The Cheyenne Basin: Geology and Well Construction

Matt Sares
DWR Hydrogeology Section
January 14, 2021
Outline

1) Cheyenne Basin Memo
2) Geology of the Cheyenne Basin
3) Well Construction based on geology
4) Resources
• April 2018 memo sent to all contractors – explaining that the LFH aquifer is present outside the Denver Basin to the North in the Cheyenne Basin
• Important because the LFH Rule 10.4.8 applies to the aquifer wherever it is present and used as an aquifer.
• You should know that all permit applications in the Cheyenne Basin are reviewed by the Hydrogeology Section
  • Each of the well permits will have a NOTE below the Well Conditions that gives depths for the top and base of the LFH or other potential target aquifers.

• It is imperative that a contractor be familiar with the potential aquifers and confining layers, and other conditions at their well site. (Rule 10.1.2)
• The rest of this talk is about helping you, the contractor, be familiar with geology and well construction in the Cheyenne Basin.
Where is the Cheyenne Basin?
• No real break in LFH from Denver Basin up into Cheyenne Basin
• Dark blue is the LFG outcrop in the Denver Basin
• Pink is the extent of the LFH in the Cheyenne Basin
A look at Hydrogeologic Units:

- Alluvium
- High Plains aquifer is divided by formation here: Ogallala and White River are considered different aquifers
- Laramie Formation – shale with sandstone. An upper Laramie aquifer is broken out in certain parcels where it’s defined as a separate nontributary aquifer. There is a confining layer between Upper Laramie and LFH
- LFH aquifer
- Upper Pierre aquifer
- Basin boundary is drawn along the extent of the Laramie-Fox Hills aquifer – outside the line the LFH is not present – it’s been eroded away.
- Modern Alluvium along the South Platte River and tributaries – light yellow
- Older alluvium on western side of the basin – along SH-85 in the Greeley–Nunn–Carr corridor -stippled orange and light green
- Northern tier with Ogallala Fm and White River Fm at the surface – light orange
- Medium green color in middle and south is Laramie Fm and LFH at the surface
- Pierre Shale is the dark green color outside the perimeter of the basin boundary
- Note the Upper Crow Creek Designated Basin - specific DesBas rules apply here (read your permit!)
• Cross-sections from DWR’s report on the Upper Pierre aquifer in the Cheyenne Basin —
• The cross-sections can be very helpful to understand the geology near your drilling site — from the surface down to the Pierre Shale.
• We’ll be using the west to east A-A’ cross-section for illustration purposes in following slides.
• Note the structure of the basin
• Laramie and older sediments have been folded into bowl-like structure that tilts to the east
• Time of erosion after the Laramie was deposited
• The younger White River and Ogallala are deposited on the old eroded landscape
Now let’s look at some well construction scenarios...
• This is the situation in much of the Cheyenne Basin – Laramie Fm is at the surface
• In some areas it will be covered with a veneer of alluvium, usually 0-50 thick.
Well Construction in the Cheyenne Basin

Well on “Older Alluvium” SW part of basin:

- Alluvial well
  - Type III (Rule 10.4.7)

- Laramie Fm well
  - Type II Overlain by Type III (Rule 10.4.6.3)

- Laramie-Fox Hills well?
  - Laramie-Fox Hills (Rule 10.4.8)
Aquifers: Crow Ck Alluvium, Alluvial Fan Aquifer, White River, Upper Laramie, Laramie-Fox Hills, Upper Pierre

Aquifers in Designate Basins are distinctly regulated — Look at your permit carefully!

Alluvial Fan deposits (Qf) can be up to 150 ft thick!

Rule 10.4.6.3 applies - Type III above Type II – isolation of alluvium. -more than 150 ft alluvium above Type II can request variance for an alternate construction method

Policy 2017-2 – Type III above Type I – must fully isolate alluvium.
Resources

- **Colorado Groundwater Atlas — Online:**
  - GIS Map - linked at the top of the page

- **Upper Pierre Aquifer of the Cheyenne Basin, Geologic Cross-Sections:**
  (DWR Water Resources Investigation 2017-1a)
  - [https://dnrweblink.state.co.us/dwr/0/edoc/3207851/DWR_3207851.zip?searchid=0bd68dc0e59-ad96-7a01e961b582](https://dnrweblink.state.co.us/dwr/0/edoc/3207851/DWR_3207851.zip?searchid=0bd68dc0e59-ad96-7a01e961b582)

- **The Pawnee Aquifer, Denver-Julesburg Basin, Northeastern CO**

- **Water Resources of Upper Crow Creek, CO**
  Colorado Geological Survey SP-29