

**Monthly Letter Progress Report #1 – March 2016
Study of Brackish Aquifers in Texas – Project No. 3 –
Rustler Aquifer**

TWDB Contract No. 1600011949

Submitted to

**Texas Water Development Board
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1.0 Budget and Expenses

This report summarizes the project costs for the billing period from Contract Approval Date (January 6, 2016) through April of 2016. The total expenses through March 2016 are \$28,692. A budget breakdown by tasks is provided in Table 1. A copy of the progress report has been sent to TWDB contracts department along with the monthly invoice.

TASK	DESCRIPTION	Budget	Invoices			Remaining Budget
			Current	Previous	Total	
1	Project Management	\$9,235	\$2,196	\$0	\$2,196	\$7,039
2	Delineate Vertical & Horizontal Extent of Fresh, Brackish & Saline Groundwater	\$97,688	\$19,917	\$0	\$19,917	\$77,771
3	Quantify Volume of Fresh, Brackish & Saline Groundwater	\$13,679	\$1,303	\$0	\$1,303	\$12,375
4	Delineate Potential Production Areas	\$20,532	\$5,087	\$0	\$5,087	\$15,445
5	Documentation and Technology Transfer	\$23,086	\$0	\$0	\$0	\$23,086
6	Final Report, Documentation & Technology Transfer	\$35,780	\$0	\$0	\$0	\$35,780
Total		\$200,000	\$28,503	\$0	\$28,503	\$171,497

Table 1. Project Budget Versus Expenses

2.0 Progress on Tasks

This report summarizes activities on project tasks through the month of April February, 2016 and represents the first progress report on this contract

Task 1 Project Management

INTERA Project Management activities have been focused on several items since INTERA was given the notice to proceed in January. Primary activities have included:

- The Project Manager worked with the TWDB to get a signed contract for the work which was finally signed by the TWDB on March 22, 2016. Once INTERA had a signed prime contract we could work on signing subcontracts.
- The Project Manager spoke with David Carter (TWDB) regarding the classification of Drilling Info, Well Green and Subsurface Library as vendors. It was agreed that this approach was appropriate.
- The Project Manager set the project up within INTERA and started developing the key subcontracts that are early time mission critical which include the subcontract with Dr. Dennis Powers and the subcontract with Dr. Carlos Torres-Verdin (University of Texas). Both of these subcontracts have been signed.
- INTERA lead technical staff Daniel Lupton, Dr. Dennis Powers and the Project Manager met with TWDB BRACs staff at INTERA's offices on March 10th, 2016. Daniel and Dr. Powers led the discussion of progress to date on developing the hydrostratigraphy of the Rustler Formation members. It was decided at this meeting that the potential production zones would likely be limited to the Culebra and Magenta dolomites and the Lower Unnamed Member.

Task 2 Delineate Vertical and Horizontal Extent of Brackish and Saline Groundwater

Task 2 has been subdivided into 6 subtasks. Progress made on the 6 subtasks is as follows:

Task 2.1 – Acquire and Digitize Geophysical Well Logs: At this point, structural picks for the tops of the Member Units within the Rustler Formation have been made at 513 separate locations with geophysical logs (see Figure 1). After the completion of the picks, they will be transferred to Dr. Dennis Powers for QA/QC. After Dr. Powers completes his review of all of the picks, surfaces representing the best approximation of the spatial distribution of the geologic contacts will be created. In addition, upon completion of Dr. Powers check, wells that are being used for cross sections and wells that are being used for water quality analysis will be digitized by Well Green. We anticipate that this process will begin before May 1st.

Task 2.2 – Draft Techniques and Approaches Report and Meeting: Progress on this subtask is directly related to Dr. Torres-Verdin's work. Currently Dr. Torres-Verdin has made an initial selection of 12 wells that each have multiple geophysical log (most commonly resistivity/SP/porosity/gamma). These logs will be used to numerically evaluate the impacts that the particular logging tool and borehole environment have on the calculation of water quality. The results of this analysis will provide insight into the calculation water quality from resistivity logs. Dr. Torres-Verdin's first update is scheduled for April 30th and will provide the necessary information to succinctly detail our process for the calculation of water quality from resistivity logs. In addition, samples of water quality from water wells have been acquired and all of the wells have been evaluated in section with geophysical logs. This distribution of water quality samples will be used in combination with calculated water quality from resistivity logs to interpolate water quality distributions within the Rustler Formation.

Task 2.3 – Evaluate Structure and Lithology: This task is approximately 60 percent complete. Picks have been made on 513 wells for the member units of the Rustler Formation. In April, the picks will be sent to Dr. Powers for review. Upon completion of his review INTERA will interpolate the picks and create surfaces for the individual member units, accounting for the extreme structure present in the study area. In addition, the distribution of picks for the Member Units of the Rustler has also created a boundary that we understand to be the transition between the collapse and karstified Rustler and the stratigraphically intact Rustler. This transition is marked by an inability to decipher the individual member units to the west of the north south line and ability to decipher the individual member units to the east of the line. In most cases this line is parallel with outcrop and approximately 10-20 miles down dip.

Task 2.4 – Generate Surfaces Defining the Member Units of the Rustler: As previously mentioned, INTEA has made picks for the Member Units of the Rustler at 513 separate locations (Figure 1). However, the process of generating surfaces defining the Member Units of the Rustler has not yet begun. It is anticipated that this process will begin in late April.

Task 2.5 – Formation Parameter Sensitivity Analysis: Using a combination of the IHS, DrillingInfo, BRACS and Subsurface Library log databases, INTERA selected 30 “Potential Key Wells” that had some combination of Gamma, Caliper, SP, Resistivity, Neutron Porosity or Acoustic Porosity logs (Figure 1). These wells were submitted to Dr. Torres-Verdin on April 1st. Dr. Torres-Verdin will provide INTERA with the most ideal distribution of 20-25 well logs to get digitized. It is anticipated that he will provide this list in late April.

Task 2.6 – Interpret Water Quality Based on Distribution of Resistivity: INTERA has identified 93 resistivity logs that can be made publicly available and have a log curve running through the majority of the Rustler Formation. After Dr. Torres-Verdin makes his selection of potential key wells, INTERA will allow the distribution of potential key wells to guide the selection of resistivity logs to use to calculate water quality from. Additionally, INTERA will use the wells determined to have water quality samples from the Rustler Aquifer to guide the calculation of water quality. All of the water quality samples with adequate data will be used to calculate a Sodium Chloride based Total Dissolved Solids value (TDS_{NaCl}) and the ratio between the TDS and the TDS_{NaCl} values will be determined and used as a conversion between the two values.

Task 3 Quantify Volume of Fresh, Brackish and Saline Groundwater

In an attempt to work more efficiently, INTERA has purchased an extra subscription to the well log analysis program Petra and a portion of that has been applied to Task 3. Otherwise, no work was performed on this task in through April.

Task 4 Delineate Potential Production Areas

Task 4.1 - Refine Hydrostructural Model and Transmissivity Estimates

Structural picks made in support of Task 2 were used to evaluate the current distribution of the major structural features, mainly faults. Currently, it is anticipated that the faults are accurately represented using the hydrostructural zonation of the Rustler Aquifer. The hydrostructural zonation will be further evaluated during the surface creation process as derivative surfaces of the top of Rustler structural surfaces are made. Areas of high increase in slope will correspond to areas of potential faulting.

Transmissivity estimates, or areas of transmissivity were investigated during the month of March. In general the Vaca Triste Member of the Salado Formation was not discernable in the study area. Therefore, it was necessary to come up with a different metric for the identification of collapsed Rustler Formation. It is still anticipated that areas of collapsed Rustler Formation will result in higher transmissivities. In general, given the highly predictable nature of the stratigraphy of the Rustler Member Units, areas where a relatively straight forward pick for all or most of the Rustler Member Units was determined to be an area that has not experienced solution collapse and in turn an increase in transmissivity. At this point, that area appears to be confined to the outcrop area and approximately 10-20 miles down dip of the outcrop. In addition, to support the transmissivity evaluation, all submitted drillers reports with screen information were sample to the structural top and bottom of the Rustler Formation. Wells that were mostly within the Rustler Formation and had a specific capacity test or simply a production value were pulled aside and will be posted on a map of the study area to evaluate trends.

Task 4.2 – Map Hydrogeologic Barriers

Significant progress was made on this task. At this point, the major faults in the area are the main hydrogeological barrier and are accurately represented using the hydrostructural zonation.

Task 4.3 – Identify Protected Areas

Currently, all wells through to be screened or completed into the Rustler in the Submitted Driller's Reports database and Groundwater Database from the TWDB have been accumulated. Water quality distributions based on wells that have water quality data have shown that there are some wells in the Rustler outcrop area that are producing water at or below the brackish threshold of 1,000 mg/L TDS. It is anticipated that this area will be identified as a protected area. In addition, there are other cluster of wells that are producing from the Rustler that could be candidates for Protected Areas. The only currently operating groundwater district, the Middle Pecos GCD, has been contacted and their advice has been solicited. We are currently waiting to hear back from them.

Task 4.4 – Identify Potential Production Areas

No work was performed on this task in through March.

Task 4.5 – Potential Production Area Meeting with TWDB

No work was performed on this task in through March.

Task 5 Determine Availability of Brackish Groundwater in Potential Production Areas

No work was performed on this task in through March.

Task 6 Final Report, Documentation and Technology Transfer

No work was performed on this task in through March.

3.0 Planned Activities for the Next Month

The project timeline is quite compressed on this project with a draft report due July 31st. The following section will define key expected activities that will be performed or completed in April of 2016.

Task 1 Project Management

In addition to standard project management activities, the following tasks will be performed in April as part of Project Management:

- Subcontracts for Dr. Jack Sharp and Carollo will be completed.
- The INTERA Team will visit with the TWDB to define a date for the Stakeholder Meeting to proposed potential production areas. In our meeting held on March 22nd we targeted the middle of June. Middle Pecos GCD has already called asking about the date of the meeting and said they would be happy to help organize.

Task 2 Delineate Vertical and Horizontal Extent of Brackish and Saline Groundwater

Planned activities for task 2 are as follows:

Task 2.1 – Acquire and Digitize Geophysical Well Logs:

Given our current budget, we anticipate digitizing: the gamma curve for all geophysical logs in cross sections, the deep resistivity curve for some adequate distribution of the 93 publicly available resistivity logs and all curves for the Key Wells that will be sent to Dr. Torres-Verdin for his sensitivity analysis.

Task 2.2 – Draft Techniques and Approaches Report and Meeting:

We will begin drafting this report in early May so it is not anticipated that any writing on this will occur in the month of April.

Task 2.3 – Evaluate Structure and Lithology:

The majority of this work has been completed and any future work on this will be in support of Task 2.4.

Task 2.4 – Generate Surfaces Defining the Member Units of the Rustler:

This task will begin in late April and should take until early May.

Task 2.5 – Formation Parameter Sensitivity Analysis:

Dr. Torres-Verdin has agreed in his contract to provide us the necessary information to calculate brackish Potential Production Areas (PPAs) by the end of May. In order to provide that information Dr. Torres-Verdin will need to be close to or at completion with his formation parameter sensitivity analysis. Dr. Torres-Verdin has agreed to provide us with some insights by April 30th.

Task 2.6 – Interpret Water Quality Based on Distribution of Resistivity:

Once Dr. Torres-Verdin provides the results of his formation parameter sensitivity analysis, his recommendations will be used to interpret water quality from resistivity signatures. Given that the

structural picks will already be made and the resistivity signatures will be digitized, it is anticipated that implementing his recommendations will be a relatively quick process. If Dr. Torres-Verdin gets us the necessary information in April, then work related to this task will be in.

Task 3 Quantify Volume of Fresh, Brackish and Saline Groundwater

This task will be implemented using three sets of data: 1) water quality sampled from water wells deemed to be producing from the Rustler Formation, 2) water quality calculated from resistivity logs run through the Rustler Formation and 3) structural picks used to confine the sampled/calculated water quality values to the limestones of the Los Medanos Member and the Culebra and Magenta Dolomite Members of the Rustler Formation. Currently the first and third input datasets are almost complete. What remains is to calculate water quality from resistivity logs and interpolate structural surfaces for the various member units. It is anticipated that a small portion of this will be completed in April and the rest in mid to late May.

Task 4 Delineate Potential Production Areas

For the month of April, we anticipate continuing the processes of: refining the hydrostructural and transmissivity estimates and mapping hydrogeologic barriers. It is possible that in late April/early May we will be ready to identify potential production areas.

Task 5 Determine Availability of Brackish Groundwater in Potential Production Areas

No work is expected to occur on this task in April.

Task 6 Final Report, Documentation and Technology Transfer

It is expected that some work on Task 6 will occur in April as we prepare for the Stakeholder Meeting and prepare the Draft Report.

4.0 Problems/Issues and Actions Required/Taken

No problems or issues were encountered in March.

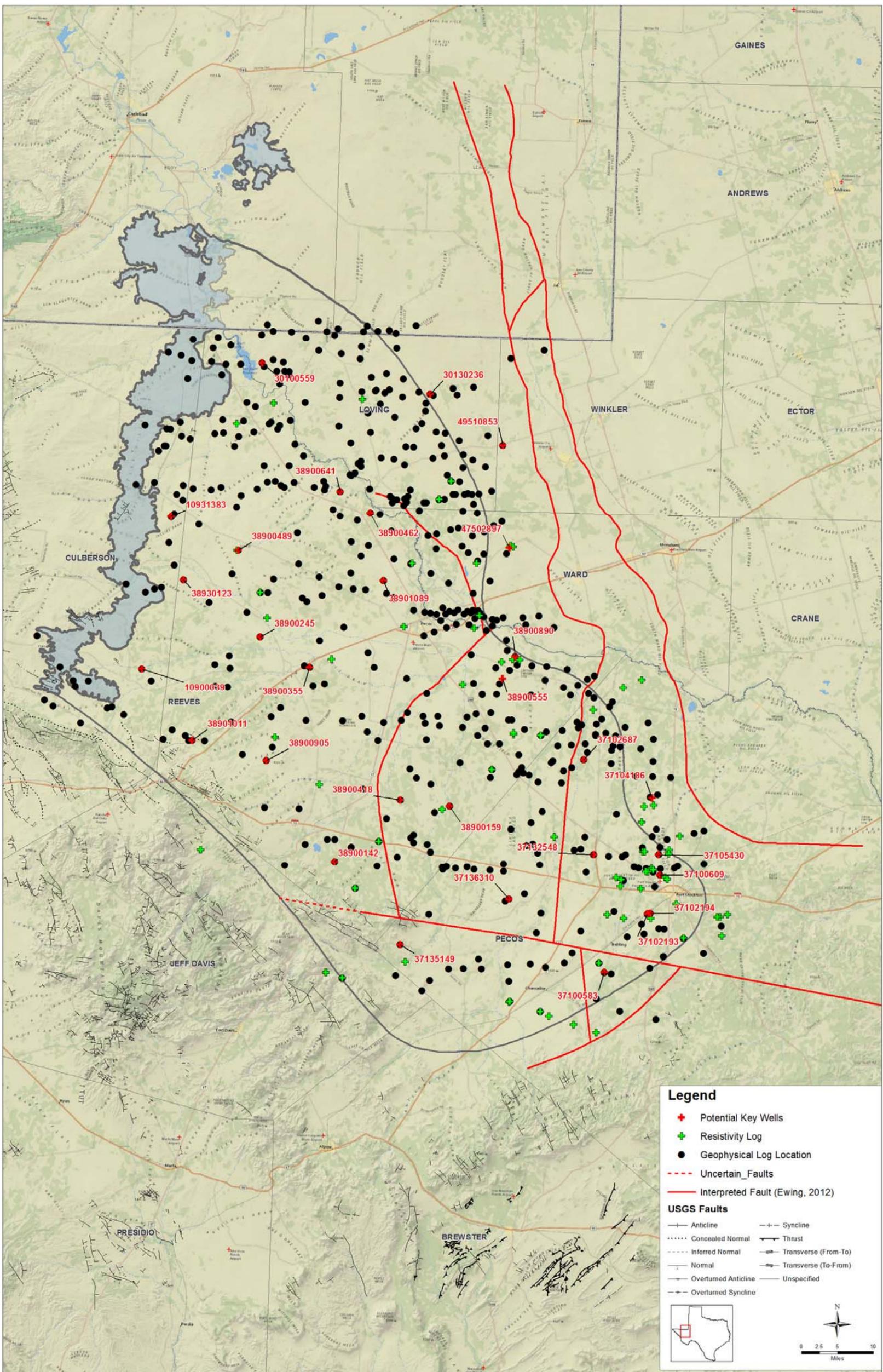


Figure 1 Distribution of potential key wells, publicly available resistivity logs and geophysical log locations used to make structural picks.