COMMONWEALTH of VIRGINIA
DEPARTMENT OF TRANSPORTATION
PO BOX 3071
SALEM, VA 24153-0560

DAVID S. EKERN, P.E.
COMMISSIONER

July 15, 2009

MEMORANDUM

TO: Tim Dowdy, VDOT Project Manager

SUBJECT: Preliminary Pavement Design
0114-154-101 UPC: 8746
Peppers Ferry Road Widening and Improvements
Proposed Location for Improvements – Sta. 2+99.08 to Sta. 18+30.00
From: Int. with Route 460 Business
To: 0.9 mi. S. of Int. with Route 460 Business
Montgomery County – Town of Christiansburg

Provided in this memorandum are the preliminary pavement design recommendations for the above referenced project. These recommendations were based upon traffic records and subsurface soil information retrieved from the previous soil survey investigations, including the soil survey for the adjacent Peppers Ferry Road project (0114-154-103, UPC: 71586).

Section 1: Project Information
The purpose of this project, as understood at the time of the writing of this report, is to widen and improve Peppers Ferry Road (Rt. 114) from the intersection of Route 460 Business to the limits of the adjacent Peppers Ferry Road widening project (0114-154-103, UPC: 71586).

Section 2: Objective
The primary objective of this report is to develop preliminary pavement design recommendations for the subject project.

Section 3: Existing Pavement Information
The majority of this project follows the existing alignment of Rt. 114. However, in order to consider utilization of existing pavement, it would first be necessary to core the pavement as well as analyze the current condition of the existing pavement structure.

Based on limited visual observations it appears that utilization of the existing pavement may be possible if the proposed grade is higher than the existing grade. A test pit that was dug for the adjacent Peppers Ferry Road project (0114-154-103, UPC: 71586) showed 6-inches of existing asphalt as well as 10-inches of No. 1 sized aggregate subgrade stabilization. It is possible that a similar existing pavement structure would be found for this project; however, it is also possible that the existing pavement on this project is highly variable as the Rt. 114 and Rt. 460 Business intersection has undergone numerous changes over the years due to the amount of commercial development around the intersection. For preliminary consideration purposes, if it is not possible for the proposed grade to be at least 3.5-inches higher than the existing grade, utilization of the existing pavement should not be considered as an option. If it is possible for the proposed grade to be 3.5-inches or higher than the existing grade a more in-depth existing pavement condition analysis can be performed.

Section 4: Soils Summary

There are four CBR sample reports on file for the Peppers Ferry Road projects that were collected and tested during previous soil investigations. Only one of the four CBR samples came from within this project's limits. That sample was tested on 6/25/1990 and was classified as a silty clay (ML) with a CBR value of 7.0, a liquid limit (LL) of 49 and a plasticity index (PI) of 23. The other three samples were classified as high plasticity silts (MH) with LL greater than 50, PI greater than 20 and natural moisture contents well above 30% greater than optimum. Despite the before mentioned poor soil indicators (LL, PI, Natural Moisture, etc.) all four samples had relatively high CBR values. While not determined as of yet, it is assumed that the subgrade will more than likely be stabilized as it was for the adjacent Peppers Ferry Road project (0114-154-103, UPC: 71586). With that said, given the information currently available the following calculations and considerations were made for the existing subgrade:

<u>MH Descriptive Statistics</u>
Average CBR = 9.1
85th Percentile = 8.1
Standard Deviation = 1.40
Coeff. of Variation = 15.5%

Resilient Modulus, Mr = 8,700 psi

Section 5: Traffic Analysis Summary

For this project traffic data was retrieved from the following publications:

"2007 VDOT Daily Traffic Volume Estimates Including Vehicle Classification Estimates"
"2004 VDOT Daily Traffic Volume Estimates Including Vehicle Classification Estimates"
"1995 Commonwealth of Virginia Department of Transportation Average Daily Traffic Volumes"
"1985 Commonwealth of Virginia Department of Highways and Transportation Average Daily Traffic Volumes"
"1975 Commonwealth of Virginia Department of Highways and Transportation Average Daily Traffic Volumes"

A summary of the traffic data retrieved from each publication is as follows:

Rt. 114 Historic Traffic Data

	1975	1985	1995	2004	2007
ADT	7,510	10,635	11,000	13,000	13,000
Tractor Trailer %	0.7	0.6	NA	1.0	1.0
Single Unit %	4.6	3.4	NA	1.0	2.0
Direction %	50	50	50	57	58

5.A Traffic Data Inputs

Using the information provided from the mentioned traffic publications, the following summarized traffic data inputs were developed for pavement design purposes:

Traffic Data Inputs for Pavement Design

Year	2010
Average Daily Traffic (ADT)	13,800
Traffic Growth Rate	2.0%
Design Lane Factor	90%
Directional Split	58%
Percent Trailer Trucks	1.0%
Percent Single Unit Trucks	2.0%
ESAL Factor for Trailer Trucks	1.28
ESAL Factor for Single Unit Trucks	0.37
ESAL Factor for Passenger Cars	0.0002

The ADT given in the table above is a projection of the 2007 ADT to 2010 using the given growth rate. This growth rate was selected by comparing the growth rates calculated from year to year using the publicized traffic data. It appears that early in its history, Rt. 114 had growth rates on the order of approximately 3.5% per year; however, as of recent years growth rates have dropped to less than 1.0% per year. Therefore, a growth rate of 2.0% was selected for this analysis.

5.B Cumulative Truck Traffic Computations (ESALs)

Design Equivalent Single Axle Loads (ESALs) were developed using the traffic data inputs assuming a 30-year design life:

Design ESALs	2,152,214

Section 6: Preliminary Pavement Design Recommendations

Using the information obtained from the soil analysis and the traffic analysis as summarized in Sections 4 and 5 respectively, the following preliminary pavement design recommendations were developed using the 1993 AASHTO Guide for the Design of Pavement Structures. The preliminary pavement design recommendation for the Rt. 114 mainline should be used for all turn lanes, connections and side roads as well.

Rt. 114 Mainline Preliminary Pavement Design Recommendations
Surface: 1.5” (165 lbs/sy) Asphalt Concrete, Type SM-9.5D
Intermediate: 2.0” (220 lbs/sy) Asphalt Concrete, Type IM-19.0D
Base: 4.0” Asphalt Concrete, Type BM-25.0A
Subbase: 8.0” Graded Aggregate, Type I, 21-B

As mentioned, the pavement design recommendation provided in this report should be considered preliminary and subject to change. When updated soil and traffic information is made available the provided design will be reanalyzed for adequacy. If subgrade stabilization (No. 1 stone) is not recommended or used for this project as it was for the adjacent Peppers Ferry Road project the preliminary pavement design given could change quite significantly dependent upon the outcome of an updated analysis.

David T. Lee, P.E.
Salem District Materials Engineer

Travis S. Higgs, P.E.
Salem District Pavement Design

Attachment

Pavement Design Calculation Worksheet

1993 AASHTO Pavement Design

DARWin™ Pavement Design System

A Proprietary AASHTOWARE™
Computer Software Product

Flexible Structural Design Module

0114-154-101 (UPC: 8746)
Montgomery County - Town of Christiansburg
Route 114 - Pepper's Ferry Road
30-year Design

Flexible Structural Design Module Data

18-kip ESALs Over Initial Period:	2,152,214
Initial Serviceability:	4.2
Terminal Serviceability:	2.9
Reliability Level (%):	90
Overall Standard Deviation:	0.49
Roadbed Soil Resilient Modulus (PSI):	8,700
Stage Construction:	1
Calculated Design Structural Number (SN):	***4.05***

Specified Layer Design

Layer	Material	Str. Coeff.	Dra. Coeff.	Thickness	Application	Calc. SN
1	SM-9.5 mm D	0.44	1	1.5"	165 lbs/sy	0.66
2	IM-19.0 mm D	0.44	1	2.0'	220 lbs/sy	0.88
3	BM-25.0 mm A	0.4	1	4"	-	1.60
4	Graded Agg. 21-B	0.12	1	8"	-	0.96
TOTAL	-	-	-	15.5"	-	4.10

Simple ESAL Calculation

Performance Period (years):	30
Two-Way Daily Traffic (AADT):	13,800
Heavy Vehicle % (FHWA Class 5 or greater:	3
Number of Lanes in Design Direction:	2
Percent of Trucks in Design Direction:	58
Percent of Trucks in Design Lane:	90
Avg. Initial Truck Factor (ESALs/Heavy Veh):	0.673
Annual Traffic Growth Rate (%):	2
Total Calculated Cumulative ESALs:	***2,152,214***