbound	Inside	6.85	27	581	148	0
Eastbound	Inside	6.95	21	573	147	0
Eastbound	Inside	7.05	32	727	159	0
Eastbound	Inside	7.15	32	915	172	0
Eastbound	Inside	7.26	37	806	165	0
Eastbound	Inside	7.35	39	679	156	0
Eastbound	Inside	7.46	41	975	176	0
Eastbound	Inside	7.55	20	498	140	20
Eastbound	Inside	7.65	36	1086	182	0
Eastbound	Inside	7.75	32	696	157	0
Eastbound	Inside	7.85	28	686	156	0
Eastbound	Inside	7.95	29	795	164	0
Eastbound	Inside	8.06	28	957	175	0
Eastbound	Inside	8.15	36	1439	200	0
Eastbound	Inside	8.35	29	832	167	0
Eastbound	Inside	8.46	28	622	151	0
Eastbound	Inside	8.56	31	684	156	0
Eastbound	Centre	6.60	69	995	177	0
Eastbound	Centre	6.70	46	1038	179	0
Eastbound	Centre	6.80	32	943	174	0
Eastbound	Centre	6.90	31	747	161	0
Eastbound	Centre	7.00	32	723	159	0
Eastbound	Centre	7.10	32	605	150	0
Eastbound	Centre	7.20	32	716	159	0
Eastbound	Centre	7.30	41	919	172	0
Eastbound	Centre	7.41	32	777	163	0
Eastbound	Centre	7.50	31	892	171	0
Eastbound	Centre	7.60	37	1202	189	0
Eastbound	Centre	7.71	30	905	171	0
Eastbound	Centre	7.80	29	391	130	52
Eastbound	Centre	7.90	50	975	176	0

APPENDIX C: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Centre	8.00	61	860	169	0
Eastbound	Centre	8.10	51	755	161	0
Eastbound	Centre	8.20	53	861	169	0
Eastbound	Centre	8.30	50	739	160	0
Eastbound	Centre	8.40	59	789	164	0
Eastbound	Centre	8.51	63	948	174	0
Eastbound	Centre	8.60	45	862	169	0
Eastbound	Outside	6.60	57	763	162	0
Eastbound	Outside	6.65	52	637	153	0
Eastbound	Outside	6.71	56	762	162	0
Eastbound	Outside	6.75	63	397	130	0
Eastbound	Outside	6.80	42	598	149	0
Eastbound	Outside	6.85	48	638	153	0
Eastbound	Outside	6.90	39	524	143	5
Eastbound	Outside	6.96	43	507	141	0
Eastbound	Outside	7.00	52	715	159	0
Eastbound	Outside	7.05	44	512	142	0
Eastbound	Outside	7.10	41	604	150	0
Eastbound	Outside	7.15	46	780	163	0
Eastbound	Outside	7.20	48	684	156	0
Eastbound	Outside	7.25	48	723	159	0
Eastbound	Outside	7.30	45	800	165	0
Eastbound	Outside	7.35	48	772	163	0
Eastbound	Outside	7.40	44	405	131	20
Eastbound	Outside	7.45	45	483	139	0
Eastbound	Outside	7.50	42	557	146	0
Eastbound	Outside	7.57	36	729	160	0
Eastbound	Outside	7.65	51	454	136	0
Eastbound	Outside	7.70	44	529	143	0
Eastbound	Outside	7.75	62	800	165	0
Eastbound	Outside	7.80	49	778	163	0
Eastbound	Outside	7.85	58	653	154	0
Eastbound	Outside	7.90	54	694	157	0

APPENDIX C: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Outside	7.96	52	672	155	0
Eastbound	Outside	8.00	42	604	150	0
Eastbound	Outside	8.05	43	554	146	0
Eastbound	Outside	8.10	50	842	167	0
Eastbound	Outside	8.15	50	736	160	0
Eastbound	Outside	8.20	50	641	153	0
Eastbound	Outside	8.30	43	372	127	33
Eastbound	Outside	8.36	37	750	161	0
Eastbound	Outside	8.41	42	609	150	0
Eastbound	Outside	8.45	42	581	148	0
Eastbound	Outside	8.50	39	348	125	49
Eastbound	Outside	8.55	52	670	155	0
Eastbound	Outside	8.60	49	691	157	0
Eastbound	Outside	8.65	46	653	154	0
Westbound	Inside	6.60	22	1122	184	0
Westbound	Inside	6.70	22	1208	189	0
Westbound	Inside	6.80	23	1269	192	0
Westbound	Inside	6.90	21	799	165	0
Westbound	Inside	7.00	27	1346	196	0
Westbound	Inside	7.10	27	1144	185	0
Westbound	Inside	7.20	38	1363	197	0
Westbound	Inside	7.30	39	1697	211	0
Westbound	Inside	7.40	37	1290	193	0
Westbound	Inside	7.50	30	957	175	0
Westbound	Inside	7.60	58	1571	206	0
Westbound	Inside	7.70	32	1288	193	0
Westbound	Inside	7.80	66	1762	214	0
Westbound	Inside	7.90	28	942	174	0
Westbound	Inside	8.00	25	784	163	0
Westbound	Inside	8.10	23	986	176	0
Westbound	Inside	8.20	26	862	169	0
Westbound	Inside	8.30	29	962	175	0
Westbound	Inside	8.40	28	905	172	0

APPENDIX C: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Inside	8.50	27	1228	190	0
Westbound	Inside	8.60	20	595	149	0
Westbound	Centre	6.65	18	433	134	98
Westbound	Centre	6.75	15	415	132	125
Westbound	Centre	6.85	18	428	134	102
Westbound	Centre	6.95	17	566	147	75
Westbound	Centre	7.05	22	671	155	22
Westbound	Centre	7.15	21	516	142	61
Westbound	Centre	7.25	24	760	162	0
Westbound	Centre	7.35	24	724	159	1
Westbound	Centre	7.45	26	656	154	4
Westbound	Centre	7.55	15	340	124	147
Westbound	Centre	7.65	28	986	176	0
Westbound	Centre	7.75	23	466	137	61
Westbound	Centre	7.85	29	805	165	0
Westbound	Centre	7.95	22	631	152	27
Westbound	Centre	8.05	23	582	148	33
Westbound	Centre	8.15	19	708	158	30
Westbound	Centre	8.25	20	513	142	65
Westbound	Centre	8.35	19	803	165	12
Westbound	Centre	8.45	23	657	154	17
Westbound	Centre	8.60	21	596	149	40
Westbound	Outside	6.60	48	707	158	0
Westbound	Outside	6.65	43	784	163	0
Westbound	Outside	6.70	42	805	165	0
Westbound	Outside	6.75	40	682	156	0
Westbound	Outside	6.80	40	830	167	0
Westbound	Outside	6.85	41	855	168	0
Westbound	Outside	6.90	39	898	171	0
Westbound	Outside	6.94	42	874	169	0
Westbound	Outside	7.00	47	800	165	0
Westbound	Outside	7.05	48	744	161	0
Westbound	Outside	7.10	39	842	167	0

APPENDIX C: HIGHWAY 7 FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Outside	7.15	41	848	168	0
Westbound	Outside	7.20	45	880	170	0
Westbound	Outside	7.25	41	725	159	0
Westbound	Outside	7.30	44	799	164	0
Westbound	Outside	7.35	40	799	165	0
Westbound	Outside	7.40	45	777	163	0
Westbound	Outside	7.44	45	802	165	0
Westbound	Outside	7.50	43	870	169	0
Westbound	Outside	7.55	39	923	173	0
Westbound	Outside	7.65	40	862	169	0
Westbound	Outside	7.70	30	610	150	14
Westbound	Outside	7.75	39	783	163	0
Westbound	Outside	7.80	42	814	165	0
Westbound	Outside	7.85	49	840	167	0
Westbound	Outside	7.90	40	889	170	0
Westbound	Outside	7.95	45	780	163	0
Westbound	Outside	8.00	43	752	161	0
Westbound	Outside	8.05	39	850	168	0
Westbound	Outside	8.10	40	866	169	0
Westbound	Outside	8.15	38	774	163	0
Westbound	Outside	8.20	35	828	166	0
Westbound	Outside	8.25	42	770	162	0
Westbound	Outside	8.30	40	758	162	0
Westbound	Outside	8.35	41	817	166	0
Westbound	Outside	8.39	40	861	169	0
Westbound	Outside	8.45	39	800	165	0
Westbound	Outside	8.50	35	860	169	0
Westbound	Outside	8.53	36	431	134	36
Westbound	Outside	8.60	33	647	153	0
Westbound	Outside	8.65	28	707	158	4

APPENDIX C: HIGHWAY 7B FWD RESULTS						
Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Inside	2.60	28	334	115	89
Eastbound	Inside	2.80	75	365	118	0
Eastbound	Inside	3.01	90	446	126	0
Eastbound	Inside	3.17	50	424	124	1
Eastbound	Inside	3.40	153	606	140	0
Eastbound	Inside	3.50	60	512	132	0
Eastbound	Inside	3.60	64	483	130	0
Eastbound	Inside	3.80	70	514	133	0
Eastbound	Inside	4.00	81	379	120	0
Eastbound	Inside	4.20	90	423	124	0
Eastbound	Inside	4.40	111	544	135	0
Eastbound	Inside	4.60	111	569	137	0
Eastbound	Inside	4.80	70	695	147	0
Eastbound	Inside	5.01	51	448	127	0
Eastbound	Inside	5.20	86	531	134	0
Eastbound	Inside	5.39	49	426	124	4
Eastbound	Inside	5.60	48	424	124	6
Eastbound	Inside	5.80	75	597	139	0
Eastbound	Inside	6.01	32	410	123	54
Eastbound	Inside	6.20	64	567	137	0
Eastbound	Inside	6.40	56	1457	188	0
Eastbound	Inside	6.60	38	481	130	18
Eastbound	Inside	6.80	32	491	131	34
Eastbound	Inside	7.00	45	548	135	0
Eastbound	Inside	7.20	43	1678	197	0
Eastbound	Inside	7.40	34	602	140	6
Eastbound	Inside	7.63	34	802	154	0
Eastbound	Inside	7.80	28	497	131	47
Eastbound	Inside	8.00	34	563	137	12
Eastbound	Outside	2.50	81	505	132	0
Eastbound	Outside	2.55	52	603	140	0
Eastbound	Outside	2.60	40	446	126	47
Eastbound	Outside	2.65	35	416	124	69
Eastbound	Outside	2.70	74	412	123	0

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Outside	2.75	101	478	129	0
Eastbound	Outside	2.80	53	372	119	35
Eastbound	Outside	2.85	97	371	119	0
Eastbound	Outside	2.91	91	403	122	0
Eastbound	Outside	2.95	93	453	127	0
Eastbound	Outside	3.00	115	345	116	0
Eastbound	Outside	3.05	92	483	130	0
Eastbound	Outside	3.10	69	486	130	0
Eastbound	Outside	3.15	61	512	132	0
Eastbound	Outside	3.21	72	395	121	0
Eastbound	Outside	3.25	93	418	124	0
Eastbound	Outside	3.30	86	418	124	0
Eastbound	Outside	3.35	138	597	139	0
Eastbound	Outside	3.40	116	393	121	0
Eastbound	Outside	3.45	81	603	140	0
Eastbound	Outside	3.50	82	453	127	0
Eastbound	Outside	3.55	96	383	120	0
Eastbound	Outside	3.60	90	412	123	0
Eastbound	Outside	3.65	76	308	112	16
Eastbound	Outside	3.70	77	552	136	0
Eastbound	Outside	3.75	68	372	119	9
Eastbound	Outside	3.80	69	434	125	0
Eastbound	Outside	3.86	82	417	124	0
Eastbound	Outside	3.90	92	402	122	0
Eastbound	Outside	3.95	108	489	130	0
Eastbound	Outside	4.00	81	363	118	0
Eastbound	Outside	4.05	88	451	127	0
Eastbound	Outside	4.10	63	400	122	9
Eastbound	Outside	4.15	78	401	122	0
Eastbound	Outside	4.20	105	438	126	0
Eastbound	Outside	4.25	91	482	130	0
Eastbound	Outside	4.30	70	514	133	0
Eastbound	Outside	4.35	67	517	133	0
Eastbound	Outside	4.40	96	488	130	0

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APPENDIX C: HIGHWAY 7B FWD RESULTS						
Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Outside	4.45	71	475	129	0
Eastbound	Outside	4.50	90	514	133	0
Eastbound	Outside	4.55	59	513	132	0
Eastbound	Outside	4.60	139	606	140	0
Eastbound	Outside	4.65	85	527	134	0
Eastbound	Outside	4.70	51	499	131	8
Eastbound	Outside	4.75	48	488	130	18
Eastbound	Outside	4.80	61	466	128	0
Eastbound	Outside	4.90	128	665	144	0
Eastbound	Outside	4.95	59	457	127	3
Eastbound	Outside	5.00	53	467	128	12
Eastbound	Outside	5.10	84	487	130	0
Eastbound	Outside	5.16	92	448	127	0
Eastbound	Outside	5.20	99	501	131	0
Eastbound	Outside	5.30	97	487	130	0
Eastbound	Outside	5.35	63	438	126	0
Eastbound	Outside	5.40	36	317	113	94
Eastbound	Outside	5.50	40	370	119	66
Eastbound	Outside	5.55	51	395	121	33
Eastbound	Outside	5.60	36	338	115	87
Eastbound	Outside	5.65	46	266	106	81
Eastbound	Outside	5.75	67	478	129	0
Eastbound	Outside	5.81	83	466	128	0
Eastbound	Outside	5.90	59	502	131	0
Eastbound	Outside	5.95	49	635	142	0
Eastbound	Outside	6.00	31	340	115	106
Eastbound	Outside	6.05	34	403	122	76
Eastbound	Outside	6.15	34	393	121	79
Eastbound	Outside	6.20	53	457	127	15
Eastbound	Outside	6.30	30	314	112	117
Eastbound	Outside	6.35	28	241	103	150
Eastbound	Outside	6.40	35	883	159	0
Eastbound	Outside	6.50	29	431	125	89
Eastbound	Outside	6.55	29	482	130	79

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Eastbound	Outside	6.60	32	481	130	64
Eastbound	Outside	6.70	28	364	118	110
Eastbound	Outside	6.75	28	358	117	112
Eastbound	Outside	6.80	35	455	127	60
Eastbound	Outside	6.85	33	505	132	57
Eastbound	Outside	6.90	30	369	119	100
Eastbound	Outside	6.95	34	474	129	60
Eastbound	Outside	7.00	29	369	119	106
Eastbound	Outside	7.05	33	475	129	63
Eastbound	Outside	7.10	30	465	128	75
Eastbound	Outside	7.15	27	469	129	90
Eastbound	Outside	7.20	28	552	136	67
Eastbound	Outside	7.25	28	447	127	92
Eastbound	Outside	7.30	31	488	130	69
Eastbound	Outside	7.35	35	608	140	30
Eastbound	Outside	7.41	28	406	122	100
Eastbound	Outside	7.50	29	549	136	64
Eastbound	Outside	7.55	32	536	134	55
Eastbound	Outside	7.60	28	474	129	84
Eastbound	Outside	7.70	27	472	129	86
Eastbound	Outside	7.75	33	640	143	29
Eastbound	Outside	7.80	32	488	130	65
Eastbound	Outside	7.90	26	435	125	101
Eastbound	Outside	7.95	36	626	142	23
Eastbound	Outside	8.00	40	609	140	12
Eastbound	Outside	8.10	93	666	145	0
Westbound	Inside	2.50	61	527	134	0
Westbound	Inside	2.60	33	386	120	56
Westbound	Inside	2.70	70	457	127	0
Westbound	Inside	2.80	99	319	113	0
Westbound	Inside	2.90	81	420	124	0
Westbound	Inside	3.00	123	499	131	0
Westbound	Inside	3.10	60	548	135	0
Westbound	Inside	3.20	89	387	121	0

APPENDIX C: HIGHWAY 7B FWD RESULTS						
Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Inside	3.30	93	425	124	0
Westbound	Inside	3.40	74	516	133	0
Westbound	Inside	3.50	65	486	130	0
Westbound	Inside	3.60	63	561	136	0
Westbound	Inside	3.70	70	557	136	0
Westbound	Inside	3.80	65	486	130	0
Westbound	Inside	3.90	90	448	127	0
Westbound	Inside	4.00	81	362	118	0
Westbound	Inside	4.10	53	490	130	0
Westbound	Inside	4.20	139	566	137	0
Westbound	Inside	4.30	56	525	133	0
Westbound	Inside	4.40	106	410	123	0
Westbound	Inside	4.50	112	524	133	0
Westbound	Inside	4.60	207	627	142	0
Westbound	Inside	4.70	53	613	141	0
Westbound	Inside	4.80	62	669	145	0
Westbound	Inside	4.90	65	458	128	0
Westbound	Inside	5.00	102	397	122	0
Westbound	Inside	5.09	75	461	128	0
Westbound	Inside	5.20	75	520	133	0
Westbound	Inside	5.30	68	491	131	0
Westbound	Inside	5.40	34	304	111	76
Westbound	Inside	5.50	68	472	129	0
Westbound	Inside	5.60	108	478	129	0
Westbound	Inside	5.70	73	436	125	0
Westbound	Inside	5.80	58	570	137	0
Westbound	Inside	5.90	45	479	129	0
Westbound	Inside	6.00	50	495	131	0
Westbound	Inside	6.10	47	678	145	0
Westbound	Inside	6.20	81	632	142	0
Westbound	Inside	6.30	30	397	122	65
Westbound	Inside	6.40	63	1989	208	0
Westbound	Inside	6.50	45	1502	189	0
Westbound	Inside	6.60	42	736	149	0

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Inside	6.70	36	679	145	0
Westbound	Inside	6.80	37	690	146	0
Westbound	Inside	6.90	46	799	154	0
Westbound	Inside	7.00	35	583	138	6
Westbound	Inside	7.10	39	736	149	0
Westbound	Inside	7.20	39	820	155	0
Westbound	Inside	7.30	42	761	151	0
Westbound	Inside	7.40	33	588	139	11
Westbound	Inside	7.50	47	1257	179	0
Westbound	Inside	7.60	50	1664	196	0
Westbound	Inside	7.70	35	494	131	25
Westbound	Inside	7.80	26	480	130	60
Westbound	Inside	7.90	38	705	147	0
Westbound	Inside	8.00	65	761	151	0
Westbound	Inside	8.10	63	857	157	0
Westbound	Outside	2.45	74	462	128	0
Westbound	Outside	2.50	41	447	127	44
Westbound	Outside	2.55	35	404	122	73
Westbound	Outside	2.60	33	378	120	87
Westbound	Outside	2.65	60	333	115	32
Westbound	Outside	2.70	97	361	118	0
Westbound	Outside	2.75	116	410	123	0
Westbound	Outside	2.80	120	409	123	0
Westbound	Outside	2.85	83	407	123	0
Westbound	Outside	2.90	89	447	127	0
Westbound	Outside	2.95	120	518	133	0
Westbound	Outside	3.00	91	538	135	0
Westbound	Outside	3.05	82	615	141	0
Westbound	Outside	3.10	62	521	133	0
Westbound	Outside	3.15	59	459	128	3
Westbound	Outside	3.20	76	380	120	0
Westbound	Outside	3.25	109	457	127	0
Westbound	Outside	3.30	103	437	126	0
Westbound	Outside	3.35	86	559	136	0

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Outside	3.40	75	564	137	0
Westbound	Outside	3.45	80	458	128	0
Westbound	Outside	3.50	49	170	92	112
Westbound	Outside	3.55	55	419	124	20
Westbound	Outside	3.60	56	554	136	0
Westbound	Outside	3.65	62	494	131	0
Westbound	Outside	3.70	56	574	137	0
Westbound	Outside	3.75	56	626	142	0
Westbound	Outside	3.80	90	515	133	0
Westbound	Outside	3.85	91	460	128	0
Westbound	Outside	3.90	84	407	123	0
Westbound	Outside	3.95	83	431	125	0
Westbound	Outside	4.00	71	363	118	6
Westbound	Outside	4.05	54	476	129	8
Westbound	Outside	4.10	46	375	119	49
Westbound	Outside	4.15	77	373	119	0
Westbound	Outside	4.20	106	684	146	0
Westbound	Outside	4.25	124	571	137	0
Westbound	Outside	4.30	62	567	137	0
Westbound	Outside	4.35	126	495	131	0
Westbound	Outside	4.40	114	433	125	0
Westbound	Outside	4.45	82	499	131	0
Westbound	Outside	4.50	94	477	129	0
Westbound	Outside	4.55	70	616	141	0
Westbound	Outside	4.60	95	498	131	0
Westbound	Outside	4.65	62	645	143	0
Westbound	Outside	4.70	49	563	137	0
Westbound	Outside	4.75	50	494	131	13
Westbound	Outside	4.80	64	554	136	0
Westbound	Outside	4.85	74	621	141	0
Westbound	Outside	4.90	97	622	141	0
Westbound	Outside	4.95	59	495	131	0
Westbound	Outside	5.00	93	409	123	0
Westbound	Outside	5.05	96	467	128	0

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Outside	5.10	112	450	127	0
Westbound	Outside	5.15	96	412	123	0
Westbound	Outside	5.20	84	426	124	0
Westbound	Outside	5.25	65	380	120	11
Westbound	Outside	5.30	69	458	128	0
Westbound	Outside	5.35	53	563	137	0
Westbound	Outside	5.40	36	376	119	78
Westbound	Outside	5.45	64	438	126	0
Westbound	Outside	5.50	60	331	114	33
Westbound	Outside	5.55	72	364	118	5
Westbound	Outside	5.60	93	436	125	0
Westbound	Outside	5.65	80	408	123	0
Westbound	Outside	5.70	76	417	124	0
Westbound	Outside	5.75	61	476	129	0
Westbound	Outside	5.80	51	483	130	12
Westbound	Outside	5.85	57	462	128	5
Westbound	Outside	5.90	39	457	127	48
Westbound	Outside	5.94	39	483	130	41
Westbound	Outside	6.00	47	487	130	19
Westbound	Outside	6.05	46	349	117	57
Westbound	Outside	6.10	49	536	134	5
Westbound	Outside	6.15	69	440	126	0
Westbound	Outside	6.20	74	550	136	0
Westbound	Outside	6.25	30	376	119	99
Westbound	Outside	6.30	27	465	128	88
Westbound	Outside	6.35	41	1155	174	0
Westbound	Outside	6.40	53	2249	217	0
Westbound	Outside	6.45	34	655	144	24
Westbound	Outside	6.50	33	599	139	36
Westbound	Outside	6.55	33	532	134	51
Westbound	Outside	6.60	36	593	139	29
Westbound	Outside	6.65	37	660	144	11
Westbound	Outside	6.70	34	615	141	31
Westbound	Outside	6.75	35	479	129	56

APPENDIX C: HIGHWAY 7B FWD RESULTS

Direction	Lane	LKI Station (km)	Subgrade Modulus, Mr (MPa)	Pavement Modulus, Ep (MPa)	Existing Structural Number (mm)	Strengthening Requirement (mm)
Westbound	Outside	6.80	36	591	139	30
Westbound	Outside	6.85	31	475	129	72
Westbound	Outside	6.90	30	650	143	38
Westbound	Outside	6.95	38	652	143	10
Westbound	Outside	7.00	38	638	142	14
Westbound	Outside	7.05	39	713	148	0
Westbound	Outside	7.10	36	624	141	21
Westbound	Outside	7.15	36	669	145	13
Westbound	Outside	7.20	37	662	144	12
Westbound	Outside	7.25	38	647	143	12
Westbound	Outside	7.30	36	668	145	13
Westbound	Outside	7.35	41	688	146	0
Westbound	Outside	7.40	39	643	143	10
Westbound	Outside	7.45	44	715	148	0
Westbound	Outside	7.50	38	688	146	4
Westbound	Outside	7.60	31	542	135	54
Westbound	Outside	7.65	33	613	141	35
Westbound	Outside	7.70	39	707	147	0
Westbound	Outside	7.74	36	584	138	29
Westbound	Outside	7.80	37	616	141	22
Westbound	Outside	7.85	32	497	131	63
Westbound	Outside	7.90	33	587	139	40
Westbound	Outside	7.95	37	635	142	17
Westbound	Outside	8.00	70	645	143	0
Westbound	Outside	8.05	72	742	150	0
Westbound	Outside	8.10	85	852	157	0

APPENDIX D

APPENDIX D HIGHWAY 7B STRENGTHENING REQUIREMENTS "SPIKES"

APPENDIX D: HIGHWAY 7B STRENGTHENING REQUIREMENT "SPIKES"			
Direction	Lane	LKI Station (km)	Strengthening Requirement (mm)
Eastbound	Inside	2.60	89
Eastbound	Inside	6.01	54
Eastbound	Inside	6.80	34
Eastbound	Inside	7.80	47
Eastbound	Outside	2.60	47
Eastbound	Outside	2.65	69
Eastbound	Outside	2.80	35
Eastbound	Outside	5.40	94
Eastbound	Outside	5.50	66
Eastbound	Outside	5.55	33
Eastbound	Outside	5.60	87
Eastbound	Outside	5.65	81
Eastbound	Outside	6.00	106
Eastbound	Outside	6.05	76
Eastbound	Outside	6.15	79
Eastbound	Outside	6.30	117
Eastbound	Outside	6.35	150
Eastbound	Outside	6.50	89
Eastbound	Outside	6.55	79
Eastbound	Outside	6.60	64
Eastbound	Outside	6.70	110
Eastbound	Outside	6.75	112
Eastbound	Outside	6.80	60
Eastbound	Outside	6.85	57
Eastbound	Outside	6.90	100
Eastbound	Outside	6.95	60
Eastbound	Outside	7.00	106
Eastbound	Outside	7.05	63
Eastbound	Outside	7.10	75
Eastbound	Outside	7.15	90
Eastbound	Outside	7.20	67
Eastbound	Outside	7.25	92
Eastbound	Outside	7.30	69
Eastbound	Outside	7.35	30
Eastbound	Outside	7.41	100
Eastbound	Outside	7.50	64
Eastbound	Outside	7.55	55
Eastbound	Outside	7.60	84
Eastbound	Outside	7.70	86
Eastbound	Outside	7.75	29
Eastbound	Outside	7.80	65
Eastbound	Outside	7.90	101
Westbound	Inside	2.60	56
Westbound	Inside	5.40	76
Westbound	Inside	6.30	65
Westbound	Inside	7.80	60
Westbound	Outside	2.50	44
Westbound	Outside	2.55	73
Westbound	Outside	2.60	87

APPENDIX D: HIGHWAY 7B STRENGTHENING REQUIREMENT "SPIKES"			
Direction	Lane	LKI Station (km)	Strengthening Requirement (mm)
Westbound	Outside	2.65	32
Westbound	Outside	3.50	112
Westbound	Outside	4.10	49
Westbound	Outside	5.40	78
Westbound	Outside	5.50	33
Westbound	Outside	5.90	48
Westbound	Outside	5.94	41
Westbound	Outside	6.05	57
Westbound	Outside	6.25	99
Westbound	Outside	6.30	88
Westbound	Outside	6.50	36
Westbound	Outside	6.55	51
Westbound	Outside	6.60	29
Westbound	Outside	6.70	31
Westbound	Outside	6.75	56
Westbound	Outside	6.80	30
Westbound	Outside	6.85	72
Westbound	Outside	6.90	38
Westbound	Outside	7.60	54
Westbound	Outside	7.65	35
Westbound	Outside	7.74	29
Westbound	Outside	7.85	63
Westbound	Outside	7.90	40