

MAKING DRILLING WATER CLEAR

By Todd Giddings, Ph.D., P.G., PGWA Education Committee Chairman

In the current economic recession, most geothermal heat pump system installations are retrofit systems, because new house construction is at a minimum. This means that you are drilling the geothermal boreholes in a nicely landscaped yard and so you may have a huge challenge controlling and containing the muddy drilling water and the rock cuttings. Many rock formations in Pennsylvania, and especially limestone, yield a significant amount of groundwater during air-rotary drilling that contains a lot of silt and clay sediment. When you start producing 50 or 200 gallons per minute of very muddy groundwater during the borehole drilling, you now have a very tough job to keep this sediment-laden water from running into the neighbor's yard and onto their patio.

Even when this muddy groundwater is flowing through lawn grass, it still is carrying a load of suspended silt and clay that makes a mess of the lawn, patio, driveway, sidewalk, or street that it flows onto. The silt and clay particles are so small that they will not settle out of the water quickly, even if you excavate a sediment trap pit that is big enough to hold your pickup truck.

The Pennsylvania Ground Water Association demonstrated the use of Polyacrylamide polymer to make the drilling water crystal clear at their 2010 Summer Field Conference in June. An air-rotary drill rig was used to deepen an existing borehole on the site, producing muddy water that contained the drill cuttings, and silt and clay sediment. The demonstration was very successful because we made the very muddy water become crystal clear by the end of our treatment trench. The Polyacrylamide polymer is available as a powder, liquid, or solid "brick" form, and because a specific polymer formulation needs to match the groundwater quality and the type of silt and clay sediment, you must submit samples of the water and sediment that you are going to treat to the manufacturer for analysis so that you will buy the correct formulation for your site.

To use a Polyacrylamide polymer to remove the silt and clay sediment from your drilling water, you should follow this sequence of steps: **1)** submit a water sample and a drill cuttings/sediment sample to the polymer manufacturer for testing; **2)** receive a polymer formulation recommendation from the manufacturer; **3)** order the recommended polymer powder and solid bricks; **4)** evaluate the slope and available



1. *Excavating a one cubic yard settling pit to catch the rock chips and sand-size cuttings in the drilling water. A short collector trench extends under the back of the drill rig to carry the drilling water and cuttings into the pit.*



2. *Excavating a two-foot wide by six-inch deep treatment trench down the slope of the site from the cuttings pit.*

area at your loopfield site and lay out your pit and treatment trench locations; **5)** excavate a pit that has a volume large enough to hold the volume of rock chips that you will be producing from the drilling of the geothermal boreholes; **6)** excavate or construct on the ground the treatment trench; **7)** line the treatment trench with plastic sheeting; **8)** place jute erosion blanket material in the bottom of the trench; **9)** place the polymer bricks in the upper end of the trench; **10)** place pieces of concrete blocks or large rocks on the brick ropes to hold the bricks in place and to cause turbulent flow and mixing; **11)** sprinkle some polymer powder on the jute blanket to enhance the sediment removal; **12)** drill the geothermal boreholes and direct the drilling water, cuttings, and sediment flow into the pit; **13)** clean out the pit if it fills up with rock cuttings; **14)** add to the length of the treatment trench if the flow rate of the drilling water overwhelms the sediment removal capacity of the polymer bricks in the trench.

When the muddy groundwater flows from the borehole into the pit, its velocity drops dramatically, and all of the coarse particles (ranging in size from bedrock chips down

to sand-sized particles) immediately settle out of the water and collect on the bottom of the pit. The remaining muddy water contains the silt- and clay-sized particles that are too small to quickly settle out by gravity. Some of the clay-sized particles have electrostatic charges on them, and these colloidal clay particles will stay in suspension and will not settle out of the muddy water by gravity.

So this is where the Polyacrylamide polymer becomes a very useful way to make your very muddy drilling water crystal clear and in a short distance of flow. Be sure to submit water and cuttings/sediment samples to the polymer manufacturer for testing so you will get a recommendation for the correct polymer formulation to buy. There are more than 60 types of polymers, and you need to use the correct one for your water and sediment conditions. The purpose of the plastic sheet lining in your excavated or constructed trench is to contain all of the muddy drill water and to make cleanup easy. The purpose of the pieces of concrete block or large rocks in the trench is to cause turbulence in the muddy water flow and to cause mixing of the polymer throughout all of the water flowing in the ditch.



3. *Lining the treatment trench with a heavy plastic sheet. Bentonite clay was used at the settling pit to seal the plastic sheet to the soil.*



4. *Placing jute erosion matting in the bottom of the plastic-lined trench. The fibers in the woven strands of the jute mat provide ideal attachment locations for the treated sediment flocs to grab onto as they flow by in the water.*



5. The Floc Logs® (polymer bricks) and the pieces of concrete block are placed on the jute erosion mat. The muddy water slowly dissolves the polymer Floc Logs® as it flows by. The concrete block pieces cause turbulent flow that mixes the polymer in the muddy water.

6. Sprinkling some Silt Stop® powdered polymer onto the jute erosion mat enhances the formation and attachment of the flocs at the beginning of the treatment process when the muddy water first flows over the mat.

Photos by Todd Giddings



7. The muddy drilling water and the cuttings from the drill rig (top of photo) flowed into the pit where the rock chips and sand-size particles settled to the bottom by gravity. The muddy water then flowed down the length of the trench where the polymer caused flocs to form and to attach to the jute mat.

The polymer attaches to electrostatic charges on the silt and clay particles and destabilizes their dispersion in the water. The particles now attract each other instead of repelling each other and they aggregate due to the interparticle electrostatic attractive charges and form groups of particles called flocs. The flocs attract each other and come together to form a large mass through a process called flocculation. The purpose of the jute matting is to provide a whole lot of fibers for the polymer-treated silt and clay particles to grab onto in the coagulation process. The coagulation process causes the flocs to be so attracted to the jute fibers and the flocs already on the fibers that the flocs grab onto the fibers even though they are in flowing water with a velocity that without any polymer would carry them away.

Everyone was very impressed when they saw the 20 gpm flow of very muddy drilling water become completely clear in a distance of only 30 feet in the ditch. A longer ditch and more polymer bricks would be required to treat higher rates of flow of drilling water. We cause the muddy water flow rate to increase to more than 40 gpm, and this caused the muddy water to still be turbid after 40 feet of flow in the trench. The jute matting and powdered polymer on the ground surface at the end of the trench treated the remaining sediment in this high flow so that it was completely clear due to 10 more feet of treatment surface.

The polymer treatment of muddy drilling water has a broader application beyond the geothermal borehole drilling industry into the water-well drilling industry. Any significant groundwater yield that is produced during the air-rotary drilling of a water-supply well can also be difficult to treat before it is discharged into a nearby stream, storm drain, or neighbor's yard. The pit that catches the cuttings is the first Best Management Practice, and the polymer treatment that quickly clarifies the drilling water is the second Best Management Practice.

The Pennsylvania Ground Water Association thanks the following companies for the equipment, material, and labor that they provided to conduct this demonstration of the treatment of muddy drilling water at the 2010 Summer Field Conference on June 11, 2010. The Polyacrylamide polymer Floc Logs® and Silt Stop® powder were provided by Applied Polymer Systems, Inc., and they can be contacted at www.siltstop.com. Floc Log® and Silt Stop® are registered trademarks of Applied Polymer Systems, Inc. The Schramm drill rig, the service truck, and the drilling crew were provided by Edward Powell Pump and Well Drilling, Inc., and they can be contacted at www.powellpumpandwell.com. Eastern Drillers Manufacturing Co., Inc. provided the air-rotary down-the-hole hammer and two button bits, and they can be contacted at www.edmmfg.com.

Note: Be sure to check with the polymer manufacturer that the polymer type is safe to use in the environment and that it is not toxic to fish and other aquatic organisms in a receiving stream.



8

8. The muddy water (shown in the right cup) from the settling pit flowed into the plastic-lined trench and was treated by the polymer to become clear (left cup).



10

10. The biodegradable jute mat with all of the floc mass of sediment still attached was disposed of by burial on site. The plastic sheet was folded up and placed in a dumpster, and the settling pit and trench were backfilled.

“Everyone was very impressed when they saw the 20 gpm flow of very muddy drilling water become completely clear in a distance of only 40 feet in the ditch.”



9

9. The jute mat is completely covered by the aggregated mass of flocculated silt and clay. The cohesiveness of floc mass is shown by the way it sticks to the hand.