

To: STRONGER Colorado Hydraulic Fracturing State Review Team

From: Colorado Oil and Gas Conservation Commission Staff

Date: September 28, 2011

Regarding: Additional Information on Surface Casing Depths

As authorized by the Review Team, we have set forth below additional information on how we ensure that surface casing depths are adequate to protect fresh groundwater and avoid the penetration of lost circulation zones or gas-producing formations.

At the outset, it may be helpful to summarize the process that our engineering staff follows in approving surface casing depths:

1. Initially, our engineers review the application for permit to drill for the well location, total depth, objective formations, and proposed casing and cementing program.
2. Our engineers then review our records to identify the surface casing depths for any nearby oil and gas wells, and they also review the geophysical logs from the oil and gas well with the shallowest surface casing depth. Using these logs, they identify all fresh water aquifers, including those not tapped by water wells. Then they determine the depth of surface casing needed to cover these aquifers completely. If the geology is steeply dipping, then they often review the geophysical logs for other oil and gas wells to ensure that they understand the formation depths.
3. Our engineers also consider aquifer mapping information compiled by the Colorado Geologic Survey (CGS) and Division of Water Resources (DWR) to determine the depth of fresh water zones. This information is particularly important if there are no nearby oil and gas wells or if our engineers are unfamiliar with the area.
4. If data is limited, then our engineers consult with CGS, DWR, the Bureau of Land Management (BLM) and the operator to obtain additional information.
5. Our engineers then review the records for water wells within a one mile radius to ensure that the proposed surface casing exceeds the depth of the deepest water well. If there are no water wells within one mile, then this review is increased to two miles.
6. Our engineers then apply their professional judgment and experience. In appropriate cases, they will adjust the surface casing depth to provide an additional margin of safety.
7. Our engineers then determine the adequacy of the proposed surface casing program. If the casing is too short, then they require that it be increased to ensure that it is set fifty feet below the deepest aquifer and the deepest water well. If the casing appears longer than necessary, then they work with the operator to ensure that well bore stability and cement integrity will not be compromised.

8. Following completion of the well, our engineers review the well log to confirm that the surface casing covered the bottom of the fresh water and require remedial cementing and other action where necessary.

This process is explained in greater detail below with respect to the issues of minimum and maximum surface casing depths.

Minimum Surface Casing Depths. Minimum surface casing depths have not been an issue in Colorado. By regulation, surface casing must protect not only aquifers,¹ but all fresh water of whatever quantity or use. Where subsurface conditions are unknown, surface casing must “reach a depth below all known or reasonably estimated utilizable domestic fresh water levels.” Rule 317.e. Where subsurface conditions are known, surface casing must reach a depth “sufficient to protect all fresh water.” Rule 317.f. When reviewing a surface casing proposal, our engineers ensure that these requirements are satisfied by considering all available information and exercising their professional judgment.

Our engineers begin by reviewing surface casing depths and geophysical logs from nearby oil and gas wells. Typically, at least one such well log is reviewed, with additional logs reviewed in areas where the geology is complicated or we have less experience. This information is used to identify fresh water aquifer depths and ensure that the surface casing for the proposed well will cover all such formations. Our engineers also use aquifer mapping information from the CGS and DWR in many cases, and such information is particularly useful where nearby oil and gas wells do not exist or we are unfamiliar with the area. The CGS has mapped fresh water aquifers across much of the state, and the DWR has created an electronic tool that uses geophysical log data to identify aquifer depths in the Denver Basin and certain other areas. In complex situations, our engineers also consult with other state agencies, such as CGS and DWR, and the operator, and obtain information from federal agencies, such as BLM and the United States Geological Survey. Water well depths are used only to ensure that the surface casing will be deeper than all nearby water wells, including any water wells drilled deeper than the deepest fresh water aquifer. They are also used to address water wells that are not drilled into aquifers, but into smaller, isolated ground water sources, such as naturally fractured shale, or coal bed methane formations.

Our engineers also apply their professional judgment and local experience to ensure that the surface casing will protect all fresh water. Rather than mechanically applying a particular depth from another source, our engineers consider a variety of factors to ensure that all fresh water is protected. These factors include the amount of information available, reservoir pressure, area geology, and projected completion geometry. Based upon these factors, our engineers increase the depth of the surface casing to include an additional safety factor where appropriate.

After the well is drilled, our engineers review the well completion report and geophysical logs. This review confirms whether the surface casing did in fact cover the bottom of the aquifer or other ground water. In the few instances where this did not occur, we required prompt remedial action, including

¹ By statute, aquifers are defined as formations that could yield a sufficient quantity of water that may be extracted and applied to a beneficial use. C.R.S. 37-90-103(2).

remedial cementing, a cement bond log, and bradenhead monitoring. This step ensures that all fresh water supplies are protected, not just in theory but in fact.

Maximum Surface Casing Depths. Similarly, maximum surface casing depths have not been an issue in Colorado. In almost all cases where we disagree with the proposed surface casing depth, it is because the proposed depth is too shallow and not too deep. In the few cases where unusually deep surface casing has been proposed, we required both justification for the proposed depth and assurance that it will not compromise well bore stability and cement integrity. To this end, we have refused to allow operators to extend their surface casing to avoid having to use intermediate casing. Our engineers have also worked with operators who are active in new areas or using new technology to ensure that they are using best practices to maintain well bore integrity.

As explained above, our engineers establish the surface casing depth on a case-by-case basis using all available information and their professional judgment and experience. As part of this process, they consider the risk of encountering lost circulation zones and shallow gas-producing formations, which, as a practical matter, are limited to discrete areas of the Piceance Basin. To assess this risk, our engineers review local geology and data from nearby oil and gas wells. Where appropriate, they require modifications to the proposed casing and cementing program, including adjusting surface casing, adding stage cement, conducting formation integrity tests, and installing intermediate casing. They may also require observation by staff of the cementing process. As part of our review of the well completion report, our engineers review the volume of cement pumped and our inspectors may verify that the cement has risen to the surface. If there are problems or concerns, we again require remedial cementing, a cement bond log, and bradenhead testing. In the Piceance Basin areas, we require operators to notify us before initiating operations, to conduct formation integrity tests after setting surface casing, and to install intermediate casing where appropriate. Additional notice and remedial action are required if specified volumes of fluids are lost. For all of these reasons, we believe that our program adequately addresses the risks in question.

In addition, we do not believe that a maximum surface casing standard would be effective or practical in Colorado. Our geology is highly variable and diverse across the state and in many areas the topography changes dramatically, which does not lend itself to fixed standards. Also, in the limited areas of the Piceance Basin where lost circulation or gas producing zones are encountered, they are often at shallow depths, such as 100 to 200 feet below ground. A maximum surface casing depth would not prevent the penetration of these zones when drilling surface casing. Rather, the risk associated with these zones is better addressed by requiring formation integrity tests and intermediate casing. As explained above, our engineers impose these requirements in appropriate situations.