PROJECT
PROFILE

Expendable Dipole Probe for E-Logging

Allows Pressure Grouting Via Primary Rod String

Protecting Aquifer Integrity

prepared by: Wes McCall, Environmental Geologist, Geoprobe Systems

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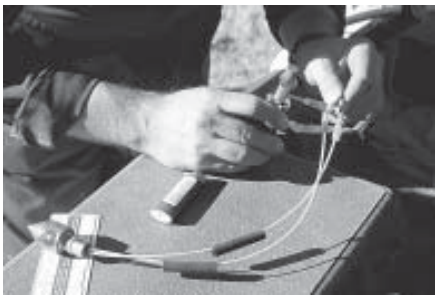
Shepard Engineering in Salina, Kansas, was interested in using the Direct Image® Electrical Conductivity Logging (E-log) System (manufactured by Geoprobe Systems) to define the subsurface geology at a facility in southcentral Kansas on the Arkansas River floodplain. There was concern about using conventional drilling because of known heavy metals contamination in the upper aquifer of the alluvial aquifer system. State regulators wanted to be sure a borehole or pathway was not created to the lower aquifer through the clay aquitard to allow the heavy metals to migrate into the lower aquifer. The lower aquifer is used as the primary drinking water supply in a nearby town, and as a primary irrigation and livestock water supply locally.

Expendable dipole probes (Geoprobe Systems Part No. SC310) for the electrical conductivity logging system were used for the project. These expendable dipole probes allow the field operator to run an E-log and then pressure grout through the primary probe rod string as the rods are retracted. This eliminates the need to install a secondary rod string for grouting after the conductivity probe is removed. Pressure grouting through the primary rod string assures that the probehole is sealed, and that no communication between the upper and lower aquifer can occur. Using Geoprobe's GS1000 or GS500 Grout Machine lets you pressure grout through the primary rods while monitoring the in-line pressure of the grout. Field operators observed the pressure gauge (and listened to the pump engine) and retracted the rods only during the positive pressure stroke of the pump to be sure that grout was being injected as the rods were retracted. As an additional measure to assure a good seal, field operators over grouted, using more 'pump strokes per probe rod' than was needed to fill the calculated boring volume (Table 1). One full pump stroke delivers about 13 cubic inches of grout which is enough to fill 10 inches of 1.25" diameter probe hole.



Attaching the SC310 Probe to the signal cable using heat shrink tape and miro-torch. A heat gun can be used on the shrink tape.

Closeup of the GS1000 Grout Machine showing the in-line pressure gauge and relief valve assembly (GS1090) used to monitor injection pressure of the 25% solids bentonite slurry.

The conductivity system was operated with the track-mounted Geoprobe Model 54DT. As shown on the preceding page, the SC310 probe attaches to the prestrung signal cable using heat-shrink tubing. The SC310 probe is inserted into an AT1213 Expendable Point Holder (Figure 1) on the lead 1.25-in. probe rod (AT1236 or AT1248). Once this initial set-up is completed then the E-logging system is operated as with all other electrical conductivity probes for E-logging. The SC310 probe, mounted in the lead probe rod, is advanced and additional prestrung rods are added to the tool string until the desired depth log is completed. After the log is completed the signal cable is snapped off of the expendable SC310 probe and grout is prepared. (Note: The SC310 can also be used with 1.0-inch probe rods.)

Geoprobe Model 54DT was used to advance the SC310 Expendable Dipole Probe over 80-feet below grade. The 12-volt outlet (Power Point) on the 54DT and a power inverter supplied all of the power required to operate the E-log hardware and computer.

Once the E-log is completed, the signal cable is snapped off of the expendable SC310 probe before the Grout Pull Cap (GS1254) is attached to the rod string.

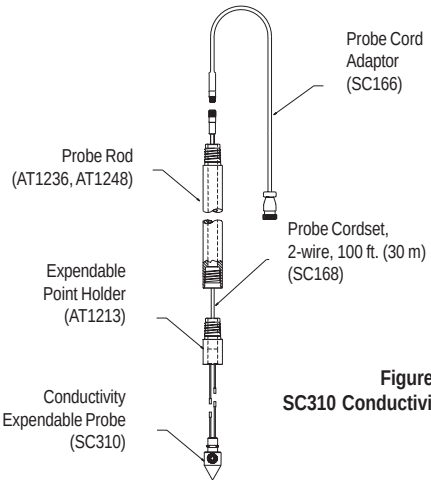


Figure 1
SC310 Conductivity Tool String

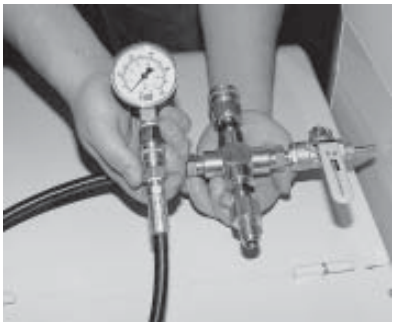
Table 1
E-LOG and GROUT VOLUME RECORD
Heavy Metals Site
Southcentral, Kansas

E-Log No.	Log+Grout+Decon (hrs:min)	Total Depth (feet)	Calculated Volume (gallons)	Grout Injected (gallons)	Pump Pressure (psi)	Pump Strokes per 4-ft Rod
PI-01	2:45	85	5.4	8.5	200 to 120	8
PI-02	2:00	68	4.5	6	75 to 100	8
PI-03	1:30	68	4.5	6	100 to 125	8
PI-04	1:45	64	4.1	4.5	100 to 125	6
PI-05	total below for 05 &05b	50	3.2	5	100 to 125	6 (Cable broke rerun log)
PI-05b	2:30	65	4.1	5.5	100 to 150	6
PI-06	2:00	65	4.1	4.5	150 to 200	6
PI-07	1:50	65	4.1	5	125 to 200	6

Note: Total time for E-logging, grouting, and decon at all seven locations was 14 hrs and 20 min. for a total of 480 feet of logging (not including footage at PI-05). That is an average of 2 hrs and 3 min. per log, or less than 2 minutes per foot. This does not include mobilization or travel time to the site.

Knowing the depth and diameter of the probehole, the required grout volume was calculated (Table 1), and at least 20 percent excess was prepared. A 25 percent solids bentonite slurry was used to seal the probeholes. The high pressure grout hose (GS1052) was attached directly from the GS1000 pump on the grout machine to the grout pull cap (GS1254). An inline pressure gauge (GS1090) was used to monitor the pressure. Initially the rods were retracted a couple of inches and then grout was pumped into the rods to fill them (Figure 2). A pressure spike (500+psi) was usually observed when the rods were filled and just as the expendable SC310 probe was popped off. A pump-n-pull routine was then used being sure to retract only on the positive pressure stroke of the pump. Rod cleanup was done using a 50-gallon water tank equipped with a battery powered pump from a pickup truck.

As Table 1 shows, seven logs were completed ranging in depth from 64-ft to 85-ft depth. The 85-ft log (PI-01) took 2 hours and 45 minutes to set up, log, grout, and decon. The quickest log to complete was at PI-03 which took 1 hr and 30 min. to set up, log, grout, and decon. At the PI-05 location, rods were driven as fast as possible through soft materials which loosened the connection between the SC310 probe and the signal cable. This required the field team to grout out from about 50 feet and start all over again (ref: 2 hrs 30 min. at PI-05).



The pressure gauge and relief valve assembly (GS1090) used to monitor inline grout pressure during retraction grouting.

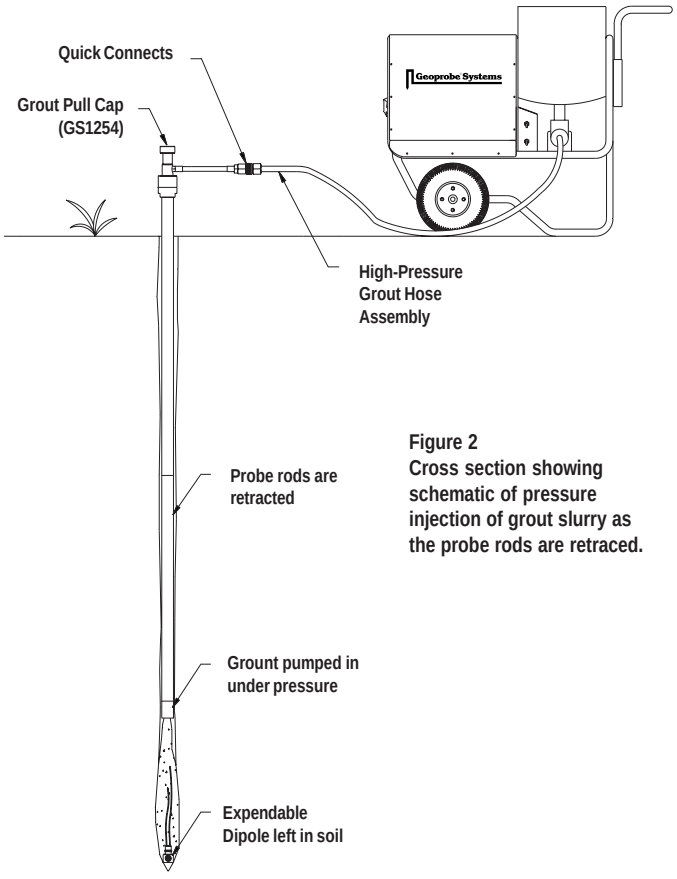


Figure 2
Cross section showing schematic of pressure injection of grout slurry as the probe rods are retraced.

The GS1000 Grout machine connected to the tool string with the high-pressure hose (GS1052) and grout pull cap (GS1254). Using the rod grip puller (GH2150K) makes the retraction grouting easy and quick.

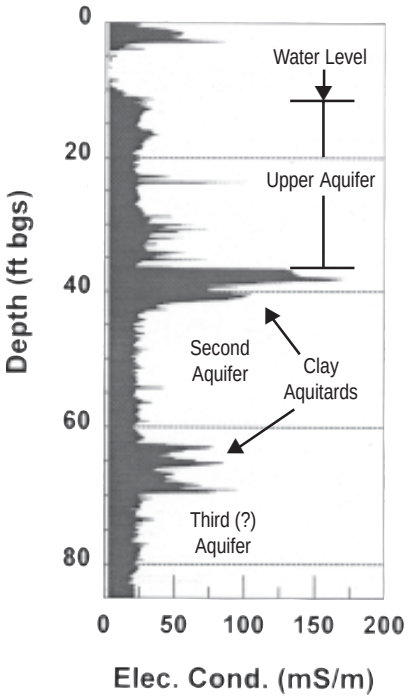
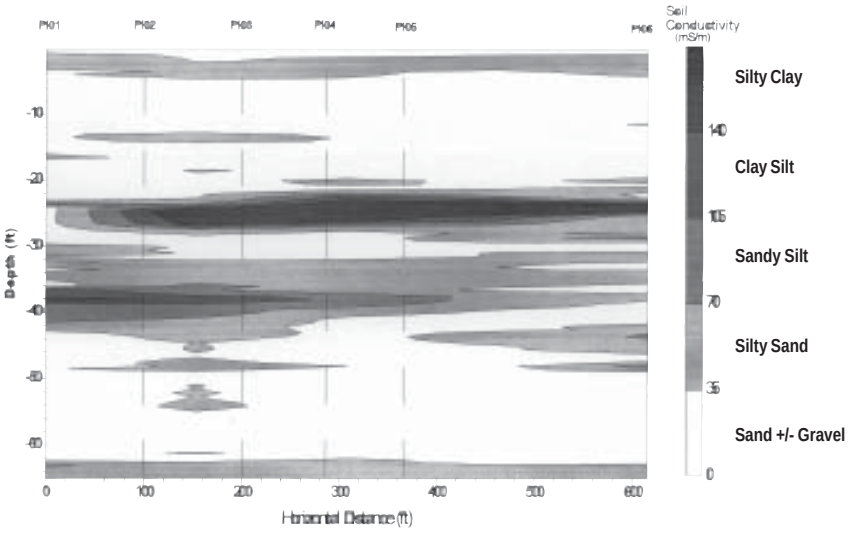


Figure 3
Electrical Conductivity Log
P1-01 E'Log

Figure 3 shows the E-log from PI-01 with a total depth of just over 84 feet. This is one of those rare situations where the water table can be clearly detected with the E-log. The water table is observed on this log at about 11 ft bgs where the dry sands become saturated. This was confirmed by sampling. A few targeted soil samples were collected with the Large Bore Soil Sampler to verify the E-logs. A cross section based on six of the logs run in a line across the facility (Figure 4) shows how the silt and clay rich layers (70 mS/m to 200 mS/m) thicken, thin, and even pinch out across the area.

Editor's Notes: Quite a bit of detailed information for less than 15 hours of work. Now, just how many days would it take to do this with a hollow stem auger and split spoon sampler?? Is that 4 days? Or maybe 6 days? And then what will you do with all of the contaminated cuttings?? This is why you use a Geoprobe and E-logging .... it gives you the power to understand the subsurface. Need more information? Contact Geoprobe Systems in Salina, Kansas, 1-800-436-7762.

Figure 4
Heavy Metals Site Cross Section
Southcentral, Kansas



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