January 15, 2010

Dr. Paul R. Lowe; Assistant Vice President for Research
Kansas State University
2 Fairchild Hall
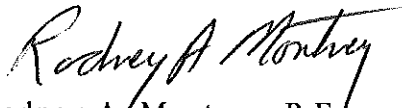Manhattan, Kansas 66506-5103

Dear Mr. Lowe:

We have enclosed an executed copy of a contract coversheet for the following project:

    C1435 KSU (RE-0361-01; TPF-5(079)) "Implementation of the 2002 AASHTO Design Guide for Pavement Structures."

Sincerely,

Richard E. Kreider Jr., P.E., Bureau Chief
Materials and Research

Rodney A. Montney, P.E.
Engineer of Research

c: Mustaque Hossain, Ph.D., Department of Civil Engineering, KSU (w/a)
    Steve Foust, Asst. P&R Engineer, FHWA (w/a)
    Pam Anderson, Bureau of Fiscal Services (w/a)
    Susie Lovelady, Bureau of Program and Project Management (w/a)
    Greg Schieber, P.E., Bureau of Materials and Research (w/a)
    Susan Barker, P.E., Bureau of Materials and Research (w/a)
    Becky Welsh, Bureau of Materials and Research (w/a)
    Darleen Bernhardt, Bureau of Materials and Research (w/a)

CONTRACT COVER SHEET

Agency No.	Div. No.	Current Document Number
276		A1001435

Document Date:	12/11/09 Effective Date:		Agy Contract No. C1435

Vendor Information	Contracting Agency Name & Address

Vendor Information

No/Sfx   367010000   05

Name   Kansas State University

            Associate Vice Provost for Research

Street   2 Fairchild Hall

City, State   Manhattan, KS 66506-1103

& Zip

Contracting Agency Name & Address

Kansas Department of Transporation

Bureau of Materials and Research

2300 S. W. Van Buren

Topeka, Kansas 66611

Sfx	T/C	Ref. Doc.	Sfx	M	Fund	BFY	Index	PCA	Sub-obj	Det	R	Amount	Agency Use
01	864				4100	10	0555	99170	2790			200,000.00	009

Document Total
$ 200,000.00

CONTRACT TYPE:

☐ New Contract

☒ Amended Contract Terms

☐ Re-encumber Previously Approved Contract

PRIOR DOC. NO.

A0901435

CONTRACT DESCRIPTION: KSU (RE-0361-01) TPF-5(079) "Implementation of the 2002 AASHTO Design Guide for Pavement Structures." Increase of funds and extension of time.

Legal Basis for Contract (Cite state or federal statutes or regulations, etc.)   **Prior Authorization**

PAYMENT SCHEDULE:

Total Contract Commitment Amount: $ 809,963.00

Contract Beginning Date: October 1, 2003   Contract Ending Date: August 31, 2011

Payment Frequency: _____ payment(s) of $ _____ due   upon receipt of

Payment Frequency: _____ payment(s) of $ _____ due   approved invoice

APPROVALS:

_____   DEC 1 8 2009
Director of Purchasing   Date
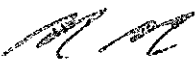
_____   DEC 1 8 2009
Director of Accounts and Reports   Date

Approved as to form and execution:
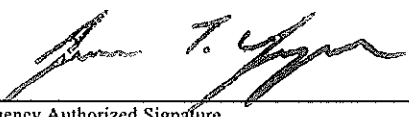
_____   12-16-09
Dept of Admin Attorney, Attorney General, or Agency   Date
Attorney

AGENCY APPROVALS:

_____

_____

This contract was prepared and executed at my direction with full knowledge of the obligations incurred. All required approvals for our State agency have been obtained.

_____   12-16-09
Agency Authorized Signature   Date

AGREEMENT FOR TECHNICAL ASSISTANCE
BETWEEN THE SECRETARY OF TRANSPORATION
AND
KANSAS STATE UNIVERSITY

SUPPLEMENTAL AGREEMENT

This agreement, made and entered into this ___8___ day of _December_ 2009 for Technical Assistance between the Secretary of Transportation of the State of Kansas, hereinafter referred to as Secretary, and Kansas State University, hereinafter referred to as KSU. Collectively referred to as the "Parties".

RECITALS:

WHEREAS, the Secretary and KSU entered into an Agreement for Technical Assistance dated September 4, 2003, hereinafter referred to as original Agreement for the Project entitled "Implementation of the 2002 AASHTO Design Guide for Pavement Structures", and

WHEREAS, funding for this Project originates with the U.S. Department of Transportation, award number KSU-01435, and

WHEREAS, the Secretary agrees to provide additional time of 20 months and additional funds of $200,000 to perform the additional work described in the attached letter hereto and incorporated herein as Special Attachment No. 1.

NOW, THEREFORE, the Secretary and KSU in consideration of the need to clarify the Original Agreement the Parties hereto agree to as follows:

Section 2. <u>Contract Dates.</u>
KSU may continue work in conformity with the Proposal and the Proposal Expansion under this Agreement for an additional period of 20 months. The previous completion date was December 31, 2009, and the revised completion is August 31, 2011.

Section 3. <u>Basis of Payment.</u>
The Secretary agrees to reimburse KSU an additional amount not to exceed $200,000 in accordance with the proposed budget, (attached), to cover the cost of the work described in the Proposal Expansion. The total amount available for reimbursement under the Agreement shall not exceed $809,963.
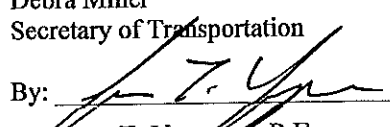
All other terms and conditions of the Original Agreement for Technical Assistance, dated September 4, 2003, shall remain in force.
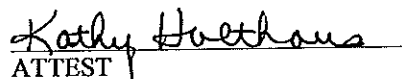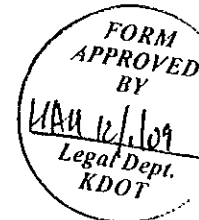
KSU

_____
Paul R. Lowe
Assist. Vice President for Research

_____
ATTEST:

Debra Miller
Secretary of Transportation

By: _____
Jerome T. Younger, P.E.
Deputy Secretary for Engineering and
State Transportation Engineer

_____
ATTEST

FORM
APPROVED
BY
_____
Legal Dept.
KDOT

K-STATE
Kansas State University

November 13, 2009

Department of Civil Engineering
2118 Fiedler Hall
Manhattan, KS 66506-5000
785-532-5862
Fax: 785-532-7717

Mr. Rodney Montney
Engineer of Research
KDOT Materials & Research Center
2300 S.W. Van Buren St.
Topeka, KS 66611.

Re: FHWA Pooled Fund Project TPF-5(079) RE-0361-01 (Implementation of the 2002 AASHTO Design Guide for Pavement Structures) - KSU Account 5-33013

This letter is to request additional funds and time extension for the completion of the above referenced project. The funds are necessary because of modifications and additions required to the initial work plan and have been approved by the NYSDOT project supervisors. The following major task has been added to the work plan:

- Development of an M-E PDG-based design procedure for new flexible pavement structures in New York State

A detailed description of the plan for the additional work to be conducted for NYSDOT has been shown in the Appendix 1 of the proposed agreement for cost and time extension. It has been estimated that the additional task will need 36 months of time. However, additional funds of $200,000 and a time extension to 08/31/2011 only requested for this project at this time. Most of the work will be subcontracted to the University of Texas at Arlington (UTA). Dr. Stefan A. Romanoschi, Associate Professor of Civil Engineering, will serve as the Principal Investigator at UTA.

If you approve this time and cost extension, please sign both copies and return one copy to this office.

Sincerely,   APPROVED:

FORM
APPROVED
BY
Legal Dept.
KDOT

Mustaque Hossain, Ph.D., P.E.   Paul R. Lowe
Principal Investigator   Assistant Vice President for Research

KDOT

Proposed Budget Add Amount
For the period January 1, 2010 to August 31, 2011

    A. Personnel
        1. Mustaque Hossain, Principal Investigator

    B. Subcontract to the University of Texas, Arlington $200,000
        (see attached detail)

        Total Direct Costs $200,000

    C. Facilities and Administrative Costs
        46% of MTDC   -0-

        TOTAL REQUESTED ADD AMOUNT $200,000

THE UNIVERSITY OF TEXAS AT ARLINGTON

OFFICE OF GRANT & CONTRACT SERVICES

September 4, 2009

Nancy Prockish
Accountant & Grant Specialist
Engineering Experiment Station
Kansas State University
1048 Rathbone Hall
Manhattan, KS 66506

SUBJECT: **UTA 26-7900-21**

Dear Ms. Prockish:

The University of Texas at Arlington (UT Arlington) is pleased to submit the following proposal for additional funding:

TITLE:	FHWA Pooled Fund Project TPF-5 (079) RE-0361-01 (Implementation of the 2002 AASHTO Design Guide For Pavement Structures
PRINCIPAL INVESTIGATOR:	Stefan A. Romanoschi, Ph.D.
AMOUNT REQUESTED:	$200,000
PROJECT PERIOD	January 1, 2010 through August 31, 2011

If you require additional information or assistance in finalizing the award, please do not hesitate to contact Elvin Franklin, Grant and Contract Specialist, in the Office Grant and Contract Services at area code (817) 272-3656 or via email at efrank@uta.edu.

Sincerely,

Jeremy Forsberg
Assistant Vice President for Research

Stefan A. Romanoschi
Associate Professor of Civil Engineering
The University of Texas at Arlington

Re: FHWA Pooled Fund Project TPF-5(079) RE-0361-01 (Implementation of the 2002
AASHTO Design Guide for Pavement Structures)

This is to request additional funds and time extension for the completion of the project. The
funds are necessary because of a major work has been added to the work plan: the *Development
of an M-E PDG based design procedure for new flexible pavement structured in New York State.*
A detailed description of the plan for the additional work to be conducted for NYSDOT, as
approved by the NYSDOT research monitoring personnel, is given in Annex 1.

It is envisioned at this stage that the completion of the additional work to be conducted to
develop the M-E PDG based procedure will need approximately 36 months. However, additional
funds of $200,000 (see Annex 2 for an Itemized budget) and a time extension to 8/31/2011 only
is requested for this research project at this time. Depending on the progress, the results obtained
in this period and future work needs, some other extensions requests may be submitted in the
future.

ANNEX 1:

DEVELOPMENT OF A M-E PDG BASED DESIGN PROCEDURE FOR NEW FLEXIBLE PAVEMENT STRUCTURES IN NEW YORK STATE

I. Research Problem Statement:

The National Academy of Science through its NCHRP Program (specifically NCHRP Project 1-37A) dedicated significant resources to develop a user-friendly procedure capable of executing mechanistic-empirical design while accounting for local environmental conditions, local highway materials, and actual highway traffic distribution by means of axle load spectra. The resulting procedure is very sound and very flexible and it considerably surpasses any currently available pavement analysis tool; it is expected it will be adopted by AASHTO as the new AASHTO design method for pavement structures, in place of the earlier empirical based procedure.

The implementation of the design procedure in New York State DOT is a challenging task. The procedure requires an extensive array of input data which must be specific to local conditions: material characteristics, traffic and climatic data as well as performance requirements. The models in the M-E PDG were calibrated at national level using LTPP data and they must be calibrated to New York State specific conditions. Work conducted so far by a research team at Kansas State University and the University of Texas at Arlington has compiled a database of input values (materials, traffic, climate) as part of the work conducted for the Pooled Fund Study TPF-5(079).

The software and the documentation related to the M-E PDG design guide are available to the public and research community. However, they are very complex and require specific and advance expertise; personnel trained to use them will not likely exist in the NYSDOT Regional offices.

For a successfully use of the M-E PDG method for the design of flexible pavements in the NYSDOT Regional offices, a simplified Pavement Design Procedure must be developed. The engineer designing new flexible pavements will need to select from tables and then input in a spreadsheet a limited set of design data to obtain the layer thicknesses. The development of the Pavement Design Procedure should address all main aspects of the pavement performance analysis, in particular: (1) recommended input parameters appropriate to New York (2) comparison of M-E PDG designs with those obtained with New York State's current practice and past pavement performance, (3) development a pavement design procedure based on the MEPDG that fits New York's environment, materials, construction practices, soils and maintenance needs, and (4) training of design personnel in the NYSDOT Regional offices.

II. Research Proposed: The objective of this research is to develop/automate a pavement design procedure for flexible pavement structures based on the MEPDG that fits New York's environment, materials, construction practices, soils and maintenance needs and to assist the NYSDOT pavement design personnel in the implementation of the Procedure in to the pavement design practice. It is envisioned that this study will be accomplished thru the following tasks:
1. Collect and review relevant literature and current practices- The efforts will concentrate on assembling information from the activities conducted for local calibration in other states and

regions. Currently, more than 20 states have reported interest in implementing the M-E PDG for pavement design and are at various stages of calibrating and implementing the procedure. This information will be obtained from published and unpublished reports, contacts with transportation agencies and industry organizations, and other resources. FHWA has had assumed a leadership role and has not only surveyed the implementation activities but has also facilitated regional collaboration. Several reports and circulars have been published in the last two years summarizing the efforts done at national level. The review shall focus on work that can be applied to NYS conditions.

An excellent report that will be extensively used for local calibration is entitled *Seasonal Variations of In-Situ Materials Properties in New York State* [Orr and Irwin, 2006]. The findings published in the report will help in the selection of the resilient modulus values for subgrade soil and in modeling their variation throughout the seasons.

2. <u>Survey of the Pavement Design Practice in the Regional Offices</u> – In this task, a questionnaire will be drafted and then distributed to the 11 regional offices. The questionnaire will ask the engineer in charge of pavement design about the most representative materials used in the construction of flexible pavements in the region, typical layer thicknesses used, drainage condition, and typical pavement performance. Follow-up visits of the research team to the regional offices will be take place if necessary in order to:

- Clarify questions that may arise;
- Discuss the material types and quantities that will be needed for laboratory testing in Task 3 and decide on the best method for material transport;
- Explain better to the design engineer the objective and the work plan approach of this research effort
- Make the research team more familiar with the design issues in each region.

3. <u>Enhancement of the Pavement Material Database</u> – The current database with representative material characterization and pavement condition data will be expanded to include more data related to the characteristics of the pavement materials used in each region of the New York State. It is proposed that extensive material testing to be conducted in this task, so that the existing material database be expanded significantly. Samples of representative materials from all 11 regions will be collected and the following tests will be performed:

- Dynamic modulus on Hot-Mix Asphalt
- Shear stiffness and phase angle on asphalt cement
- Tri-axial resilient modulus on subgrade soil and unbound granular base materials.

In addition to this, the traffic data to be collected by the classification and WIM stations in NYSDOT in 2008, 2009, 2010 and 2011 will be analyzed and converted in the input format required by the M-E PDG software. The conversion will be done using the TrafLoad software.

Tables with recommended/typical values for the design input variables will be developed for each of the 11 regions of NYSDOT. The values in the tables will be compared to determine similarities between regions in terms of materials used in pavement construction, climate and traffic variables.

4. Calibration of the M-E PDG Model –This task will aim at developing calibration factors for the distress models (e.g. rutting, cracking, IRI), for new flexible pavements. It is proposed at this stage that the calibration be done using the data collected for the SPS1 and GPS1 sections of the LTPP program in the New England states (CT, MA, ME, NH, NY, RI, VT), New Jersey and NE Pennsylvania. The assumption made here is that the pavement configuration, material, traffic and climatic conditions are similar for the states in the region and, therefore, the distress models should be the same. The data will be extracted from the of the Long-Term Pavement Performance database, Release 23.0 (January 2009).

As part of the work conducted for the Pooled Fund Study TPF-5(121), over the past several years NYSDOT has been constructing experimental sections. Among them, two flexible pavement experiments: one near Cuba, NY and the second a perpetual pavement near Angelica, NY. The materials used in the construction of these pavements were tested. The pavements were instrumented and their performance monitored. Traffic and climate monitoring devices were also installed. That is, data collected from these test sections will also be used to calibrate the MEPDG procedure to New York conditions.

The calibration will be performed following the principles recommended in:

- **NCHRP Digest 284,** (December 2003); *Refining the Calibration & Validation of HMA Performance Models: An Experimental Plan and Database.*
- **NCHRP Digest 283,** (December 2003); *Jackknife Testing – An Experimental Approach to Refine Model Calibration and Validation.*
- **NCHRP 9-30** – *Experimental Plan for Calibration & Validation of HMA Performance Models for Mix & Structural Design.*
- **NCHRP 1-40B** – *Local Calibration for the Recommended Guide for M-E Design of New and Rehabilitated Pavement Structures.*

These publications describe in detail the principles and the major steps that constitute the basis for an efficient calibration of the distress models.

5. Development of the Design Procedure – The Flexible design catalogs with a step by step Pavement Design Procedure and update standards sheets for rural and urban design will be developed in this task. For each one of the 11 region of NYSDOT, the M-E PDG software with calibrated distress models will be run for the representative pavement materials and climate conditions in that region. Thicknesses of the base and asphalt concrete surface layers as well as the traffic volume and reliability level will be varied over typical expected ranges and the design outputs will be obtained. This work will be conducted in order to obtain the relationships between the input and output design values.

An easy-to-use spreadsheet program will be developed based on these relationships; recommended input values will be included in the spreadsheet. The user of the Pavement Design Procedure will be able to perform the design by inputting in the spreadsheet the typical input values after selecting them from tables provided within the spreadsheet. A detailed manual to accompany the spreadsheet will also be submitted.

6. Comparison of M-E PDG designs with those obtained with New York State's current practice and past pavement performance. In this task, the output of the Pavement Design Procedure will be compared to the design solutions provided by the design catalog currently used by NYSDOT for flexible pavement structures. The comparison will aim not only at identifying differences between the solutions obtained thru the two design procedures; it will also relate the

obtained solutions to the past performance of representative pavement sections in each of the 11 regions. A summary of findings for each of the eleven regions will be drafted and it will be reported for consultation to each engineer in charge of pavement design in that region. This is necessary in order to determine the effectiveness of the new design procedure.

7.   Reporting and Training - A final report will be prepared that will give detailed information on methodology and the data used for the model calibration, the development of the Pavement Design Procedure, computer program, and manuals for pavement design engineers and supervisors. The report will include recommendation on the optimum use of the Pavement Design Procedure as well as recommended default input values. Training of the NYSDOT pavement design personnel will be conducted to ease their work in understanding and using the Pavement Design Procedure and to better inform them on the work conducted for its development.

The efforts and results of the work conducted to calibrate the distress models and develop the Pavement Design Procedure will be disseminated to the engineering community through journal and conference publications and presentations. However, this will be done only **after** the Procedure will be approved and adopted by NYSDOT for the design of flexible pavement structures in New York State.

ANNEX 2

Budget	1/1/10-8/31/10	9/1/10-8/31/11	Total	Cost Share
A. SENIOR PERSONNEL				
Dr. Romanoschi (3/2 summer months)	28,033	19,250	47,283	
TOTAL SENIOR PERSONNEL	28,033	19,250	47,283	0
B. OTHER PERSONNEL				
Graduate Students	16,000	18,720	34,720	
Hourly Students	2,000	4,700	6,700	
Other				
TOTAL SALARY & WAGES	46,033	42,670	88,703	0
C. FRINGE BENEFITS				
Dr. Romanoschi (3/2 summer months)	8,410	5,775	14,185	0
Graduate Students (10%)	1,600	1,872	3,472	0
Undergraduate Students (8.3%)	166	390	556	0
Others				0
TOTAL FRINGE BENEFITS	10,176	8,037	18,213	0
TOTAL SALARY, WAGES, BENEFITS	56,209	50,707	106,916	0
D. EQUIPMENT				
1	0	0	0	
TOTAL EQUIPMENT	0	0	0	0
E. TRAVEL			0	
DOMESTIC			0	
Research Dissemination &		0	0	
Visits to research sites	500	2,000	2,500	
Total Domestic Travel	500	2,000	2,500	0
FOREIGN				
Total Foreign Travel	0	0	0	0
F. PARTICIPANT SUPPORT COSTS			0	
1. Stipends		0	0	
2. Travel	14,200	14,200	28,400	
TOTAL PARTICIPANT COSTS	14,200	14,200	28,400	0
G. OTHER DIRECT COSTS			0	
1. Material and Supplies	400	630	1,030	
2. Publication Costs	200	300	500	
3. Consultant Services	0	5,000	5,000	
4. Computer Services	0	0	0	
5. Other: Tuition for grad students	0	0	0	
TOTAL OTHER DIRECT COSTS	600	5,930	6,530	0
TOTAL DIRECT COSTS	$ 71,509	$ 72,837	144,346	$ -
MODIFIED TOTAL DIRECT COSTS	57,309	58,637	115,946	0
INDIRECT COSTS @ 48%	27,508	28,146	55,654	0
TOTAL DIRECT & INDIRECT COSTS	99,017	100,983	200,000	0
RESIDUAL FUNDS		0	0	
TOTAL PROJECT COSTS	$99,017	$100,983	200,000	
Total Requested Amount				
Total Cost Share				$0