Zone 3 - Delineation of the West Boundary

The west boundary of the CAPA was selected after careful consideration of the effectiveness of the Satanka Shale as a hydrogeologic confining layer over the Casper Aquifer.

Existing hydrogeologic data were evaluated and a determination was made that the Satanka Shale generally acts as a confining layer for the Casper Aquifer in the Laramie area. While the data distribution is limited, the following observations of spring and well data indicate that the lower 50 feet of the Satanka Shale can be permeable and in hydraulic connection with the Casper Aquifer.

- The base of the Satanka Shale is composed of interbedded fractured shale and sandstone.
- The water at City Spring, Soldier Springs, and Simpson Springs flows from the Casper Aquifer through approximately 50 feet of basal Satanka Shale, presumably via vertical fractures.
- Water levels measured in Section 1, Township 15 North, Range 73 West reveal only a small difference in hydraulic head between the basal Satanka Shale and the Casper Aquifer.

Based on the above data, the Technical Review Subcommittee believed that the Casper Aquifer may be vulnerable to contamination if 50 feet or less of undisturbed Satanka Shale lies between the Casper Aquifer and the ground surface. The Technical Review Subcommittee agreed that at least 75 vertical feet of undisturbed Satanka Shale (50 percent more than the thickness of the zone of apparent connectivity) was needed to effectively protect the Casper Aquifer from contaminants that may be spilled or introduced at or near the ground surface.

The actual location of the original west boundary for the CAPA was the distance from the Casper-Satanka contact that provided 75 feet of undisturbed Satanka Shale cover when the dip of the formation and slope of the ground surface were considered. Figure 3-7 illustrates the procedure to used predict the offset of 75 feet of Satanka Shale from the contact. As the dip in the Satanka Shale increases, the offset distance decreases. The stratigraphic remainder of the Satanka Shale was considered to be an effective confining layer above the Casper Aquifer.

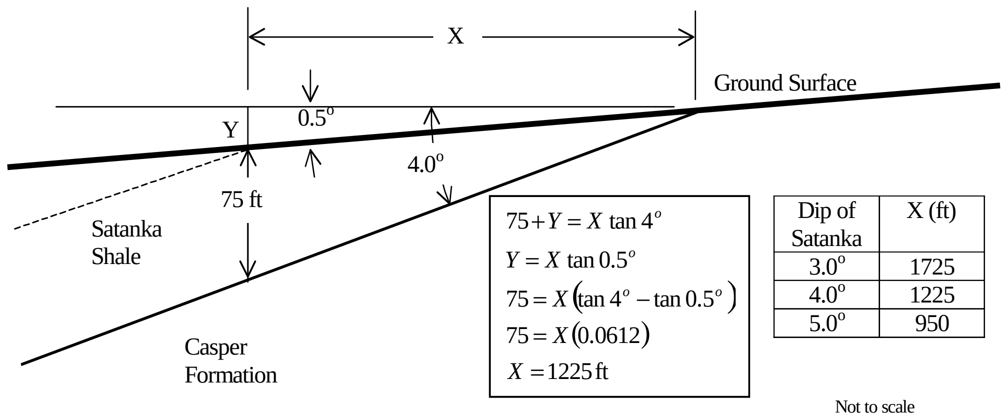

FIGURE 3-7. DETERMINATION OF THE OFFSET DISTANCES AS A FUNCTION OF DIP OF THE SATANKA SHALE.

The original west boundary of Zone 3 was delineated based on drilling data and a set of assumptions about the geology and hydraulics of the Casper Aquifer and Satanka Shale. This original boundary is now designated as the 75 feet line (Figure 1-3). The 75 feet line represents a boundary calculated from a dip formula (Figure 3-7) where there is an estimated 75 feet of Satanka Shale overlying the Casper Aquifer. However, it is known that in several instances the calculated line of 75 feet of Satanka Shale is inaccurate. At Soldier No. 1 well there is 41 feet of Satanka Shale but the calculated 75 feet line is to the east of Soldier No. 1. At Turner No. 2 well, there is 74 feet of Satanka Shale so the calculated 75 feet line should coincide with Turner No. 2 yet the calculated line is east of Turner No. 2. At Spur No. 1 well there is 54 feet of Satanka Shale and yet the calculated 75 feet line is very near that well when the actual line should be further west of the Spur No. 1. Since there are known areas where the calculated line is inaccurate, it was decided that the western boundary should be moved to ensure that at least 75 feet of Satanka Shale was overlying the Casper Aquifer.

In order to account for the uncertainty in local geology and to allow for effective implementation of the CAPP, the west boundary of CAPA Zone 3 has been straightened and moved to the west of the calculated 75 feet line. The west boundary of Zone 3 now provides an additional buffer to the calculated line of 75 feet of Satanka Shale to ensure greater protection of the Casper Aquifer. Additionally, the western boundary was moved to ensure continuous protection between Zones 1 and 2. In previous delineations there was a gap of protection between Zones 1 and 2. Finally, the line was straightened and moved primarily to section, quarter section, and quarter-quarter section lines to provide for easier implementation of the CAPP. Around the Indian Hills subdivision the CAPA west boundary coincides with south, west, and north boundary of the subdivision. The Indian Hills subdivision boundaries were used because City of Laramie sewer and water serve the subdivision, the subdivision is completely built out, and the existing development is single-family residential.

Zone 3 - Delineation of the South Boundary

The reasoning for the placement of the south boundary is as follows:

The springs along the base of the west flank of the Laramie Range, including City Springs, Pope Springs, Soldier Springs, Simpson Springs and others further south, are the surface manifestations of the intersections of east-west trending structural features and a confining bed. The geologic structures contain fractures that allow for the rapid transmission of water downgradient to the point where the water level in the Casper Aquifer intersects a confining layer and the aquifer acquires its maximum saturated thickness (i.e. the potentiometric surface intersects the ground surface). The elevations of the springs increase to the south, with the City Springs being lowest in elevation. This means that the entire Casper Aquifer south of the City Springs has the potential to contribute water to City Springs. However, the southern springs, which are higher in elevation, do not cease flowing during the year and we do not observe hydraulic gradients indicating groundwater flow in the Casper Aquifer from south to north. While there is not a flow system boundary in the Casper Aquifer between any of the springs, there is a significant difference in permeability in the rocks that contribute water to the springs, such that the non-fractured rocks have permeabilities that are orders of magnitude less than the fractured rocks. It has long been asserted that the faults and folds in the Casper Aquifer act as “collectors” of groundwater. Groundwater flowing downgradient through the low-permeability rocks that encounters the fractured rocks preferentially moves downgradient in the fracture system and is discharged at the