

Seminole Integrated Wind-Water Demonstration System

Progress Report for August, September and October 2009

Submitted to

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1.0 INTRODUCTION AND OVERVIEW

1.1 Scope and Content This progress report is submitted jointly to the Texas Department of Rural Affairs (TDRA) and to the Texas Water Development Board (TWDB). TDRA formerly was called the Office of Rural and Community Affairs (ORCA). The report is submitted as part of TDRA contract number 728082 and TWDB contract number 0804830832. In addition to project funding from the TDRA and the TWDB, major participants include the City of Seminole, Entegriy Wind Systems and the US Department of Energy through Texas Tech University. The project was initiated in April 2009 and is expected to run for two years.

1.2 Project Description This project addresses the continuing depletion of the Ogallala aquifer, the current principal source of potable groundwater for much of west Texas and northward through Kansas. The approach is to access, lift and purify brackish, much deeper water-bearing formations in the Santa Rosa of the Dockum group. On the basis of preliminary evidence, these formations are believed to occur in Gaines County at depths ranging from 1500 to 2000 ft.

The purification will be accomplished using reverse osmosis (RO). The electrical energy required for the well lift pumps and those of the RO system will be supplied principally by a grid-connected 50 kW wind turbine. The purified water is to be utilized as part of the municipal water supply of Seminole, Texas, a community with a population of about 7,000. Seminole is located in Gaines County in the southern panhandle of west Texas bordering New Mexico. The results are expected to be applicable to many other arid and semi-arid regions as well.

The project encompasses the following broad tasks:

- 1) The siting, drilling and characterization of a well drilled into the Santa Rosa, including site acquisition, pre-drilling hydro-geological investigations, permitting, logging, well completion and test;
- 2) The design and construction of required infrastructure, including site preparation, foundations and civil works to support the wind turbine, RO system and other system elements;
- 3) Installation and commissioning of a 50 kW wind turbine provided by Entegriy Wind Systems, including the foundation, electrical infrastructure and liaison with the local utility;
- 4) The procurement, installation and commissioning of a commercial reverse osmosis system, including necessary permits, civil structures, electrical work and piping;
- 5) The design, permitting and construction of an evaporation pond or other means for dealing with the concentrate from the RO system;
- 6) Operation and characterization of the integrated wind-water purification system for a period of 12 months;

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7) Documentation and reporting of project results and performance.

1.3 Summary of Previous Activities A site visit and project initiation meeting was held in Seminole on 27 April Monday. Attending were Travis Brown and Julie Hartley of TDRA; Sanjeev Kalaswad of the TWDB; Mayor Wayne Mixon and City Administrator Tommy Phillips of Seminole; Kay Howard of Howco and Jamie Chapman of Texas Tech University. Reviewed were the procurement rules and procedures, schedule and other contract details. A proposed project organizational structure was presented and approved.

Subsequent to this meeting, procurement guidelines for design and engineering services and for construction activities were discussed and reviewed extensively with procurement officials from the TDRA. It was agreed that *design and engineering services* provided by outside vendors would be procured by TTU on behalf of Seminole, invoiced by the vendors to TTU and that TTU would in turn invoice Seminole. Design, engineering and management services provided by TTU faculty and staff also would be invoiced to Seminole.

It was agreed that *construction services* would be procured directly by Seminole with support from TTU.

Two hydro-geological investigations were conducted through Gaines County, in which Seminole is located. For each, well logs were procured and analyzed to assess the currently-available information. The wells and their associated logs traversed North to South and West to East across Gaines County. The investigations were conducted by Judy Reeves of Cirrus Associates¹ under contract to Texas Tech University. The first investigation was focused on the existing Ogallala well field.

The second focused on the location of the Santa Rosa well. This second report from Cirrus. *Evaluation of the Proposed Well Location for a Municipal Water Supply Well in the Dockum Aquifer, Gaines County, Texas* dated 26 June was previously submitted electronically. The first, recently available in electronic form, arrived at substantially the same conclusions and will be forwarded with this report.

Reproduced on the following page are the conclusions and recommendations from the second report. These appeared on pages 3 and 4.

In addition to the Cirrus activities, discussions were held with Parkhill, Smith and Cooper of Lubbock regarding the design and permitting of the production well together with a possible test hole. A quote was obtained and a purchase order issued to PS&C by Texas Tech University.

¹ Information about Cirrus may be found at the web site <http://www.cirrusassociates.com> .

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Conclusions

The east-west cross section suggests that the target Santa Rosa horizon is 1540 to 1800 feet bgs. The north-south cross section suggests that the target Santa Rosa horizon is 1440 to 1840 feet bgs. Because the control wells on the east - west cross section are in closer proximity to the location of the proposed water supply well than the wells on the north-south cross section, it is more likely that the east west depths are more representative of the elevations of the Santa Rosa Formation in the vicinity of the proposed well. The actual zone can be determined during placement of a test well.

The logs indicate that the target Santa Rosa horizon is not homogeneous, but rather consists of three to five sandstone beds⁴ that are separated by thinner mudstone or shale layers. The sandstone beds range in thickness from 20 to 80 feet thick and are separated by thinner mudstone/shale beds up to 50 feet thick.

Typical porosity of sandstone is up to 30%, whereas, mudstone/shale layers have typical porosities of up to 10%, and therefore have limited storage capacity in the pore spaces. Therefore, the sandstone beds are expected to have the highest potential for well yield. Although porosity is an important property of an aquifer, the ability of the proposed well to support a municipal water supply well will depend on additional factors, such as hydraulic conductivity, which is the capacity of a porous medium to transmit water. The geophysical logs used in this study, indicate zones of higher porosity that may be suitable for well placement, but the geophysical logs do not provide information about hydraulic

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conductivity.

This study suggests a potential saturated zone of over 250 feet in the lower Dockum sediments. This saturated thickness should support a municipal water supply well, but regionally recognized problems with well yield and water quality in the Dockum aquifer must be recognized. Sustainability and water quality will be unknown until placement of a test well.

It is also important to note that recharge to the Dockum aquifer is expected to be minimal, if any, in this part of the Dockum basin, and therefore water withdrawn through a well will result in mining the aquifer.

Recommendations

The geophysical logs, coupled with knowledge of the general geology of the region and typical geophysical signatures for different lithologies, provide useful pre-drilling planning information that can improve the probability of success in placement of a water supply well.

A test well should be placed in the location of the proposed water supply well to further evaluate the lower Dockum aquifer (i.e., Santa Rosa Formation) which, based on evaluation of geophysical log data, appears to be most favorable to support a public water supply well. Because of potential water bearing units in the upper Dockum section, the upper Dockum units should be evaluated while drilling.

The reports also identified a possible second, shallower layers in the range 600 to 800 ft bgs that may be water bearing. As drilling and logging proceeds, attention will be paid to this range also.

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2.0 SUMMARY OF ACTIVITIES THIS PERIOD

2.1 Overview Activities this period included the following: 1) Under a purchase order from TTU to Parkhill, Smith and Cooper (PC&S), the investigation, design, permitting and expected cost of the Santa Rosa well were initiated; 2) In planning for the well drilling, quotes and information for well logging were obtained; 3) Initial meetings concerning layout of the Santa Rosa well and associated infrastructure were held with West Texas Consultants of Andrews, Texas.

2.2 Design and Permitting of the Santa Rosa Well Based on a proposal from PC&S, activity on the design, permitting and anticipated cost of the Santa Rosa well were initiated. Reviewed were the design, placement and permitting requirements from the Texas Commission on Environmental Quality (TCEQ) and the Llano Estacado Water District (LEWD). These are believed to be the principal agencies having jurisdiction.

Test Hole Based on the initial belief that a test hole (having a nominal 4 in diameter) would be affordable within the \$300K funds available under the TWDB contract, a test hole was considered. Based on budgetary estimates provided by Randy Taylor, LT Drilling of Sun Ray, Texas, the expected cost for a test hole to about 2000 ft was projected to be \$50,000 not including geophysical logging. Even though a test hole would provide substantive information corroborating the Cirrus logging reports, this possibility was deemed not affordable and not considered further.

Production Well With regard to the production well, the issues addressed thus far include 1) the location within the 520 acre parcel to which Seminole has the water rights; 2) the expected cost of the well; 3) the expected cost of the geophysical logging and the techniques to be utilized; 4) the anticipated time required for permitting together with the time required under TDRA rules for the advertising of the request for proposals (RFPs), receipt of bids and evaluation of bids; and 5) the expected lead time for the onset of drilling after a bid review and award is made.

Well Location Seminole is in the process of acquiring title to about five acres within the 520 acre water rights parcel. An existing Ogallala well formerly used for center-pivot irrigation is situated with the 520 acres. It is desired to be able to use this well for future municipal supply. However there is a TCEQ requirement that any other wells be situated more than 300 ft from an existing well. An additional factor is the placement of the evaporation pond. These factors will affect the shape of the five acre parcel and may require the purchase by Seminole of additional acreage. To address these issues, meetings will be held with West Texas Consultants for the planning and layout of the site.

Initial Budgetary Estimates for the Cost of the Well On the basis of informal conversations, LT Drilling projected the cost of an 1800 ft Santa Rosa well not including logging to be \$328K. This estimate was based on a 16-in diameter casing in a 20-in diameter hole. While this estimate is of concern, we are working to better understand the bases for the estimate.

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Factors driving this estimate include the well depth, but more importantly, the casing diameter. This diameter was driven by the diameter and required clearance for a pump to lift 30 gpm of water from an assumed 2000 ft depth. The pump diameter in turn appeared to be driven by the diameter of the motor. Based on the projected 40% efficiency of a 20-bowl pump lifting water 2000 ft, the power requirements would be about 60 HP (44 kW). We are seeking information from other pump manufacturers in attempts to better understand the fundamental reasons for these values and to investigate possible work-arounds or improvements.

Geophysical Logging Information and cost proposals for geophysical logging of the production well were obtained from Schlumberger and Weatherford. The estimates vary from about \$5K to \$15K, depending on the tools used and analysis. Separately Cirrus/Reeves have provided a recommended suite of tools (included as Appendix A). In addition, it is planned that Cirrus/Reeves will be onsite to monitor and evaluate the geologic materials during the drilling operation.

Time Characteristics The time required for the onset of drilling will be affected by 1) the time required for completion of the well design, issuance of permits by TCEQ and others; 2) the period required for bid advertising and evaluation; and 3) the time needed for any required environmental assessments or studies. With a drilling contract awarded and the supporting electrical and water infrastructure in place, the anticipated time required for (trouble-free) drilling is expected to be three days. It is expected that the TCEQ permit evaluation may occur in parallel with the preparation and advertising of the well drilling bid package. Once an award is made for the well drilling, the time required for mobilization and setup may be as long as 45 days. It thus appears that the time required for the onset of drilling will be significantly longer than anticipated.

Other Information Sources In addition to expertise from TTU, PC&S, Cirrus/Reeves, the geophysical logging companies and drillers, it has been suggested that the City of Hereford, Texas has extensive experience with Santa Rosa wells, although at depths of about 1000 ft. Visits are planned.

2.3 Entegritty Wind Turbine The wind turbine to be utilized as the principal electrical energy source is a 50 kW unit to be supplied by Entegritty Wind Systems, with offices in Boulder, Colorado. The availability and use of this wind turbine for a period of two years has been committed by Entegritty to Texas Tech University for use as a research wind turbine initially intended for installation at the University's Reese Test Center. With the emergence and possibility of the ORCA-TWDB Seminole wind-water project, the installation was delayed for possible use in this project.

With the ORCA and TWDB contracts in place, the documentation underlying this use is being drawn up between Entegritty and the University. The documentation will be in the form of a lease for a period of two years for a nominal payment. Schedule and maintenance support are being negotiated. It has always been agreed that the project would pay for the wind turbine foundation, installation and electrical infrastructure.

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APPENDIX A

Geophysical logging suite for the Dockum well in Gaines County

Judy Reeves [jreeves@**cirrus**associates.com]

Sent: Wed 10/28/2009 12:23 PM

To: zedwards@team-psc.com

Cc: Rainwater, Ken; Chapman, Jamie

Zane,

The basic log types that I recommended to Jamie Chapman earlier this year were:

1. Resistivity
2. Gamma ray
3. Neutron
4. Density

Different companies use different tools and tool combinations to obtain these logs and to derive different types of geophysical information. I would request that the driller ask the logging company that he intends to get a bid from for tool recommendations (based on their suite of available tools) for a water well in the Dockum in Gaines County (based on their experience with deriving useful logs for identifying porous and permeable water zones in similar rock formations (i.e., alternating shale, siltstone/mudstone, sandstone, conglomerates) and similar salinities (TDS range expected from ~2000 to ~5000 ppm). We will also want to know the tool configuration in order to determine how far off the bottom of the hole the tool will be logging (i.e. the measuring point off the bottom of the hole).

Thanks.

Judy A. Reeves

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