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February 3, 2016

Mr. Terry Maier, President  
Team Laboratory Chemical Corp.  
28650 State Highway 34  
Detroit Lakes, MN 56501

RE: Base One Stabilized Base  
Pope County, Minnesota  
AET Project No. 28-00960

Dear Mr. Maier:

We are submitting this letter report of the pavement analysis we performed on the county roads with reclaimed bituminous/aggregate base stabilized with Base One, located in Pope County, Minnesota.

## **1.0 BACKGROUND**

Team Lab's Base One stabilization system is a highly concentrated and environmental friendly liquid product that improves the pavement strength at low cost. Stabilization is now affordable option that can be considered whenever aggregate and/or reclaimed bituminous are being processed and compacted for load bearing bases.

In the green road rating system, 1-5 credit points are assigned to the pavement reuse, 50-90% of existing pavement materials by estimated volume. In place aggregate and/or reclaimed bituminous stabilized with Base One can produce up to 100% reuse of the in-place pavement materials, thereby having all the five credit points.

To evaluate the strength of a pavement base layer stabilized with Base One, the non-destructive tests, Falling Weight Deflectometer (FWD) and Ground Penetrating Radar (GPR) were used in the field. The FWD equipment is capable of simultaneously providing Resilient Modulus measurement of the stabilized base layer in a non-destructive manner while testing the performance of many miles of road in a single day. The FWD produces a force impulse through the layers which closely simulates a moving wheel load and it provides a means to determine the equivalency of various materials in relation to their ability to support dynamic or repetitive loading. The GPR equipment is capable of measuring the pavement layer thickness in a highway speed and minimizing the errors in backcalculating the Resilient Modulus from FWD data.

**2.0 RESULTS**

A 4.3 mile section of CSAH 28 from CR 79 to TH 55 in the south of Farwell, Pope County was selected for FWD testing in summer of 2011 and late spring of 2015. The section was a MnDOT research section for the stabilized reclaimed base. FWD testing was performed on a 1,900 foot section by MnDOT at 100’ interval in May, June, July, and October of 2010.

The new pavement was designed as a 7-ton road (G.E.=18.9) and consisted of 3.5” Superpave hot asphalt mix over 8” aggregate and reclaimed asphalt blend with top 4” stabilized with Base One. The results are shown in the following table. It was noted that the previous 7-day accumulated rainfall was 0.16 inches and 0 inches prior to the 2011 fall testing and 2015 spring testing, respectively. The results are shown in the following table.

Roadway	Termini		Test Time		EGE		Spring Load Capacity	
	From	To	Season	Year	15th	AVG.	15th	AVG.
CSAH 28	CR 79	TH 55	Fall	2011	18.5	20.5	11.6	12.8
			Spring	2015	20.8	22.9	11.1	12.7

The 3.5 miles long project on CSAH 28 from TH 29 to CSAH 15 in the north of Glenwood, Pope County was selected for FWD and GPR testing in summer of 2011 to verify the MnDOT results and for FWD testing in late spring of 2015. The new pavement was designed as a 9-ton road (G.E.=23.4) and consisted of 3.5” Superpave hot asphalt mix over 8” aggregate and reclaimed asphalt blend with top 4” stabilized with Base One. The results are shown in the following table.

Roadway	Termini		Test Time		EGE		Spring Load Capacity	
	From	To	Season	Year	15th	AVG.	15th	AVG.
CSAH 28	TH 29	CSAH 15	Fall	2011	23.0	25.8	14.4	16.8
			Spring	2015	20.0	21.5	12.8	14.6

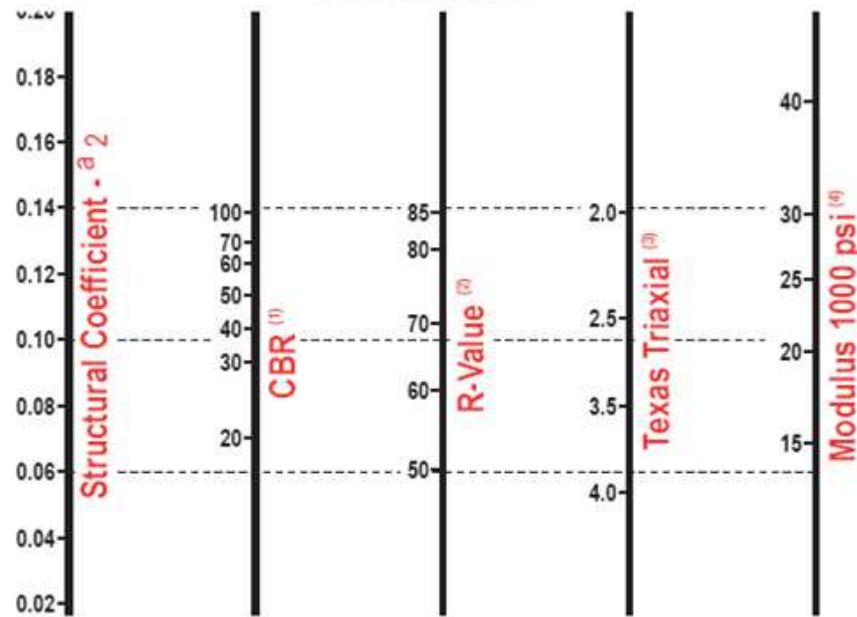
The FWD results for Pope County showed the improvement in strength (Resilient Modulus) of the reclaimed base layer stabilized with Base One, from the range of 81,000 to 102,000 psi in late spring to the range of 90,000 to 147,000 psi in fall. The FWD and GPR results from both sections of CSAH 28 showed the ultimate strength of the base layer stabilized with Base One reached 147, 000 psi for the reclaimed base (blend) in fall.

Using the following comparative chart provided by the American Association of State Highway Transportation Officials (AASHTO) for correlation with other standard index tests for additional perspective, the FWD testing demonstrated that the stabilized base was significantly stronger than 30,000 psi, a Resilient Modulus value that correlates with a CBR of 100, and an R-Value of 85.

The measurements from this group of three test values are representative of high quality crushed aggregate base materials (MnDOT Class 5), so the higher moduli of the reclaimed material stabilized with the Base One (147,000 psi, or 4.9 times the referenced 30,000 psi strength) in fall and the aggregate stabilized with Base One (102,000 psi, or 3.4 times the referenced 30,000 psi strength) in late spring demonstrate in materials engineering measurements how this advanced broad spectrum stabilization technology is producing an entirely new level of field performance and solving problems previously unaddressed. The stabilized reclaimed county road system at Pope County provides an excellent example.

The FWD results from all the test sections showed a 10 ton road and much improved G.E as compared to the design G.E.

### AASHTO Guide for Design of Pavement Structures Base Course



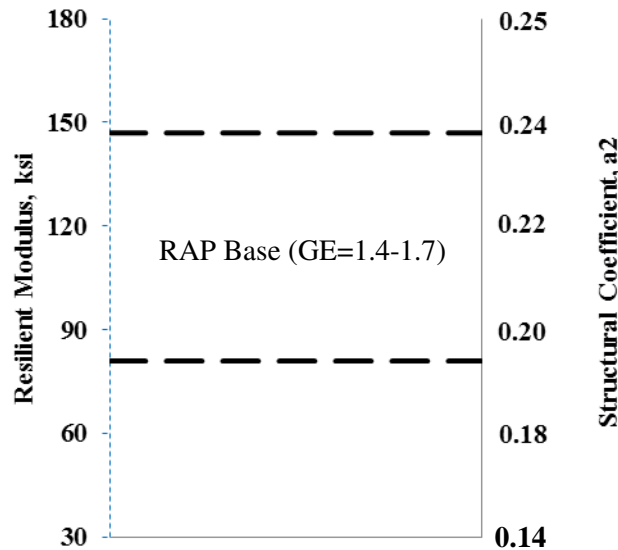
(1) Scale derived by averaging correlations obtained from Illinois.  
 (2) Scale derived by averaging correlations obtained from California, New Mexico and Wyoming.  
 (3) Scale derived by averaging correlations obtained from Texas  
 (4) Scale derived on NCHRP project (3)

The national referenced base modulus is for the ideal crushed aggregate base materials and higher than the base material available locally. In Minnesota, the high quality crushed aggregate base has the modulus of 27, 000 psi in fall, 9,700 psi in early spring and 22,700 psi in late spring, respectively. The comparison of the lowest average base modulus of two sections to that of the MnDOT referenced base modulus in late spring showed a 1.5 equivalency factor.

### 3.0 CONCLUSIONS

In summary of stabilized county roads projects in Pope County in Minnesota, the Base system stabilization technology is facilitating sustainable construction of better performing roads at far lower cost than possible with conventional road construction product. Reduction in the overall environmental impacts and financial burdens on taxpayer makes Base One as a favorable option in pavement reuse.

Values of back calculated (from field FWD testing) resilient moduli typically fall within a range of from 81 ksi and 147 ksi in late spring and fall. This is considered structurally effective in terms of stress distribution but yet not so stiff as to induce excessive shrinkage cracking distress. The estimated granular equivalency per inch under test conditions ranges from 1.4 to 1.7 for Base One stabilized RAP and aggregate base in late spring and fall.



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Sincerely,  
**American Engineering Testing, Inc.**



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**I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota**

**Date: 2/3/2016 License #: 22493**

Peer Review by:



David L. Rettner, PE  
President/Principal Engineer