U of A
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Cooperative Extension Service

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MEMORANDUM OF AGREEMENT

The Board of Trustees of the University of Arkansas, acting for and on behalf of the University of Arkansas Cooperative Extension Service (UACES), enters a cooperative research agreement with the Oklahoma State University Boone Pickens School of Geology (OSU) for research services related to Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas.

Technical services associated with this agreement will be conducted under the direction of Dr. Todd Halihan of OSU and will be in accordance with the proposal included as Exhibit A to this agreement. As UACES lacks the equipment and expertise to perform this research, OSU agrees to provide data analysis and a final report to UACES under the terms of the proposal.

In accordance with Exhibit A, UACES agrees to pay OSU a lump sum of $27,550 upon receipt and acceptance of the final report and receipt of a detailed invoice from OSU. Said consideration is inclusive of all OSU expenses for the project (Labor, Supplies and Equipment, and Travel).

As delivery of research data gathered under this project is of a timely nature, OSU agrees to report any potential delays to UACES personnel assigned to this project immediately upon discovery and coordinate with UACES personnel to determine solutions including potential amendments to this agreement.

This agreement will become effective October 1, 2014, and expire June 30, 2015, unless extended by mutual written agreement.

For UACES:

Kyleen W Prewett

Dr. Kyleen W. Prewett, Associate Director
Finance and Administration

Date: 9/18/14

For OSU:

Sheryl A. Tucker
Interim VP for Research & Technology

(Name and Title) Transfer

Date: 9/16/14

EXHIBIT A

Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas

Todd Halihan, Professor, Boone Pickens School of Geology, Oklahoma State University

Electrical resistivity imaging (ERI) provides a good method to understand the distribution of fluids and rock properties in the subsurface environment especially in the presence of fractures or karst features (Bolyard, 2007, Smith et al., 2008, Gary et al., 2009, Halihan et al., 2009). The method allows an electrical image to be created with a resolution of half the distance between electrodes, which typically provides a meter-scale dataset that can be utilized to evaluate heterogeneity and fluid distribution. Improvements in sensitivity generated by the Halihan/Fenstemaker method (OSU, 2004) allow greater differentiation of these signatures (Miller et al, in press). In a field setting, this will result in a two-dimensional mapping of subsurface electrical properties for each dataset.

For these experiments, the electrical imaging will be conducted on a one time basis to evaluate rock properties, but can also be repeated on a pre- and post-infiltration basis to generate images of changes in the electrical properties (Albano et al., 2010, Halihan et al., 2011). These transient datasets will allow an understanding of changes in fluid electrical properties as the infiltrating fluid and associated reactions will be the only subsurface change. The datasets will be used to interpret groundwater movement in a complex mantled karst with applied agricultural waste.

As part of cooperative research, Oklahoma State University (OSU) will design and conduct ERI imaging experiments and integrate ERI data with well data and other site data to provide an understanding of the subsurface distribution of flowpaths at a background and waste application study sites. Dr. Todd Halihan and his graduate research assistant (OSU) will travel to the sites to assist in experimental setup of the imaging and collecting initial data. University of Arkansas (UA) will provide 2-3 field assistants to aid in collecting data and clearing brush as needed. Aestus, LLC will be utilized to provide 3-D visualization of the field data utilizing RockWorks™. Data analysis and reporting will be performed in conjunction with research team members at UA and Aestus, LLC. The work is anticipated to begin 1 October 2014 and conclude 30 September 2015.

Potential hurdles for the research are field logistics and constraints due to site access and stream access. For this site, data quality is anticipated to be high due to the geologic setting lacking metallic infrastructure. The resistivity structure of the site will be evaluated with OSU working with UA and Aestus to ensure proper integration of the ERI acquisition location and scale with the UA well and soil sampling protocols.

The results of the work will be reported to UA, and published in appropriate journal locations. The work is intended to be applied to understanding best management practices for conducting land application of agricultural waste in karstic settings.

1.0 Scope of Work

ERI data will be collected at two sites near Mount Judea, Arkansas (Figure 1). A total of 18 ERI lines are planned to be acquired and visualized in 3-D. Current planning involves acquiring data along 10 transect lines at the northern site (MJN; Site 1) (Figures 1 and 2), and 8 transect lines at the southern site (MJS; Site 2) (Figures 1 and 3). A dozen lines will be acquired at a ~1.5 meter resolution (3 meter electrode spacing), providing datasets that are ~165 meters long horizontally with a depth of imaging of approximately 33 meters. An additional six higher resolution transect lines are planned at a ~0.5 meter resolution (1 meter electrode spacing) to provide higher resolution imaging of pathways observed during the acquisition of the coarser data for each site. It is anticipated that two field acquisition efforts will be required to ensure proper data acquisition and integration. The locations of lines may need to be shifted as field conditions dictate, relative to land access or thick vegetation.

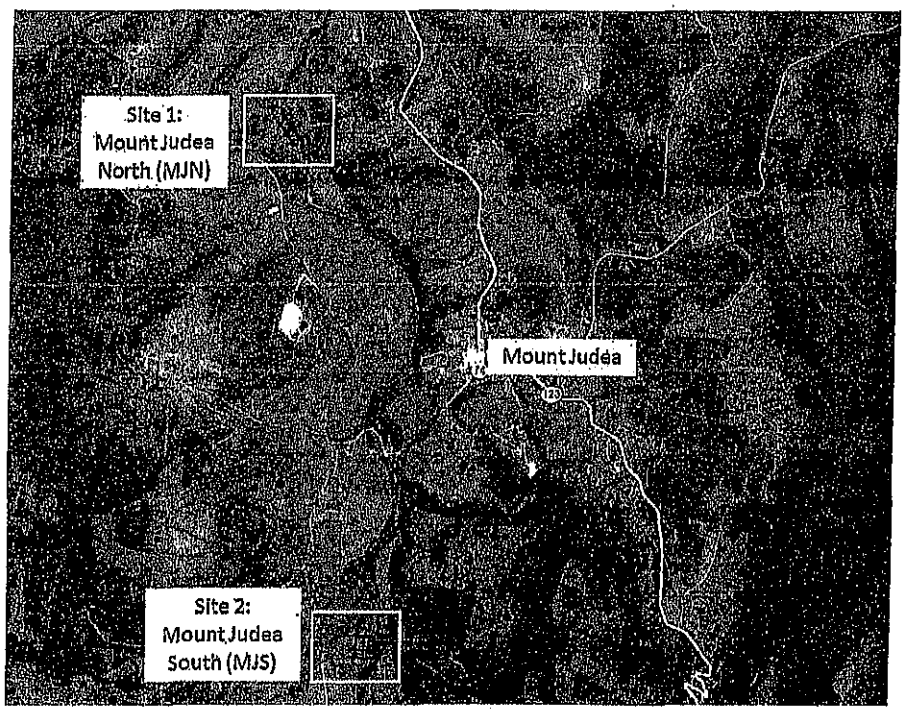

Figure 1. Location of sites for ERI imaging near Mount Judea, Arkansas.

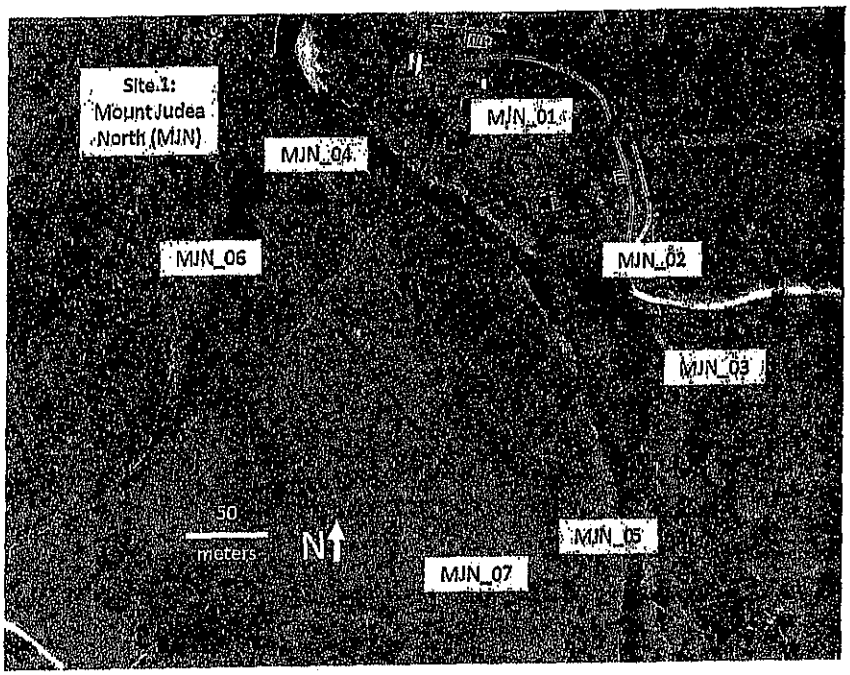

Figure 1. Location of ERI lines at northern (downgradient) site MJN. Seven 165 meter long lines illustrated. 3 additional high resolution lines (placement not shown) will be acquired after evaluating initial data.

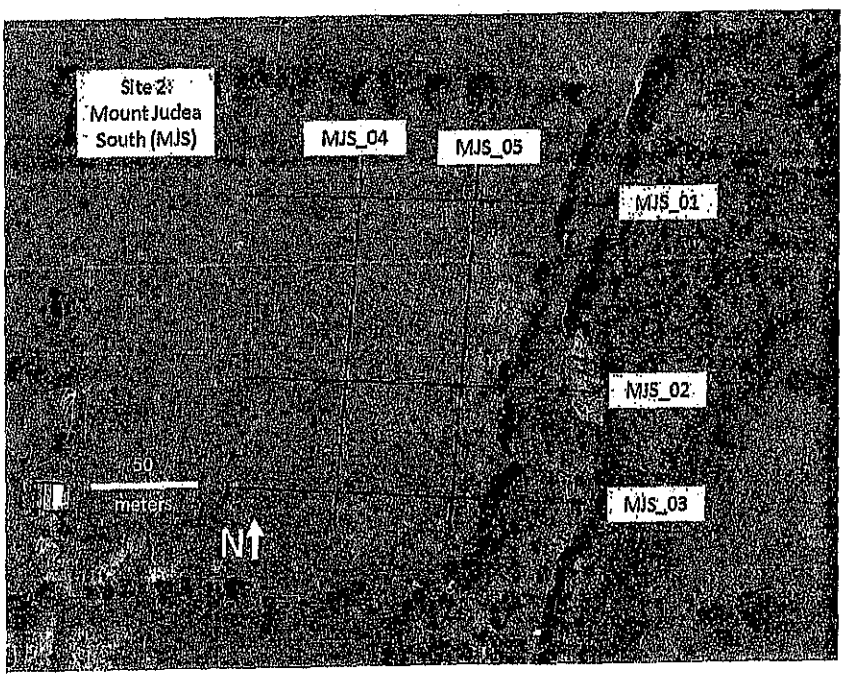

Figure 2. Location of ERI lines at southern (upgradient) site MJS. Five 165 meter long lines illustrated. 3 additional high resolution lines (placement not shown) will be acquired after evaluating initial data.

1.0.1 Assumptions for OSU

The work plan assumes the following for OSU:

1. OSU will utilize their own resistivity instrumentation for acquisition of ERI data.
2. OSU will utilize their own GPS instrumentation for acquisition of 3-D survey data.
3. ERI data can be obtained on the sites as they are largely natural settings.
4. GPS can be obtained on the sites as they are largely cleared fields.
5. OSU will work with Aestus, LLC to visualize the data. Note that Dr. Halihan has a managed conflict of interest between OSU and Aestus, LLC.

1.0.2 Assumptions for UA

The work plan assumes the following for UA:

1. UA will provide 2-3 field assistants on site to assist with acquiring ERI and survey data.
2. UA will work with land owners to obtain legal access for the OSU field team and answer questions regarding the field work.
3. UA will provide well data to OSU to include in the visualization model of the site data.

2.0 Budget

The total cost for the project is $27,550. This includes $1500 for supplies and equipment maintenance, $3405 for travel costs, and $22,645 in labor costs. Facilities and administrative costs of $11,487 have been waived for this project.

2.0.1 Budget Justification

The cost of supplies and maintenance applies to both electrical resistivity instrumentation and GPS instrumentation and associated field supplies. The travel costs include cost for travel to the field site for 8 days total on two trips and a trip for data integration to Fayetteville. Labor costs apply to a graduate research assistant and data visualization. Dr. Halihan will receive no salary for this project.

Facilities and administration costs have been waived for this project as the state of Arkansas funding for this project will not support F&A costs.

3.0 References

Albano, J., S. D. Comfort, V. Zlotnik, T. Halihan, M. Burbach, C. Chokejaroenrat, S. Onanong, and W. Clayton, 2010, In Situ Chemical Oxidation of RDX-Contaminated Ground Water with Permanganate at the Nebraska Ordnance Plant, *Ground Water Monitoring & Remediation*, 30, no. 3: 96-106, DOI: 10.1111/j1745-6592.2010.01295.x.

Bolyard, S.E., 2007, Migration of Landfill Contaminants in a Tilted-block Mantled-karst Setting in Northwestern Arkansas, M.S. Thesis, University of Arkansas, 69 p.

Gary, M.O., T. Halihan, and J.M. Sharp, Jr., 2009, Detection of sub-travertine lakes using electrical resistivity imaging, Sistema Zacatón, Mexico, 15th International Congress of Speleology, July 19-26, 2009, Kerrville, TX., p. 575-579.

Halihan, T., J. Puckette, M. Sample, and M. Riley, 2009, Electrical resistivity imaging of the Arbuckle-Simpson aquifer: Final report submitted to the Oklahoma Water Resources Board, Oklahoma State University School of Geology, 92 p.

Halihan, T., J. Albano, S.D. Comfort, and V.A. Zlotnik, 2011, Electrical Resisitivity Imaging of a Permanganate Injection During In Situ Treatment of RDX-Contaminated Ground Water , *Ground Water Monitoring and Remediation,* DOI: 10.1111/j1745-6592.2011.01361.x.

Miller, R.B., Heeren, D.M., Fox, G.A., Halihan, T., Storm, D.E., and A.R. Mittelstet, *in press,* The Permeability Structure of Gravel-Dominated Alluvial Floodplains, *Journal of Hydrology.*

OSU Office of Intellectual Property, 2004, Improved method for Electrical Resistivity Imaging.

Smith, B.D., C.D. Blome, D.V. Smith, D.D. Scheirer, M. Deszcz-Pan, and T. Halihan, 2008, Geophysical Surveys to Characterize the Hydrogeology of the Arbuckle Uplift, South-Central Oklahoma, 21st SAGEEP, Symposium on the Application of Geophysics to Engineering and Environmental Problems, Philadelphia, PA.

Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas
Proposal to University of Arkansas
Submitted by: Dr. Todd Halihan

SALARIES & WAGES*	YEAR 1	TOTAL
Graduate Research Assistant		
One Position/undetermined		
50% FTE for 9 months	14,796	14,796
TOTAL SALARIES & WAGES	**14,796**	**14,796**
EMPLOYEE BENEFITS*		
Graduate Res. Assistant: 9.32%	1,379	1,379
TOTAL EMPLOYEE BENEFITS	**1,379**	**1,379**
TOTAL SALARIES & BENEFITS	**16,175**	**16,175**
TRAVEL**		
Travel to Field Sites	3,405	3,405
TOTAL TRAVEL	**3,405**	**3,405**
OTHER DIRECT COSTS		
Material and Supplies and Maintenance Costs	1,500	1,500
Contractual Services	4,000	4,000
Tuition Remission	2,470	2,470
TOTAL OTHER DIRECT COSTS	**7,970**	**7,970**
TOTAL DIRECT COSTS	**27,550**	**27,550**
FACILITIES & ADMINISTRATIVE COSTS		
45.8% MTDC per ONR Agreement	**11,487**	**11,487**
Less OSU Contribution (Agency doesn't allow F&A)	**11,487**	**11,487**
TOTAL F&A COSTS	**0**	**0**
TOTAL AMOUNT REQUESTED	**27,550**	**27,550**

*A 3% increase each year is included on all salaries, wages, and employee benefits and tuition remission.
**Travel may be reimbursed at federal rates, which may exceed state rates.
Computer & office supplies necessary for the success of the project. These costs are disclosed in the OSU "Costing Practices for Sponsored Research" article 3.02, item I.

MEMORANDUM OF AGREEMENT
Between
The Board of Trustees of the University of Arkansas, acting for and behalf of the
University of Arkansas Cooperative Extension Service
And
Oklahoma State University Boone Pickens School of Geology

Amendment 1

The purpose of this amendment is to alter the terms of the original agreement effective October 1, 2014, for the project "Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas" as follows:

No-cost extension: The end date for the project is extended to September 30, 2015.

All other terms of the original agreement remain in effect.

Oklahoma State University

Sheryl A. Tucker
Interim Vice President for Research

5/6/15
Date

University of Arkansas
Cooperative Extension Service

Kyleen Prewett
Assoc. Director, Finance and Admin.

5/8/15
Date

UACES: 13954

UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE
Cooperative Extension Service

Purchasing Department
2301 S University Avenue
Little Rock, Arkansas 72204-4940

PURCHASE ORDER

PO Number: **P0043660**
Blanket Number:

P0043660

Please show this number on all packages and documents related to this order

Date: 09/29/14

Vendor: @00000467
Oklahoma State University
Attn: Margaret Denzler--Grants/Con
202 Life Science East
Stillwater OK 74078

Fax # 405 7443285

Ship To:
Mike Daniels
Uof Arkansas Coop Extn Service
2301 South University Avenue
Little Rock AR 72204-4940

Invoice in Duplicate: University of Arkansas Cooperative Extension Service, Accounts Payable, 2301 S University Avenue Little Rock, Arkansas 72204-4940

Address all correspondence to the Purchasing Department

PLEASE ACKNOWLEDGE RECEIPT OF THIS ORDER AND GIVE DEFINITE DELIVERY DATE

Item	Item Description	Quantity	UOM	Unit Price	Extended Price
	AGENCY CONTACT: Mike Daniels 501/671-2001 Email: mdaniels@uaex.edu Vendor Contact: Margaret Denzler E-mail: Margaret.denzler@okstate.edu				
1	MOA - Oklahoma State University Boone Pickens School of Geology (OSU) Project Title: Electrical Resistivity Imaging of Mantled Karst in the Buffalo River Basin, Arkansas for the period 10/1/14 - 6/30/15. Award not to exceed $27,550	27,550.00	$	1.0000	27,550.00
				DISCOUNT:	.00
				ADDL CHARGES:	.00
				TOTAL TAXES:	.00

E-MAILED 9-30-14

TERMS: Net 30 Days FOB:

PURCHASING AGENT: Jo Ann Fish 501/671-2296 REQUISITION # **R0037169**

DELIVER BY: 09/29/14

GENERAL CONDITIONS AND INSTRUCTIONS TO VENDORS:
The right is reserved to cancel all of any part of this order if shipment is not made within a reasonable time. No charges will be allowed for packing, crating, boxing, or cartage unless otherwise authorized. If transportation charges are to be paid by State agency; shipment is to be made by the cheapest means, unless otherwise specified. Do not insure an Agency expense unless instructed to do so. Unless otherwide specified, transportation charges must be prepaid and a copy of freight bill attached to any invoice on which charges for same are in addition to those for goods. Terms and method of payment must be shown on all invoices. When invoices subject to cash discounts are not mailed on date of shipment, discount period will be calculated from date invoice is received at the proper office. All material is subject to inspection and approval of buyer, notwithstanding prior payments to obtain cash discounts. Seller must pay all transportation charges both ways on rejected material. Acceptance of this order constitutes an agreement.

We can now send your purchase orders by e-mail. If you would prefer this method of delivery, send an e-mail to purchasing@uaex.edu. Indicate in the body of the e-mail your company name, address and the e-mail address to receive the purchase orders.

Agency Purchasing Official

I0235298

Oklahoma State University
Attn Grants and Contracts
Stillwater, OK 74076

16-NOV-15

AHOGAN

13954	7300	729490	5080022000	PS	EL	P1	13	512465	26,682.19

MOA - Oklahoma State University Boone Pickens

P0043660	16-NOV-15	30-OCT-15	1-557305-001	26,682.19

P0043660

235298

INVOICE
OKLAHOMA STATE UNIVERSITY

Fed ID# 73-6017987-E2

Original

OSU
Oklahoma State University

TO: **University of AR Cooperative Extension Service**
ATTN: Mike Daniels
2301 South University Avenue
Little Rock, Arkansas 72204-4940

OSU Account Number: 1-557305	**Invoice Number** 1-557305 - 001
Period of Award: 10/14/2014 to 09/30/2015	**OSU ID Number** 10001
Agency Award: P0043660	
Award Amount: $27,550.00	☐ Partial
Principal Investigator: Todd Halihan	■ Final

Award Title: Electrical Resistivitiy Imaging of Mantled Karst in Buffalo River Basin

Invoice Period: 10/14/2014 to 09/30/2015

DESCRIPTION	CURRENT COSTS	CUMULATIVE COSTS	CURRENT COST SHARE	OSU COST SHARE
SALARIES & WAGES	12,345.86	12,345.86		
EMPLOYEE BENEFITS	1,131.60	1,131.60		
SUPPLIES, MATERIALS, ETC.	2,751.07	2,751.07		
TRAVEL: IN STATE	344.60	344.60		
OUT OF STATE	2,224.31	2,224.31		
OUT OF COUNTRY				
OTHER:				
Fed-x, UPS-Pr Mail	26.61	26.61		
Testing Laboratories	930.00	930.00		
Other Equipment Rental	672.97	672.97		
Contractual Services	4,210.45	4,210.45		
SUBCONTRACTS:				
LESS THAN $25,000				
GREATER THAN $25,000				
EQUIPMENT:				
PARTICIPANT COSTS:				
GRA TUITION-SPONS AG	2,044.72	2,044.72		
TOTAL DIRECT COSTS	26,682.19	26,682.19		
F&A COSTS				
TOTAL COSTS	26,682.19	26,682.19		

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NOV 02 2015
OFFICE OF SPONSORED PROGRAMS

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the Federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil or administrative penalties for fraud, false statements, false claims or otherwise. (U.S. Code Title 18, Section 1001 and Title 31, Sections 3729-3730 and 3801-3812

CURRENT AMOUNT DUE	**$26,682.19**
UNPAID INVOICES	**($0.00)**

Beth A Peneaux

10/30/2015

Beth A. Peneaux, CFE
Accountant III
(405) 744-8245
beth.peneaux@okstate.edu

Date

PLEASE SEND THE REMITTANCE COPY OF THIS INVOICE ALONG WITH PAYMENT TO:

Oklahoma State University
Grants & Contracts Financial Admin.
P.O. Box 645
Stillwater, OK 74076

To pay by VISA or MASTERCARD call (405) 744-8239

OK approve
11/2/15