# Stratigraphic Characterization of the Birds Nest Aquifer in the Uinta Basin, Utah: Updated Research Regarding the Aquifer's Potential as a Significant Saline Water Disposal Zone

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Panel 2

### Project Web site: http://geology.utah.gov/emp/UBwater\_study

Birds Nest Aquifer - Upper and lower zone

Birds Nest Aquifer - Lower zone only

★ Well used in cross section

Township and Range

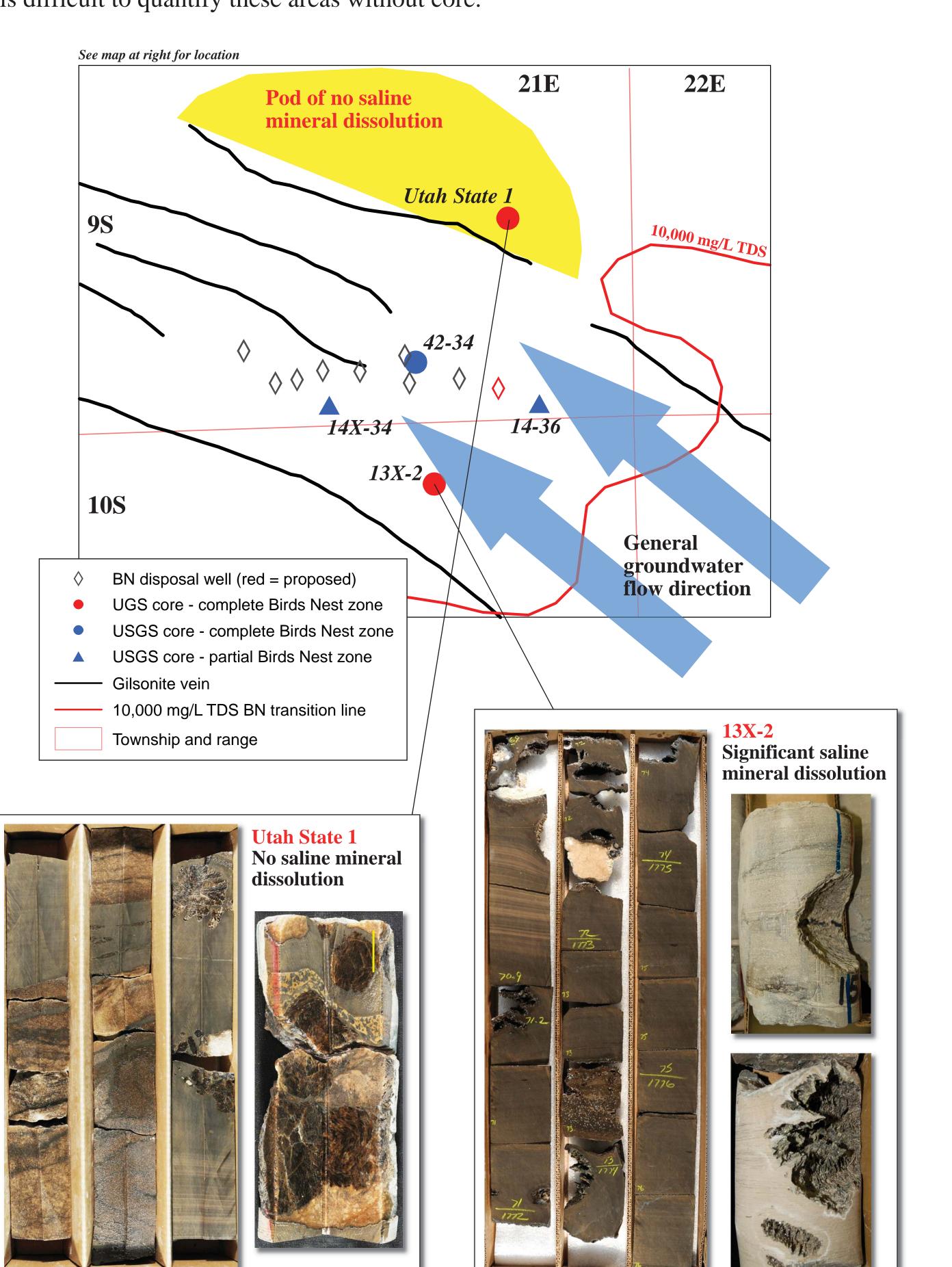
Birds Nest Aquifer - Lower zone and partial upper zone

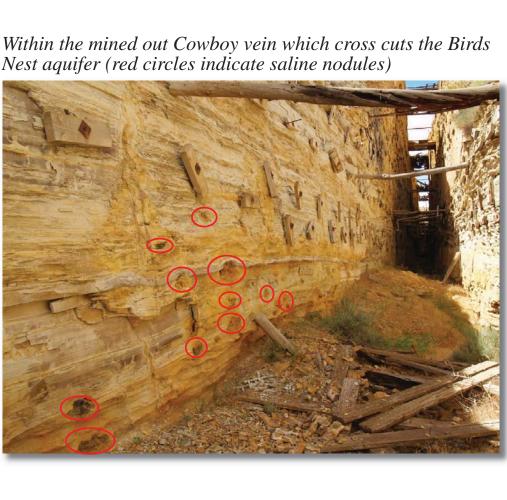
## RESULTS: INFLUENCE OF GILSONITE VEINS

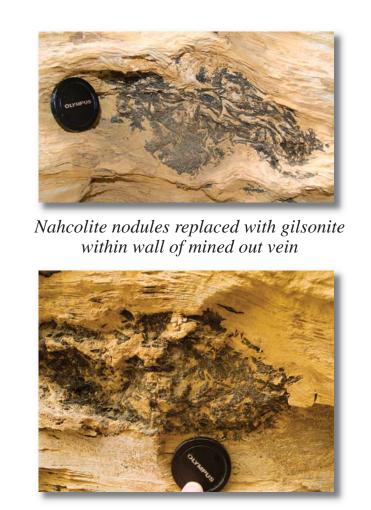
Gilsonite (a solid hydrocarbon) occurs in veins ranging in thickness from a couple inches to tens of feet and originates in the rich oil shale beds of the upper Green River Formation, continuing up to the surface, cross-cutting the Birds Nest aquifer. Questions remain as to how these veins might affect groundwater movement through the Birds Nest aquifer; whether they act as barriers to flow or whether they create vertical and/or horizontal pathways for water transmission.

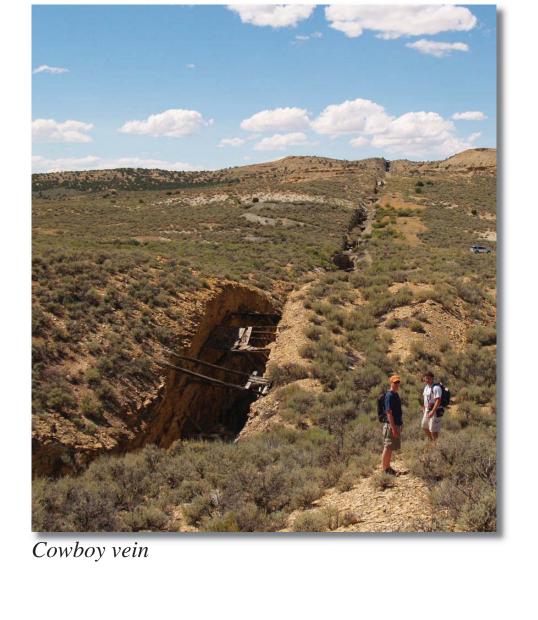
#### Core evaluation, evidence for barrier:

Near the basin's depocenter, several cores exist that recovered the entire Saline zone. Most of these cores (e.g., 13X-2) show significant saline mineral dissolution, in fact, Anadarko has begun disposing saline water into the Birds Nest in this area. However, there is one well (Utah State 1) with core slightly to the north, which shows no signs of saline mineral dissolution. This core is separated from the others by a gilsonite vein. With the beds dipping to the northwest, water generally travels from southeast to northwest. Water within the Birds Nest has dissolved the saline minerals to the south of the vein, but the gilsonite vein seems to stop water from reaching the area on its northern side, creating a zone of no dissolution. It is assumed that similar areas of no saline mineral dissolution exist throughout the Birds Nest aquifer, but it is difficult to quantify these areas without core.



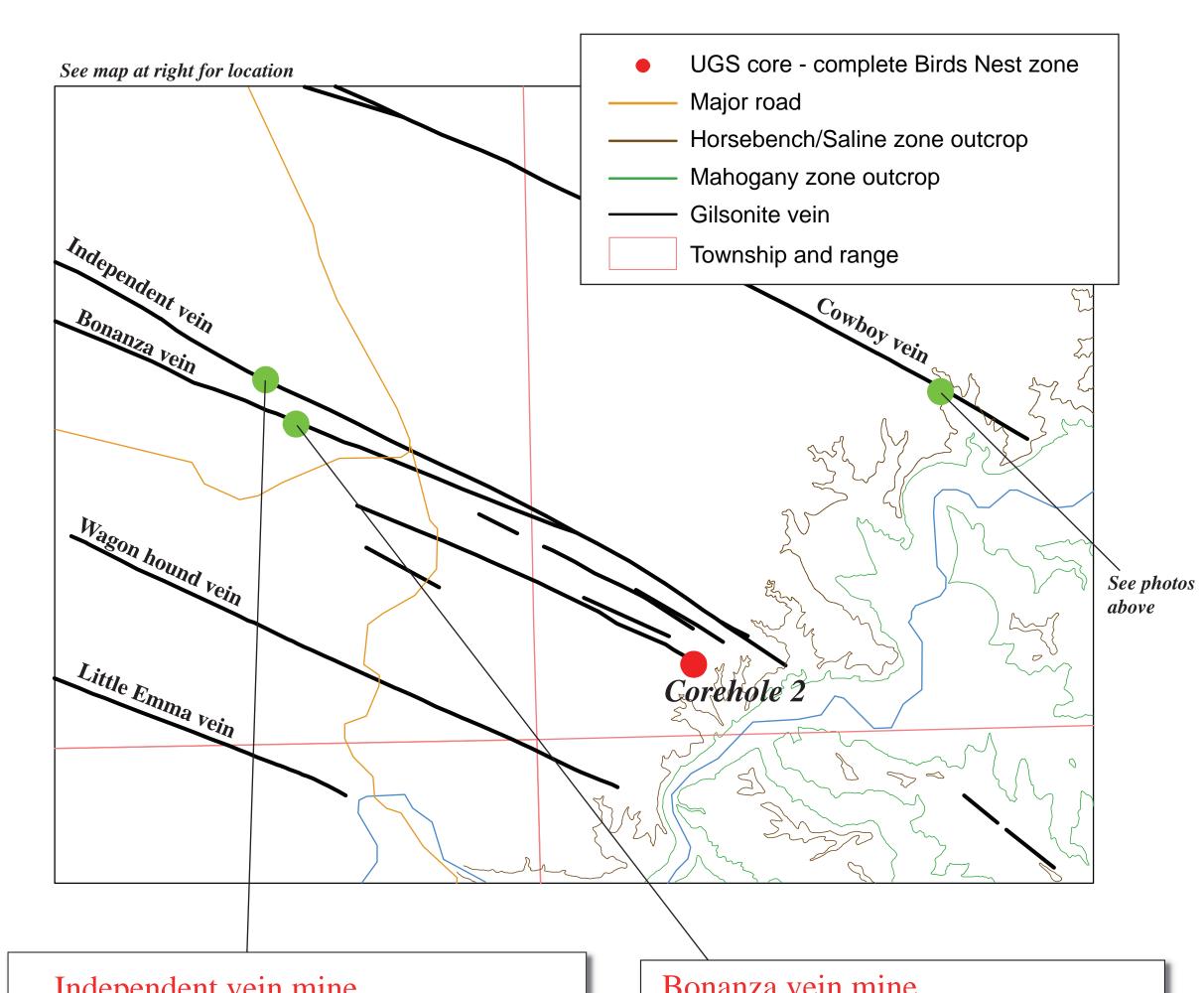




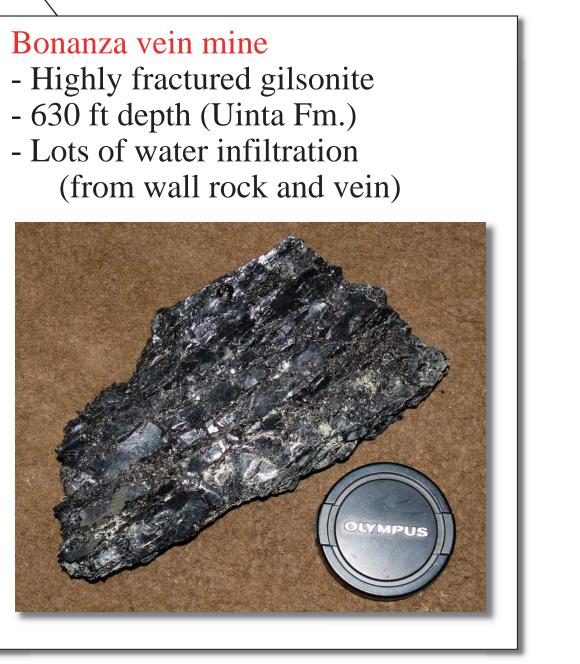


#### Gilsonite mine tour, evidence for both transmission and barrier:

UGS geologists toured two mines in different gilsonite veins to assess how groudwater interacts with the veins. The first mine contained a highly fractured type of gilsonite which easily transmitted water through the vein. The second mine contained a type of gilsonite that was very solid and transmitted no water. These observations suggest that gilsonite veins could act as both barriers or conduits for water depending on the type of gilsonite in the vein. However, gilsonite type at depth is nearly impossible to identify in the absence of an actual mine.

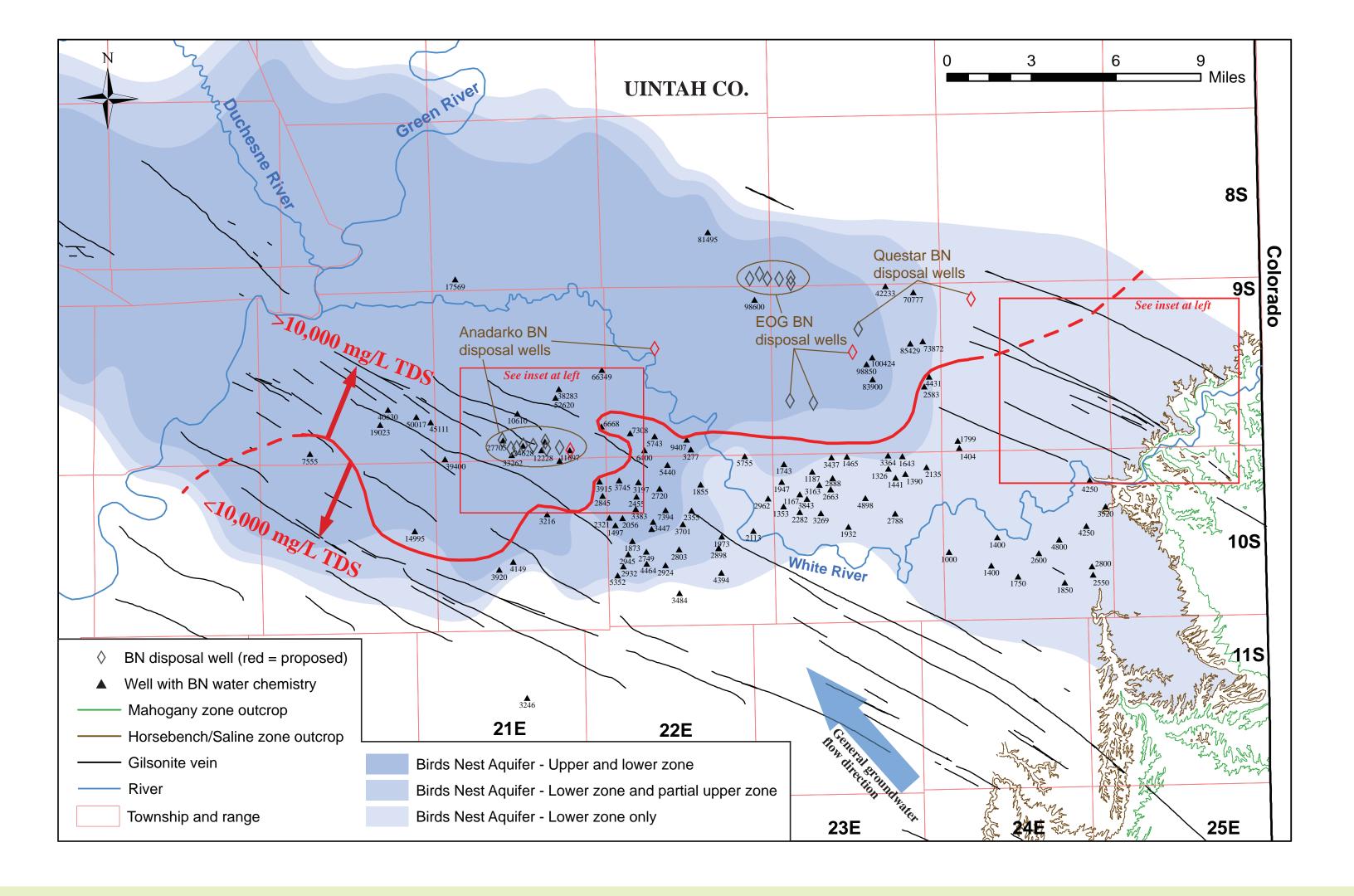






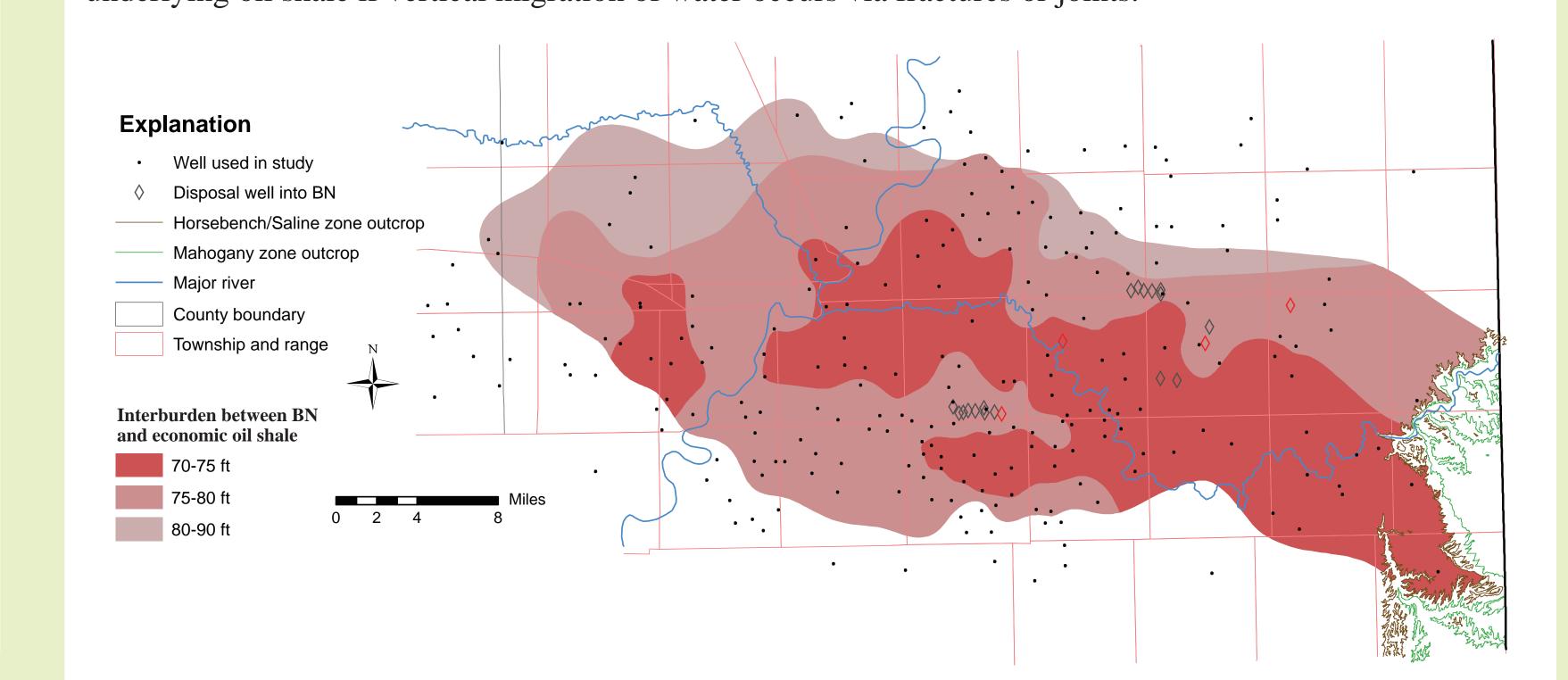
### RESULTS: WATER CHEMISTRY

Chemistry of Birds Nest water (mostly acquired by Anadarko) in the north (averaging >10,000 mg/L TDS and as high as 100,000 mg/L TDS) is distinct from that in the south (averaging <10,000 mg/L TDS and down to near 1000 mg/L TDS). This abrupt change in water chemistry is most likely due to the differing amounts of saline mineral dissolution in the two areas; the southern area may have been flushed clean, whereas saline minerals in the northern area are still actively dissolving. This transition is important because produced saline water can only be disposed into the aquifer where the water is currently 10,000 mg/L TDS and above (only north of the red line). In some areas, like near Anadarko's disposal wells, it seems that the presence of gilsonite veins has had an influence on the shape of the 10,000 mg/L TDS line. The gilsonite veins could be acting as barriers, creating underground channels of groundwater flow (see discussion at left).



## RESULTS: INTERBURDEN - BIRDS NEST TO ECONOMIC OIL SHALE

The base of the Birds Nest aquifer is between 70 and 90 ft above the top of economic oil shale, picked at the top of the Big 3 oil shale beds (see panel 1). Saline water disposal could impact development of the underlying oil shale if vertical migration of water occurs via fractures or joints.



## RESULTS: REGIONAL CROSS SECTIONS SUGGESTIONS

- The presented maps of the Birds Nest aquifer can be used as a guide to where saline water disposal might be possible. Additional drilling should be performed to confirm the presence of a suitable disposal zone (e.g., it is currently unclear where all large zones of no saline mineral dissolution exist).
- Wells for saline water disposal into the Birds Nest aquifer should be accompanied by down-dip water monitoring wells in aquifers both above and below the disposal unit.
- The effect of saline water disposal into the Birds Nest aquifer on oil shale development depends on the value of leaner deposits.
- The Saline zone in general will likely be bypassed by both mining and in-situ processes.
- Mining will focus on outcrop sections of the organic-rich Mahogany zone, ~300 feet below the Saline zone.
  In-situ extraction will likely target deposits below the Big 3 rich-oil shale beds, ~70 feet below the Saline zone.
- However, it is still unclear if water can travel vertically through the section via fractures or gilsonite veins, adversely affecting future development.
- Gilsonite veins may act as barriers to flow in some areas and pathways for vertical movement of water in others, depending on the type of gilsonite (i.e., solid or fractured) and vein thickness.
  - Little information is available on the gilsonite veins at depth near the center of the basin where active saline water disposal is taking place.
- Flow tests should be conducted in wells near gilsonite veins to test for linear movement of water.
- Tracer tests should be conducted to determine the destination of the water in the Birds Nest aquifer.

