D-2

JOINT VENTURE MOA

SIGNED DOCUMENT

CEMVM-ED-HW (1110-2-1403b) 21 April 1999

MEMORANDUM FOR RECORD

SUBJECT: Memorandum of Agreement and Research Proposal for "Micro-model Capabilities and Expanded Applications"

1. After some time the joint venture proposal has been developed.

2. Agreement to this proposal through the Memorandum of Agreement is a major milestone toward the evaluation effort.

3. A copy of the signed Memorandum of Agreement is being furnished to all team members, to all technical advisors, and to all persons committed to this agreement.

4. The evaluation effort is underway, and every effort will be made to meet desired outcomes.

Roger A Gaines

ROGER A. GAINES, P.E.
Project Manager

CF: Douglas J. Kamien
Phil G. Combs
Claude Strauser
Dewey Jones
Rob Davinroy
Steve Maynord
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Malcolm Dove
Tom Pokrefke
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MEMORANDUM OF AGREEMENT
AND
SCOPE OF WORK

7 APRIL 1999

MICRO-MODEL CAPABILITIES AND EXPANDED APPLICATIONS

1.1 General

Analysis of complex hydraulic and sediment transport problems has frequently relied on physical models. More recently, increasingly complex numerical solutions have been employed in the study of complex flow regimes. However, many hydraulic engineering problems still remain sufficiently complicated so that the equations of fluid mechanics can not be applied or do not provide the necessary answers. As such, physical modeling of the prototype at a reduced size can lead to a more complete understanding of a problem.

Physical models are generally constructed to replicate specific features of the prototype. The particular features to be replicated depend on the degree of model sophistication and the study objectives. In reproducing prototype forces, the principles of similitude are utilized. These principles are fairly straightforward. However, few models exactly replicate all the processes involved for a particular flow situation. Application and interpretation of a particular model approach is largely at the discretion of the modeler.

Historically, the Corps of Engineers has employed relatively large-scale models in the analysis of complex river engineering problems where bed response to a particular modification was sought. These large-scale models required significant resources to accomplish and often required lengthy time frames to complete. The St. Louis District Corps of Engineers has developed an approach that uses much smaller models for analyzing channel response. A strong desire for expanded use of the micro-model technology throughout the Corps of Engineers exists because of the relatively low cost and minimum space requirements for conducting these type studies. However, a number of issues about the small-scale models or micro-models have arisen. These issues should be addressed in order for the technology to become more widely accepted and to determine what limitations may exist and what the capabilities of the small-scale models are.

1.2 Team Members

During 1998 a team was established to evaluate a number of the issues. In December 1998 a joint venture was proposed between MVM, MVS, WES, and MVD. Part of the evaluation venture includes a Long-Term Training assignment

for Mr. Gaines to the University of Missouri-Rolla (UMR) where applied research will be conducted.

The joint venture team consists of the following.

Mr. Andy Gaines, MVM Project Manager and Team Leader
Mr. Rob Davinroy, MVS Team Member
Dr. Steve Maynord, WES Team Member

Technical advisors to the team consist of the following.

Mr. Claude Strauser, MVS
Mr. Charles Nickles, WES
Mr. Malcolm Dove, MVD
Mr. Dewey Jones, MVM
Mr. Tom Pokrefke, WES
Mr. Dave Gordon, MVS

A panel of three outside modeling experts will be obtained to review the evaluation process. Additional technical advisors will be added through the UMR committee selection process.

1.3 Proposed Study

1.3.1 Study Scope:

Potential advances in micro-model application are dependent on a basic understanding of micro-model procedures, identification of it's capabilities and any associated limitations and how well the micro-models reproduce prototype conditions both during calibration and any predicted channel response to alternative structures.

The proposed study will furnish part of the basic knowledge. The study will encompass three major components and will be a joint effort between the Memphis District (MVM), the St. Louis District (MVS), the Waterways Experiment Station (WES), and the Mississippi Valley Division (MVD) offices of the Corps of Engineers. Component A will provide the framework for familiarization with micro-modeling and foster team building. Component A will include studies of previous model study results in order to establish a mechanism for comparing model results to prototype data in a consistent manner. Component B will consider boundary effects of the bed material used in the micro-models as they relate to model scale and simple repeatability studies. Component C will explore micro-model repeatability at a smaller scale and a larger scale. Component C will include analysis of how well the models reproduce the prototype data.

1.3.2 Familiarization Process – Component A

This component will initiate the overall effort with a familiarization phase conducted by MVM. Analysis will begin by MVM documenting development of a

working micro-model of the Richardson Landing reach of the Mississippi River. Close participation by MVS and WES during this model study will foster open communications and will identify additional research topics. A full literature review will be accomplished in this component. Model and prototype comparisons will be made for 15 model studies. These comparisons will provide a means to evaluate models with different scales and scale distortions in light of their ability to reproduce the prototype. Methodology developed for making comparative evaluations will also facilitate comparison of other model techniques including numerical approaches at a future time.

1.3.3 Flume Studies – Component B

Analysis will encompass straight flume studies with boundary roughness applied to the flume walls and bed. Flume studies will include the five separate gradations of bed material currently utilized in micro-modeling. Additional flume studies with meandering channel alignments will be performed. Simple repeatability studies will be conducted to establish effects of bed material gradation. Varying slopes, scales, and scale distortion ratios will be included in these studies. The effects of flow level and hydrograph shape will be considered.

1.3.4 Evaluation of Model Scale Effect – Component C

This analysis will include a selected reach of the Mississippi River to be used in a comparative investigation. The reach selected for this analysis will be the Kate-Aubrey reach located in MVM. Prototype data collection will be accomplished for both high-water and low-water conditions. This reach was selected because of the availability of a previous large scale model study and because most features recommended from the larger model study have been constructed. Development of two micro-models will be accomplished during this component – one at a "traditional" micro-model scale and a second one at approximately twice that scale. Each micro-model will be calibrated for a lower energy condition (current practice) and for a higher energy condition. The two energy levels will be studied to determine whether the micro-models are reproducible at various energy levels. The two micro-models will also be analyzed in a much more detailed manner to establish how closely model bed configurations reproduce the prototype. Comparisons between models and the prototype for baseline and with recommended alternative conditions will be made for the three model scales at Kate-Aubrey. Other locations, such as Dogtooth Bend and the Greenville, MS reaches, will be analyzed in a similar manner depending on data availability.

1.4 Specific Tasks and Timeframes

Much work has been accomplished toward identifying critical components to be investigated during this research effort. However, a discrete listing of all tasks to be completed cannot be compiled early in the process owing to the fact that early developments will influence subsequent steps and items to be explored. As such, this proposal will be a "living" document and will serve as a general

guideline only. For instance, the panel of modeling experts being assembled to review this evaluation process may have suggestions/comments that may necessitate certain changes in this proposal. The tasks identified in TABLE 1.7-1 include the broadest definition of work items available to date. These work items include a number of sub-items that remain somewhat undefined at present. Efforts to further refine the specific tasks will continue and updates to TABLE 1.7-1 will be provided periodically. Costs shown are approximate only.

Pending fund availability from research and other sources, work will be accomplished according to the following general schedule:

FY1999

Familiarization with micro-models through Richardson Landing Model
    Study and Report
Proposal Development
Literature Review
Model and Prototype Comparisons for 15 model studies –
    Develop methodology & procedures for comparative analysis
    Initiate Collection of model study and prototype data
    Initiate Conversion of data to digital format
Order Kate-Aubrey insert for "traditional" micro-model scale
Kate-Aubrey micro-model study – to be conducted at MVM
    Calibrate low-energy conditions
    Recommended Alternative analysis, low-energy

FY2000

Kate-Aubrey micro-model study – to be conducted at MVS
    Complete high-energy conditions for "traditional" scale
    Recommended Alternative analysis – high-energy
Model and Prototype Comparisons for 15 model studies –
    Complete Collection of model study and prototype data
    Complete Conversion of data to digital format
    Begin Comparative analysis on 15 previous model studies
Long-Term Training at University of Missouri- Rolla
    Straight Flume Studies
    Meandering Flume Studies
Written report summarizing findings for Flume studies

FY2001

Order Kate-Aubrey insert for larger scale micro-model
Kate-Aubrey micro-model study – to be conducted at MVM
- Calibrate low-energy conditions
- Recommended Alternative analysis, low-energy
- Calibrate high-energy conditions
- Recommended Alternative analysis, high-energy

Perform comparative analysis for 3 Kate-Aubrey model studies
Perform comparative analysis for 2 Dogtooth Bend model studies
Perform comparative analysis for 2 Greenville, MS model studies (pending data availability)
Written report summarizing findings for FY2001
Peer review of work to date (Journal publication)

FY2002 (October – December)

Conclude comparative analyses
Resolve outstanding issues
Dissertation Preparation and Defense

1.5 Results

Results at the conclusion of each component will be provided to the full team for review. A written report will present study findings at the conclusion of each major work component. These reports will be prepared by the project manager/team leader (PM/TL) and reviewed by the joint venture team. The final product will be reports that document micro-model capabilities and limitations. These reports will have different formats to achieve different objectives. One of these reports will likely be an academic thesis. Another report could be a research/summary report to satisfy the objectives of the HQUSACE funded research that would be directed toward Corps of Engineer District and Division offices. A third report could be a journal paper to present findings to the civil engineering community.

1.6 Proposal Modifications

The three-member joint venture team (identified in 1.2 above) will administer the proposed work. The team has full responsibility and authority to execute the proposed work. The joint venture team has the authority to adapt the proposal scope as necessary while work progresses in order to meet study objectives. The PM/TL will be the single point of contact for any such changes. Major modifications dictated by earlier study findings will be brought to the technical advisors for input before proceeding. A major modification is defined (for the

purposes of this proposal) as a change in the overall research effort that would result in the addition of complete components, omission of proposed components (A, B, or C), and/or increases in budgetary requirements. Communications will be maintained to keep all interested parties abreast of study progress during this research effort. The MVD Chief of Engineering Division and the WES Chief of Rivers and Structures Division will be kept informed of such modifications by the PM/TL. The PM/TL will be the sole point of contact for all correspondence, written or otherwise, pertaining to this proposal and work effort.

1.7 Funding

Table 1.7-1 provides basic cost estimates for each component of the proposal. A break down of funding sources is provided in Table 1.7-2. Funding will be provided through the Corps of Engineers Research and Development Inland Navigation Program and through the MVD Channel Improvement Project.

MEMORANDUM OF AGREEMENT MADE THIS
14 DAY OF APRIL 1999

BY:

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TABLE 1.7-1 - Research Proposal to Establish Micro Model Capabilities and Expand Applications of the Technology			
Estimated Resource Allocation for Work Items			
Work Item No.	Work Item Description	Organization Tasked	Estimated Funding Requirement
I	**Component A - Familiarization Process**		
1	Richardson Landing Micro-model	Memphis	$60,000
a	Procedural Documentation	Memphis	$12,000
b	Technology Transfer	St. Louis to Memphis & WES	$15,000
c	Alternative Analysis	Memphis	$24,000
d	Report	Memphis	$12,000
2	Literature Review		
a	Large Scale Models	WES	$12,000
b	Small Scale Models	St. Louis	$12,000
c	Physical Models	WES & Memphis	$6,000
d	Scale Effects	WES & Memphis	$6,000
3	Model and Prototype Comparisons		
a	Selection of Five Large Scale Models	WES	TBD
b	Selection of Five Other Models	WES	TBD
c	Selection of Five Micro-models	St. Louis	TBD
d	Collect Model and Prototype Paper Data	WES & St. Louis	TBD
e	Convert Model and Prototype Paper Data to Digital Format	WES & St. Louis via Memphis A/E Contract	TBD
f	Establish Parameters for Comparisons	Memphis, St. Louis, WES, Others	TBD
g	Perform Comparative Analysis	Memphis	TBD
II	**Component B - Flume Studies**		
1	Straight Flume Analysis	LTT	
a	Boundary Roughness	LTT	
b	Flow Simulation	LTT	
2	Meandering Flume Analysis		
a	Single Meander Configuration		
i	Variable Flow Input	LTT	
ii	Scale	LTT	
iii	Repeatability	LTT	
iv	Grain Size Effects	LTT	
b	Multiple Meander Configuration		
i	Variable Flow Input	LTT	
ii	Scale	LTT	
iii	Repeatability	LTT	
iv	Grain Size Effects	LTT	

TABLE 1.7-1 - Research Proposal to Establish Micro Model Capabilities and Expand Applications of the Technology			
Estimated Resource Allocation for Work Items			
Work Item No.	Work Item Description	Organization Tasked	Estimated Funding Requirement
III	**Component C - Evaluation of Model Scale Effect**		
1	Selection of Reach for Scale Comparisons	Memphis, St. Louis, WES, MVD	$12,000
2	Collection of Field Data	Memphis, WES, St. Louis	WES - $12,000 Memphis - $ 24,000
3	Traditional Micro-model scale		
a	Order Micro-model Insert	Memphis	$7,500
b	Calibrate Model Under Low-Flow Conditions	Memphis	$60,000
c	Analyze Recommended Alternative	Memphis	$12,000
d	Calibrate Model Under High-Flow Conditions	Memphis	$30,000
e	Analyze Recommended Alternative with Higher Flows	Memphis	$12,000
4	Larger Micro-model Scale		
a	Order Micro-model Insert	Memphis	$12,000
b	Calibrate Model Under Low-Flow Conditions	St. Louis	$90,000
c	Analyze Recommended Alternative	St. Louis	$18,000
d	Calibrate Model Under High-Flow Conditions	St. Louis	$45,000
e	Analyze Recommended Alternative with Higher Flows	St. Louis	$18,000
IV	**Publications and Misc.**		
1	Coordination with Corps Working Committee	Memphis, St. Louis, MVD, WES	TBD
2	Periodic Reporting	Memphis	TBD
3	QA/QC of Work (Research) in progress	Memphis, St. Louis, MVD, WES	TBD
4	Documentation of Findings		
a	Proposal Development	Memphis	TBD
b	Familarization Phase	Memphis	TBD
c	Flume Studies	Memphis	TBD
d	Model Comparisons - Surface Analysis	Memphis	TBD
e	Model Comparisons - Scale Issues	Memphis	TBD
f	Recommendations (in form of a PHD Dissertation)	Memphis	TBD

TABLE 1.7-2 - Research Proposal to Establish Micro Model Capabilities and Expand Applications of the Technology			
Cost Break Down			
April 1999			
Work Item Description	Organization	MR & T Funds Required	R & D Funds Required
FY 1999			
Contract for Expert Evaluation of Procedures			
	MVM	0	0
	MVS	0	0
	WES	0	0
Comparisons of 15 Model Studies to Prototype - Begin Collection and Conversion of data; Develop Methodology			
	MVM	0	5,000
	MVS	0	5,000
	WES	0	35,000
Contract Data Conversion for 15 Studies (Pending Fund Availibility)	WES	0	14,000
Kate Aubrey Traditional Micro-model low-energy conditions: Calibration and Recommended Alternative			
	MVM	0	65,000
	MVS	0	20,000
	WES	0	35,000
Proposal Development			
	MVM	0	10,000
	MVS	0	10,000
	WES	0	5,000
Familarization Phase - During MVM Richardson Landing Micro-model Study			
	MVM	0	0
	MVS	0	0
	WES	0	26,000
Prototype Data Collection			
	MVM	24,000	0
	MVS	0	0
	WES	0	0
SUBTOTALS FY 1999		**24,000**	**230,000**

TABLE 1.7-2 - Research Proposal to Establish Micro Model Capabilities and Expand Applications of the Technology			
Cost Break Down			
April 1999			
Work Item Description	Organization	MR & T Funds Required	R & D Funds Required
FY 2000			
Pototype Data Collection			
	MVM	0	12,000
	MVS	0	0
	WES	0	0
Complete Kate Aubrey Traditional Micro-model low-energy conditions			
	MVM	0	0
	MVS	54,000	0
	WES	0	15,000
Kate Aubrey Traditional Micro-model high-energy conditions			
	MVM	0	0
	MVS	12,000	0
	WES	0	15,000
Comparisons of 15 Model Studies to Prototype - Complete Collection and Conversion of data; Continue Development of Methodology; Begin Analysis of Thalweg Locations			
	MVM	10,000	0
	MVS	10,000	0
	WES	0	138,000
Expert Consultant			
	MVM	0	0
	MVS	0	0
	WES	0	20,000
SUBTOTALS FY 2000		**86,000**	**200,000**

TABLE 1.7-2 - Research Proposal to Establish Micro Model Capabilities and Expand Applications of the Technology			
Cost Break Down			
April 1999			
Work Item Description	Organization	MR & T Funds Required	R & D Funds Required
FY 2001			
Kate Aubrey "2x" micro-model low-energy conditions			
	MVM	110,000	0
	MVS	12,500	0
	WES	0	15,000
Kate Aubrey "2x" micro-model high-energy conditions			
	MVM	75,000	0
	MVS	12,500	0
	WES	0	15,000
Analysis of 15 Model Study Comparisons			
	MVM	30,000	0
	MVS	10,000	0
	WES	0	60,000
Expert Consultant			
	MVM	0	0
	MVS	0	0
	WES	0	20,000
SUBTOTALS FY 2001		**250,000**	**110,000**
FY 2002 (October - December)			
Wrap-up Research Outcomes and Close-out of Outstanding Issues			
	MVM	50,000	0
	MVS	0	0
	WES	0	0
SUBTOTALS FY 2002		**50,000**	**0**
GRAND TOTALS FOR PROPOSAL		**410,000**	**540,000**