

**Monthly Letter Progress Report #12:  
Period 6, Fiscal Year 2017  
Study of Brackish Aquifers in Texas –  
Project No. 4 –Trinity Aquifer  
TWDB Contract No. 1600011950**

*Submitted to*

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**Monthly Letter Progress Report #12**  
**February 18, 2017-March 17, 2017**  
**Study of Brackish Aquifers in Texas – Project No. 4 –**  
**Trinity Aquifer**  
**TWDB Contract No. 1600011950**

**1.0 Budget and Expenses**

This report summarizes the project costs for the billing period from Contract Approval Date (January 6, 2016) through the end of Period 6 of Fiscal Year 2017 (March 17, 2017). The total expenses through this period are \$185,369.29. A breakdown of the budget by task is provided in Table 1. A copy of the progress report has been sent to Texas Water Development Board (TWDB) along with the monthly invoice.

**2.0 Progress on Tasks**

This report summarizes activities on project tasks during Fiscal Year 2017, Period 6 (encompassing February 17, 2017-March 18, 2017) and represents the twelfth progress report on this contract.

**Task 1: Project Management**

Progress was made on the agreements with the two in-kind teaming partners, Edwards Aquifer Authority (EAA) and Barton Springs Edwards Aquifer Conservation District (BSEACD). All documents necessary for project set-up have been delivered to EAA and BSEACD. SwRI Subcontracts and the Project Manager are working with these organizations to complete the steps necessary to finalize the in-kind agreements.

**Task 2: Data Acquisition and Method Development**

Task 2 has been subdivided into four subtasks. Progress on activities for the subtasks is as follows:

**Subtask 2.1 Acquisition and Initial Analysis of Groundwater Samples**

No work was performed on this subtask during this reporting period.

**Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs**

Development of a database with spatial attributes of all available logs [e.g. BRACS, Information

Handling Services Markit (IHS Markit), the Bureau of Economic Geology (BEG)], with care to adhere to BRACS format, continued. Other sources of relevant information including published literature, Groundwater Conservation Districts, Oil and Gas databases, water supply wells, Texas Commission on Environmental Quality (TCEQ) Public Supply, and United States Geological Survey (USGS) Produced Water databases are under consideration for use in the project. INTERA has continued their analyses of geophysical logs in the Northern Trinity in support of the calculation of water quality. An additional 73 wells, each with multiple well log curves, are under consideration for digitization.

### Subtask 2.3 Develop Technical Approach for Estimating Total Dissolved Solids from Geophysical Logs

Efforts have continued towards developing a method for correlating total dissolved solids (TDS) data and geophysical log attributes. Given its technical complexity, work on this task will continue for most of the duration of the project. The project team continues to interpret logs for stratigraphy and estimate TDS/Salinity from logs.

Although several methods remain potentially viable, the current approach for correlating TDS to geophysical log attributes requires shallow and deep resistivity curves in the water producing zones of interest as well as data for mud and mud filtrate resistivity. As such, efforts have been made to locate all logs that meet these criteria throughout the framework domain, irrespective of proximity to wells with TDS data available from TWDB's groundwater database. An initial set of these has been identified and digitized in order to initiate efforts to correlate curves to proximal TDS data. Geophysical logs in the IHS database have also been evaluated to identify wells with desired geophysical data. These efforts are necessary to identify key wells throughout the framework domain.

Unfortunately, efforts to date have shown that there is limited availability of geophysical logs with desired attributes (i.e., good quality resistivity data) near or associated with fresh water Trinity Aquifer wells in the Hill Country region. The lack of required log data will likely result in limited capability to correlate geophysical log-derived water resistivity ( $R_w$ ) values with known water compositions and measured  $R_w$  values.

Analyses of water chemistry data for the Hill Country and Northern portions of the Trinity Aquifer to characterize the spatial and hydrostratigraphic distributions of chemical constituents and TDS has been completed.

Revised TDS versus conductivity relationships (conversion factors) for the Paluxy, Glen Rose, Hensell, Pearsall, and Hosston formations of the Northern Trinity were generated. The revised conversion factors eliminate the need to estimate  $NaCl_{TDS}$  prior to calculation of TDS. Due to the influence of sulfate on conductivity being limited in the majority of Northern Trinity waters, the use of two separate factors for converting between TDS and conductivity (representing high and low slopes) is required only for the Glen Rose. A similar approach has been employed for the Hill Country waters.

Recalculating conductivities provides an explicit accounting for the highly variable water chemistry in the Trinity Aquifer and is based on methods that are well-established in the literature. Similarly, some modification of Rwe to Rw correction factors may also be required to account for the complex influences of bicarbonate and sulfate on resistivity and SP logs. Additional work will be conducted to assess needed factors for both portions of the aquifer.

#### Subtask 2.4 Use Geophysical Log Interpretation to Analyze Stratigraphy and Map Fresh, Brackish, and Saline Groundwater

Gamma ray logs are being utilized for stratigraphic interpretation. In addition, resistivity and spontaneous potential (SP) logs are being used for strategically located wells that do not have gamma logs. Also, resistivity and SP logs (potential use of SP data is likely limited to sand-dominated units such as the Hosston and Hensell but has been effective for some Cow Creek producing zones) will be utilized for the salinity analysis. Digitized well logs are being evaluated and the development of our interpretation approach is underway. Significant progress on this subtask has already occurred, and work is expected to continue in subsequent reporting periods.

#### **Task 3: Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes**

Task 3 has been subdivided into two subtasks. Progress on activities for the subtasks is as follows:

##### Subtask 3.1 Extend Stratigraphy for the Hill Country Trinity

Information on stratigraphy is being collected and evaluated based on the extent of the data acquisition domain. Literature has been assessed for useful stratigraphic and structural information (e.g., cross-sections, fence diagrams, structure contour maps, well header information, stratigraphic horizon picks from wells, and fault maps), which can be utilized to fill in data gaps as needed throughout the project.

Well logs from the BRACS well database that have stratigraphic information, including stratigraphic horizon picks and lithologic information, have been evaluated and will be quality controlled and re-interpreted as needed. The data are being evaluated to determine whether stratigraphic picks are consistent with those from other logs in the region, and/or with picks from a known reliable source such as a Key Well<sup>1</sup>. Log information from the IHS database has been evaluated and there are 458 wells that have logs that penetrate the Trinity that will be used for stratigraphic interpretation.

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<sup>1</sup> A key well is a well that is tightly constrained in terms of identification, position information, well geometry, pick information in measured depth, wireline log data tied to interval picks in measured depth, and formational water chemistry.

### Subtask 3.2 Determine Volumes of Fresh, Brackish, and Saline Groundwater

Evaluation of the relationship between electrical resistivity and fluid salinity has continued during this period. It is recognized that defining this relationship will be challenging due to the confounding influences of electrically conductive clay zones, but this work will be central to delineating the extent of brackish water in the Trinity Aquifer because geophysical logs will be the primary source of information used in this subtask.

### **Task 4: Delineate Potential Production Areas**

Team members have initiated efforts toward delineating potential production zones.

### **Task 5: Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water**

Progress on this task is contingent on completion of the previous tasks.

### **Task 6: Stakeholder Communication**

Planning for stakeholder meetings has been initiated.

### **Task 7: Reporting**

Task 7 has been subdivided into 2 subtasks. Progress on the subtasks is as follows:

#### Subtask 7.1 Project Monitoring Procedures

The project timeline has been reviewed frequently. The project budget has been monitored on a weekly basis using the SwRI Project Cost System. Project activity for each period is summarized in status reports for review by TWDB.

#### Subtask 7.2 Project Deliverables

Progress on this task during this reporting period has included preparing and delivering “Monthly Letter Progress Report #11: Period 5, Fiscal Year 2017.” Work on all portions of the Methods Report has been continued. The draft outline and decision trees have been considered while developing the report. Work on identifying the potential production zones has continued.

### **3.0 Planned Activities for the Next Reporting Period (Fiscal Year 2017, Period 6)**

#### **Task 1: Project Management**

The agreements with the two in-kind teaming partners, EAA and BSEACD, will continue to be a project-management focus during the next reporting period.

#### **Task 2: Data Acquisition and Method Development**

Task 2 has been subdivided into four subtasks. Planned activities for the subtasks are as follows:

##### **Subtask 2.1 Acquisition and Initial Analysis of Groundwater Samples**

Groundwater data, including groundwater data from within the data acquisition domain, will continue to be gathered, evaluated, and analyzed during the next reporting period. This evaluation will be ongoing for most of the project.

##### **Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs**

Additional geophysical logs (e.g., spontaneous potential, resistivity), including those from the IHS database, will be evaluated for usefulness in determining an approach for estimating TDS from the logs. Development of a database with spatial attributes of all available logs (e.g., BRACS, IHS, BEG), with care to adhere to BRACS format, will continue. Other sources of relevant information including literature, groundwater conservation districts, oil and gas databases, water supply wells, TCEQ Public Supply, and USGS Produced Water databases will continue to be evaluated as needed throughout the project. A project database of water quality data relevant to the project domain and preliminary hydrochemical facies analysis for the project domain will continue to be developed using TWDB's groundwater database.

##### **Subtask 2.3 Develop Technical Approach for Estimating Total Dissolved Solids from Geophysical Logs**

Efforts towards developing a method for correlating TDS data and geophysical log attributes will continue. Remaining well logs identified for potential digitization (those with resistivity curves that correspond to or are proximal to wells with TDS data extrapolated from TWDB's groundwater database) will be evaluated, and selected well logs will be digitized. Some wells that have both shallow and deep resistivity curves will be selected and digitized. These curves will be cross-plotted so that the resistivity of the fluid can be estimated.

##### **Subtask 2.4 Use Geophysical Log Interpretation to Analyze Stratigraphy and Map Fresh, Brackish, and Saline Groundwater**

Digitized well logs will continue to be evaluated, and the development of an interpretation approach will continue as well. Resistivity and SP curves will be utilized for salinity analysis during method development.

The project team will continue to develop and revise the decision trees and the Methods Report as the project methods are developed, tested, and evaluated.

### **Task 3: Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes**

Task 3 has been subdivided into two subtasks. Planned activities for the subtasks are as follows:

#### **Subtask 3.1 Extend Stratigraphy for the Hill Country Trinity**

Progress on this subtask will continue in the next reporting period with the assessment of relevant well data and subsequent stratigraphic interpretation.

#### **Subtask 3.2 Determine Volumes of Fresh, Brackish, and Saline Groundwater**

Evaluation of the relationship between electrical resistivity and fluid salinity will continue during the next period. It is recognized that defining this relationship will be challenging due to the confounding influences of electrically conductive clay zones, but this work will be central to delineating the extent of brackish water in the Trinity Aquifer because geophysical logs will be the primary source of information used in this subtask.

### **Task 4: Delineate Potential Production Areas**

Work on identifying the potential production zones will continue over the next period.

### **Task 5: Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water**

Efforts toward determining the amount of brackish groundwater available for production without causing negative impact on lateral and vertical fresh water will be initiated.

### **Task 6: Stakeholder Communication**

Planning for stakeholder meetings will continue.

### **Task 7: Reporting**

Task 7 has been subdivided into 2 subtasks. Planned activities for the subtasks are as follows:

#### **Subtask 7.1 Project Monitoring Procedures**

The project timeline will continue to be reviewed frequently. The project budget will continue to be monitored on a weekly basis using the SwRI Project Cost System. Project activity will continue to be summarized in status reports for review by TWDB.

#### Subtask 7.2 Project Deliverables

The twelfth (current) progress report (covering Period 6, FY 2017) will be submitted to TWDB during Fiscal Year 2017, Period 7. As progress is made toward method development, the Methods Report will continue to be prepared. Work on identifying the potential production zones will continue.

### **4.0 Problems/Issues and Actions Required/Taken**

No problems or issues were encountered during this period.

**Table 1. Project Budget Versus Expenses**

Task	Description	Budget	Invoices		Remaining Budget
			Current	Total	
1	Project Management	\$22,640.00	\$0.00	\$16,872.03	\$9,512.96
2	Data Acquisition and Method Development	\$134,555.00	\$0.00	\$94,396.61	\$40,158.39
3	Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes	\$116,878.00	\$13,642.39	\$63,436.42	\$53,441.58
4	Delineate Potential Production Areas	\$40,001.00	\$574.41	\$1,174.98	\$38,826.02
5	Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water	\$56,740.00	\$0.00	\$0.00	\$56,740.00
6	Stakeholder Communication	\$35,631.00	\$0.00	\$0.00	\$35,631.00
7	Reporting	\$13,555.00	\$95.75	\$9,489.25	\$320.76
Total		\$420,000.00	\$14,312.55	\$185,369.29	\$234,630.71