

**AMENDMENT NUMBER ONE
TO
AGREEMENT BETWEEN
MEMPHIS LIGHT, GAS AND WATER DIVISION
OF THE CITY OF MEMPHIS
AND
THE UNIVERSITY OF MEMPHIS
ON BEHALF OF
THE HERFF COLLEGE OF ENGINEERING'S
CENTER FOR APPLIED EARTH SCIENCE
AND ENGINEERING RESEARCH**

CONTRACT NUMBER 12064

THIS AMENDMENT NUMBER ONE TO CONTRACT NO. 12064 (Amendment) is entered into by and between Memphis Light, Gas and Water Division (MLGW), a municipal utility with its principal office located at 220 South Main Street, Memphis, Tennessee, 38103 and the University of Memphis (University), on behalf of the Herff College of Engineering's Center for Applied Earth Science and Engineering Research (CAESER), located at 300 Engineering Administration Building, Memphis, Tennessee, 38152, this 8th day of January, 2020, to establish the terms and compensation for aquitard breach research effective July 1, 2019.

RECITALS

WHEREAS, MLGW provides water utility services to residential, commercial, and industrial customers within the City of Memphis and elsewhere in Shelby County, Tennessee and is responsible for production, treatment and transportation of such water; and

WHEREAS, University, through CAESER, conducts research regarding groundwater and the aquifer system; and

WHEREAS, MLGW and University previously entered into Contract No. 12064; and

WHEREAS MLGW desires to exercise its option to extend this contract for an additional year;

NOW THEREFORE, in consideration of the mutual promises and covenants contained, the parties agree to amend that contract as follows:

1. **Paragraph 1 is amended to add the following language immediately following the existing language:**

Scope of Work (Year 2)

- **Continue work on four research initiatives as follows:**
 1. **Assess impact of known breaches in the Sheahan well field; determine presence of any unidentified breaches in the well field; and assess impact of the former Custom Cleaners site.**
 2. **Determine potential breach locations proximal to the Wolf River focusing on the section from Collierville-Arlington Road to Hwy 51. Methodologies to be examined include riverbed seepage measurements, detailed discharge measurements, thermal imaging surveys, and developing well transects to monitor groundwater/surface water exchange.**
 3. **Continue aquifer characterization across Shelby County to better constrain numerical model parameter estimation.**
 4. **Continue geophysical surveys of aquitard breaches on President's Island and Pigeon Industrial Park (a.k.a., Ensley bottoms) with impact to the Davis and Allen well fields.**
 5. **Continued research using stochastic modeling to determine the effectiveness of using groundwater pumping optimization to minimize contaminant movement from the water table aquifer to Memphis Aquifer.**

- **New deliverables in Year 2 will include:**
 1. **Use geophysical well records to investigate hypothetical paleo-drainage network atop the Upper Claiborne confining unit to help identify additional breach locations and better inform numerical groundwater flow simulations.**
 2. **Subsurface mapping of geologic units to identify the presence of aquitard breaches and characterize the hydraulic properties of identified breaches using geophysical techniques in conjunction with other traditional methods.**
 3. **Conduct multi-scale investigation of surface water-groundwater interactions along the Loosahatchie River and Nonconnah Creek using a variety of methodologies to identify breaches. Incorporate these findings plus those of the Wolf River (ongoing research) into Shelby County numerical groundwater model.**
 4. **Development of hypothetical groundwater models focusing on groundwater sustainability, including modeling the fate and transport of various contaminants and conducting bench scale testing of retardation reactions.**
 5. **Build upon existing Davis well field age-dating data to further refine and quantify source waters to the Memphis aquifer at the Davis well field through sampling water chemistry, groundwater age-dating, characterization of the hydrogeologic properties of a known breach impacting Davis, and development of a conceptual model of groundwater flow for later incorporation into a numerical model.**

6. Determine *in-situ* riverbed properties (hydraulic conductivity and thickness) for the Loosahatchie River, Wolf River and Nonconnah Creek to further constrain the Shelby County numerical groundwater model and for site-scale hydrogeologic analyses.
 7. Investigate Shaw well field to determine source waters and potential for modern water migration into the Memphis aquifer, development of unconfined conditions and vulnerability to nearby contaminated sites.
 8. Determine recharge mechanisms and rates to the shallow aquifer within Shelby County that contributes to its replenishment and source of additional inflow to the Memphis aquifer through aquitard breaches.
 9. Determine numerical modeling best practice for simulating groundwater conditions in the shallow aquifer that better represent groundwater levels and flow direction, vertical leakage through aquitard breaches, and avoiding inherent cell flooding (too much recharge) and drying (thin saturation depths).
 10. Use numerical modeling to correlate age-dating and geochemical observations to known/potential breaches that will include possible paleo-drainage atop the Upper Claiborne confining unit.
 11. Formulate and test methodology(ies) to reduce or eliminate preferential inter-aquifer exchange.
- The University shall provide in-field support to student research efforts by managing field campaign logistics, acquiring necessary instrumentation for data collection and its installation, ensuring research equipment is well maintained and calibrated, determining strategic locations for drilling, geophysical logging, water sampling, groundwater age-dating, etc.
 - The University shall supply detailed progress reports for each deliverable to MLGW on a monthly basis.
 - The University shall deliver the research data associated with each deliverable quarterly. All data in GIS format shall be delivered in the form of a Geodatabase file, including metadata about data points and fields held within the Geodatabase. All non-GIS data (such as field collection data), including all input data and meaningful output data shall be delivered in the format in which it is normally maintained. All deliverables shall be provided in electronic format via MLGW's Secure File Transfer Protocol (SFTP) site.
 - The University shall annually provide by April 30, a list of programs used with inputs and meaningful outputs for each with a data definition dictionary for all data forms.
 - Upon completion of each deliverable, the University shall provide a set of data tagged as the final report for that deliverable that includes the same types of information included with the annual deliverable.

- Upon termination of the Agreement, within sixty (60) days the University shall provide all data associated with open and/or non-complete deliverables in the same format required for quarterly and annual deliverables described above.
- The parties acknowledge that MLGW is focused on the wise use and protection of available water resources. This research project is funded to provide data for MLGW's use in furthering those goals. With that in mind, the University will assist MLGW, as requested, by providing data, project updates, comments, opinions, and responses to questions for use in preparation of presentations, reports and communications to the MLGW Board, the Memphis City Council, the media and the public. MLGW will schedule, coordinate and approve all presentations, public statements and communications regarding this research project. For planning purposes, MLGW anticipates activities involving CAESER input and/or participation will include:
 - A presentation to the MLGW Board once every 6 months
 - A presentation to the City Council once every 6 months
 - Two presentations to the general public annually
 - Comments for MLGW press releases and/or responses to media questions as necessary

2. Paragraph 2 is amended to add the following language immediately following the existing language:

- Review and provide input on the research topic areas and progress reports.
- Due to a delayed start of contract work in 2018, additional funds remained available at the end of the first year of the contract. For that reason and for Year 2 only, subject to the provisions of this Agreement, MLGW agrees to reimburse CAESER for the services provided in accordance with the Scope of Work for Year 2 and invoiced as provided hereafter in the amount of up to \$1,235,000 through the First Renewal Term of the Agreement.

3. Paragraph 3 is amended to add the following language immediately following the existing language:

The First Renewal Term of this Agreement shall begin on July 1, 2019 and continue through June 30, 2020.

Subject to the availability and approval of continued funding, if CAESER is not in default, all deliverables have been met to date, and CAESER has provided a proposed scope of work acceptable to MLGW for the next year, MLGW has the option to extend this contract for up to three additional one-year terms following the First Renewal Term.

4. Paragraph 5 is amended to substitute Quinton Clark for Alonzo Weaver for submission of invoices.
5. Paragraph 23 is amended to substitute Quinton Clark for Alonzo Weaver for notices to MLGW.
6. Paragraph 27 is amended to add the following language immediately following the existing language:

This Amendment shall not be binding upon the parties until it has been properly approved by the authorized officials of the respective parties; it has been signed first by the authorized representatives of University and then by MLGW. When it has been so signed and filed, this Amendment shall be effective as of the date first written above.

7. **Contract No. 12064 Affirmed:**

Except as set out above, nothing in this Amendment affects the other terms of Contract No. 12064.

IN WITNESS WHEREOF, the parties, by and through their duly authorized representatives, have executed this Agreement as of the date above written.

MEMPHIS LIGHT, GAS AND WATER

BY: 
 Jarl T. Young
 President and CEO

THE UNIVERSITY OF MEMPHIS

BY: 
 Jasbir Dhaliwal
 Executive Vice President for
 Research and Innovation

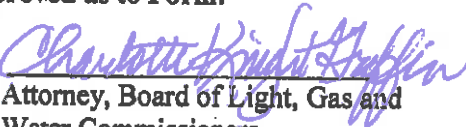
Attest:

BY: 
 Dana Jeanes
 SVP, CFO & CAO (Secretary- Treasurer)

Attest:

BY: _____

Approved as to Form:

BY: 
Attorney, Board of Light, Gas and
Water Commissioners