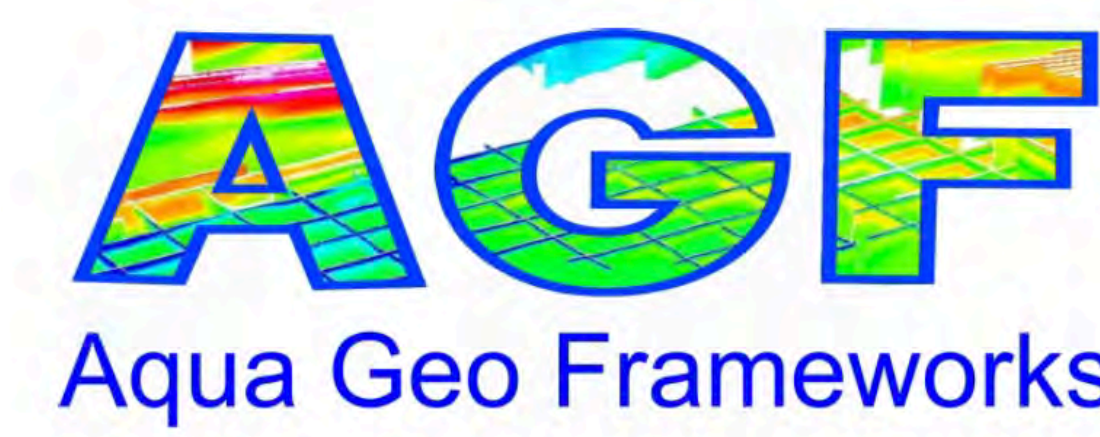


AIRBORNE ELECTROMAGNETIC MAPPING OF HYDROGEOLOGICAL FRAMEWORK IN AREAS OF EROSIONAL BEDROCK REMNANTS AND ITS CONTROL ON RECHARGE AND WATER QUALITY WITHIN SARPY COUNTY, NEBRASKA

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Abstract

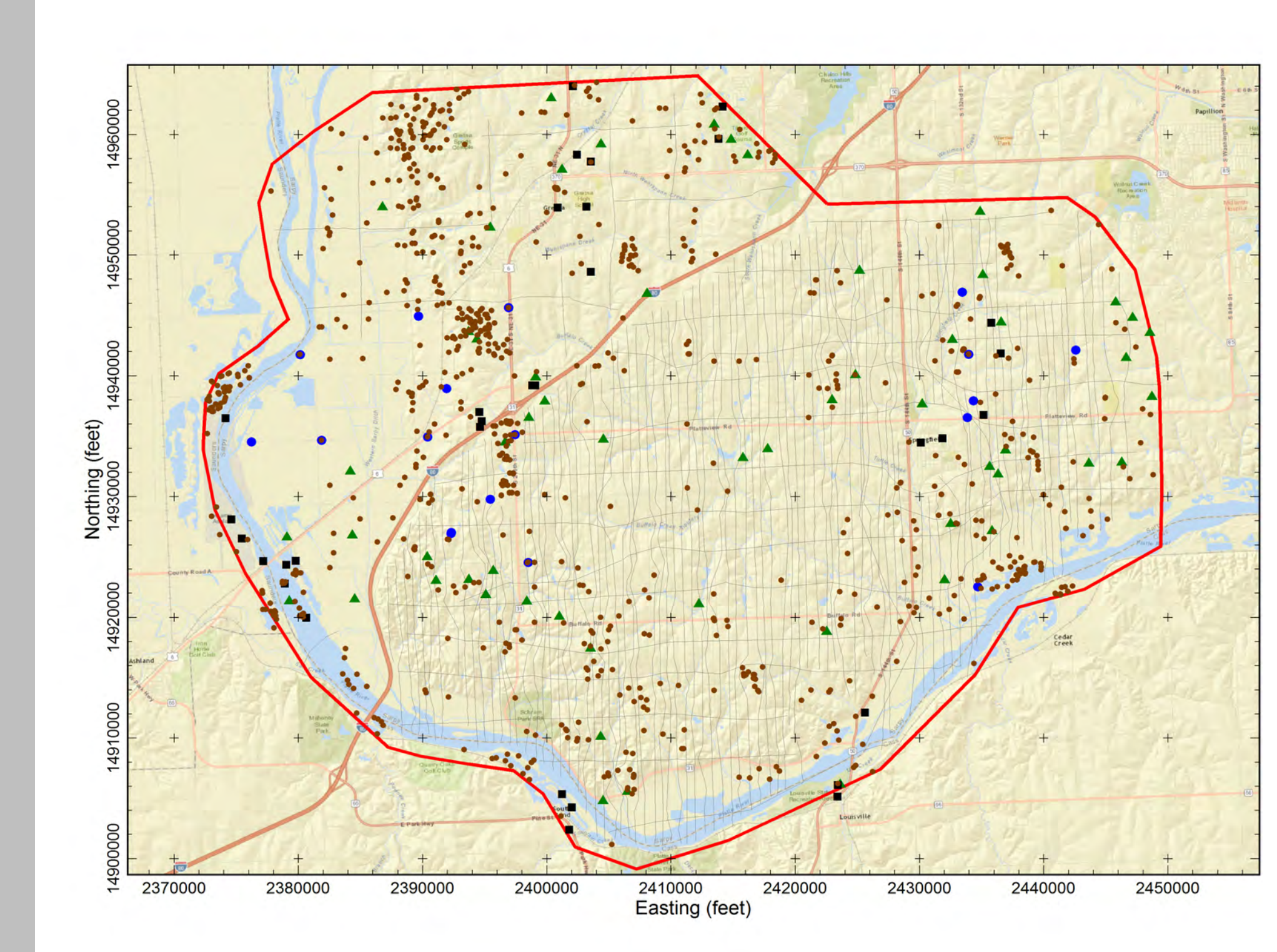
In 2016 an approximately 1,020 line-kilometer Airborne Electromagnetic (AEM) Survey was flown with the SkyTEM 304M system in the Sarpy County area of the Papio-Missouri River Natural Resources District (P-MRNRD) of Eastern Nebraska. The purpose was to map the hydrogeologic framework and provide insights into the impacts of recharge on water quality and drainage into the Platte River. This survey added to a 60 line-kilometer reconnaissance level AEM survey flown with the SkyTEM508 system in 2015 by the Eastern Nebraska Water Resources Assessment. AEM system calibration was critical in survey integration. Careful and diligent processing and inversion was required to provide high fidelity images of the subsurface. The hydrogeology of the area is controlled by the glacial and fluvial processes that eroded the Cretaceous Dakota Group into small erosional remnants that serve as aquifers. These Cretaceous Dakota remnants overlay 0 to 200-meter deep Pennsylvanian limestone aquicludes. Quaternary-aged glacial and alluvial materials overlie the area and serve as aquifers where containing coarse grained materials. The ability of the Quaternary materials to allow recharge has a direct impact on the water quality of the area and the groundwater recharge that maintains the aquifers. The recharge is also controlled by the approximately 100 m of elevation change in the area driving surface runoff. The AEM provided a 3D hydrogeological framework complemented by approximately 1,000 supply and test wells. The Cretaceous Dakota was categorized as either sandstone/sand dominant or shale/clay dominant based on the resistivities of the materials. Interconnections of the Cretaceous Dakota to the overlying Quaternary materials were also mapped. Quaternary materials were classified as non-, marginal, aquifer, and coarse aquifer materials based on the resistivity ranges. These interconnections coupled with the recharge potential of the surface materials provided 3D maps to effectively manage land use. The P-MRNRD is utilizing this information to update and enhance their Groundwater Management Plan. Ongoing activities aimed at improving water quality include: fertilizer management, proper well abandonment, enhanced water quality monitoring, improved well depth determinations, and wellhead protection.

Airborne EM System/Inversion



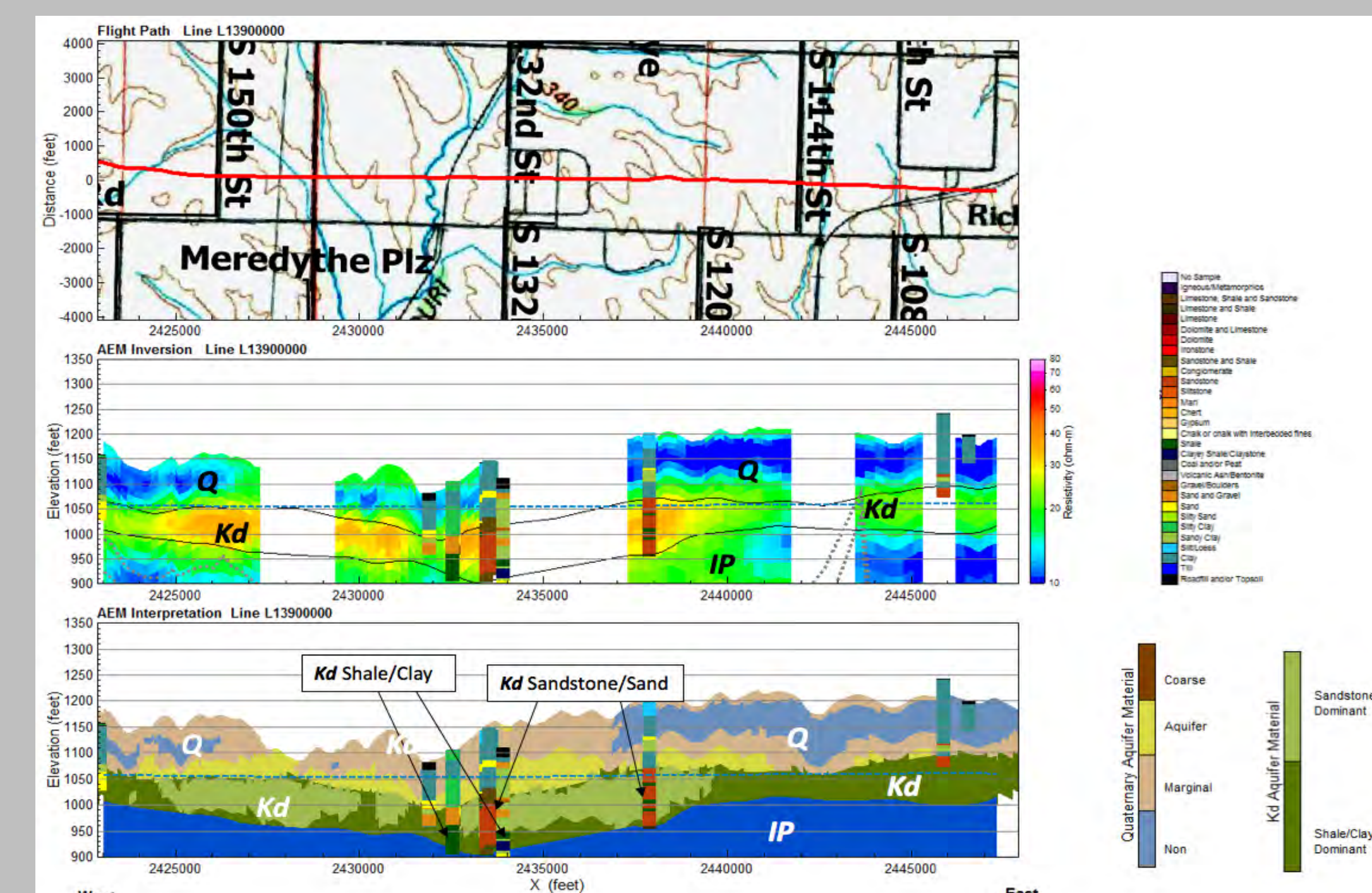
System: SkyTEM304 M
 Height: ~30 meters
 Total Acquired: 1,031 line-km
 Date: July 27-29, 2016
 Helicopter:
 Southern Helicopters Astar 350 B2-FX
 Inversion: Aarhus Geosoftware Workbench Version 5.2.0.0, Spatially-Constrained Smooth Inversion with 30 layers.
 Spatial reference distance $s = 100$ m with 0.75 power law
 $ResVerSTD = 2.0$ and
 $ResLatSTD = 1.3$

Existing Borehole Control



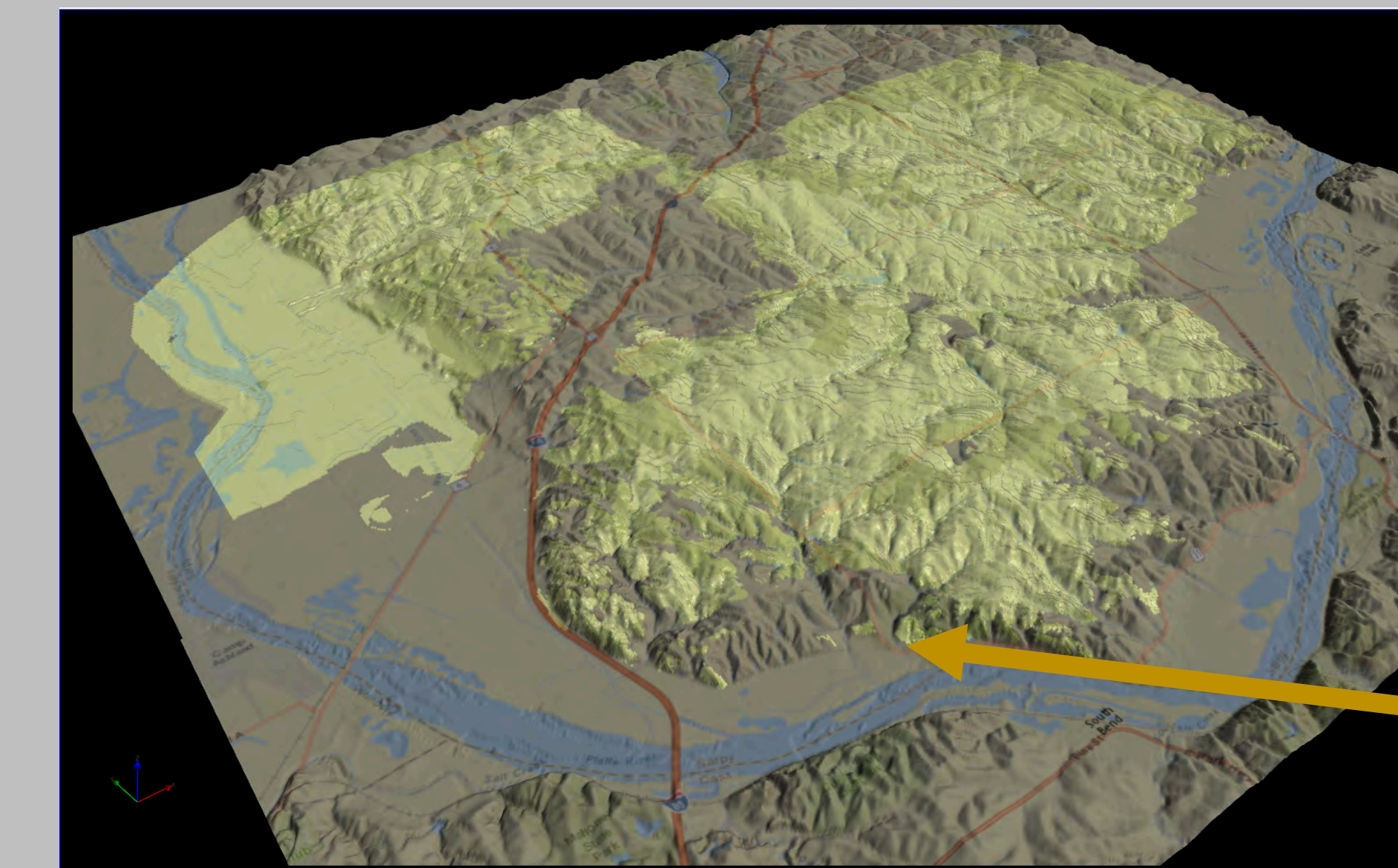
The survey area (showing gray survey lines) contained 18 University of Nebraska Conservation and Survey Division test holes (blue dots), 922 Nebraska Department of Natural Resources registered wells (brown dots), 73 local water well drillers reports (green triangles), and 32 municipal wells (black boxes). These boreholes contained various amounts of lithological, stratigraphic, geophysical, and limited hydrogeological data

Interpretation

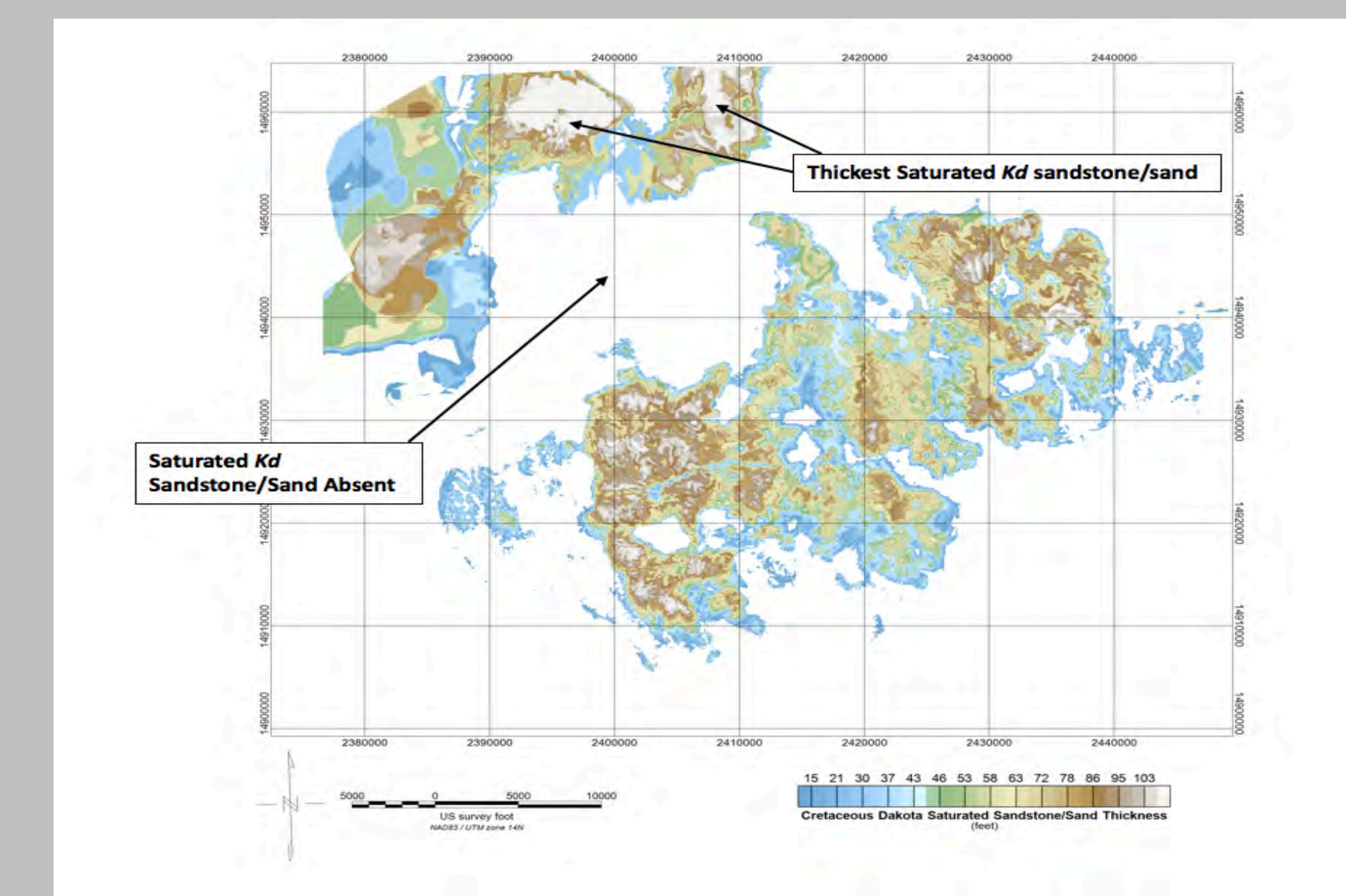


Each profile/flight line was interpreted for stratigraphic contacts, and aquifer material types. AEM resistivity, lithologic logs, stratigraphic logs, borehole geophysics, geological maps, air photos, boreholes and water well production data were utilized interactively during the interpretive process.

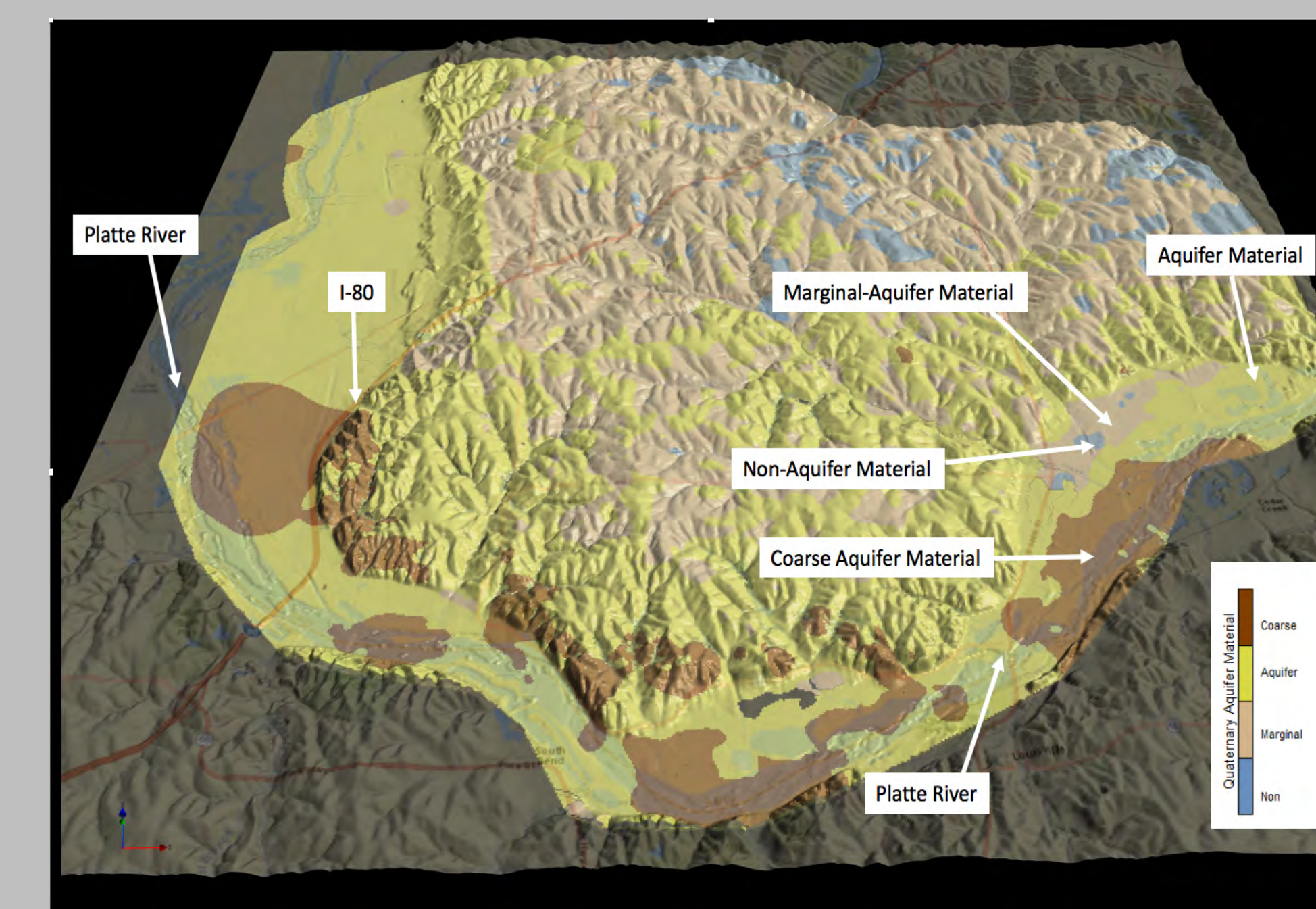
3D Hydrogeological Framework



3D view looking to the northeast of the Cretaceous Dakota Group erosional bedrock remnants



Map view of the saturated Cretaceous Dakota Group erosional bedrock remnants



3D view looking to the north of the surface materials

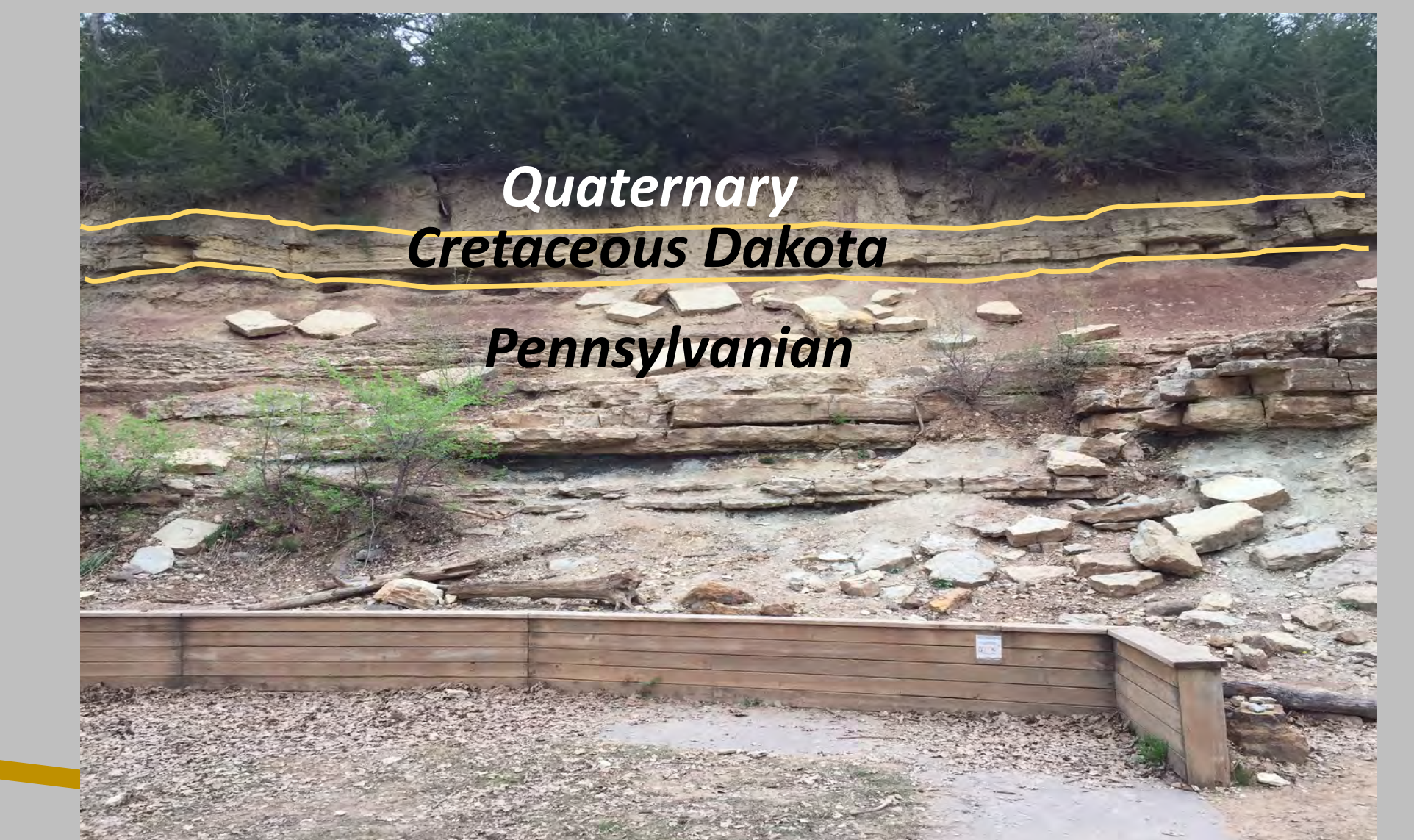
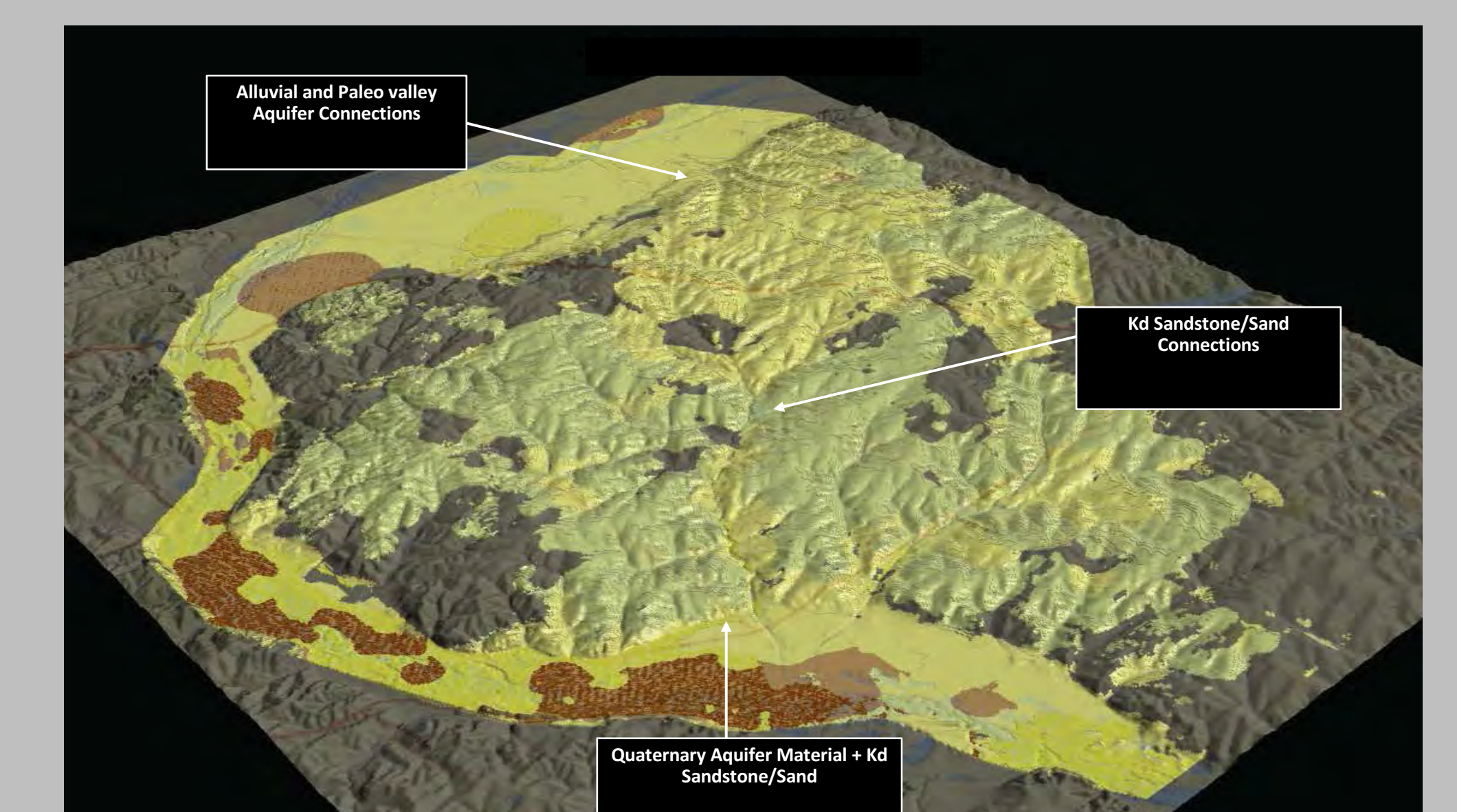
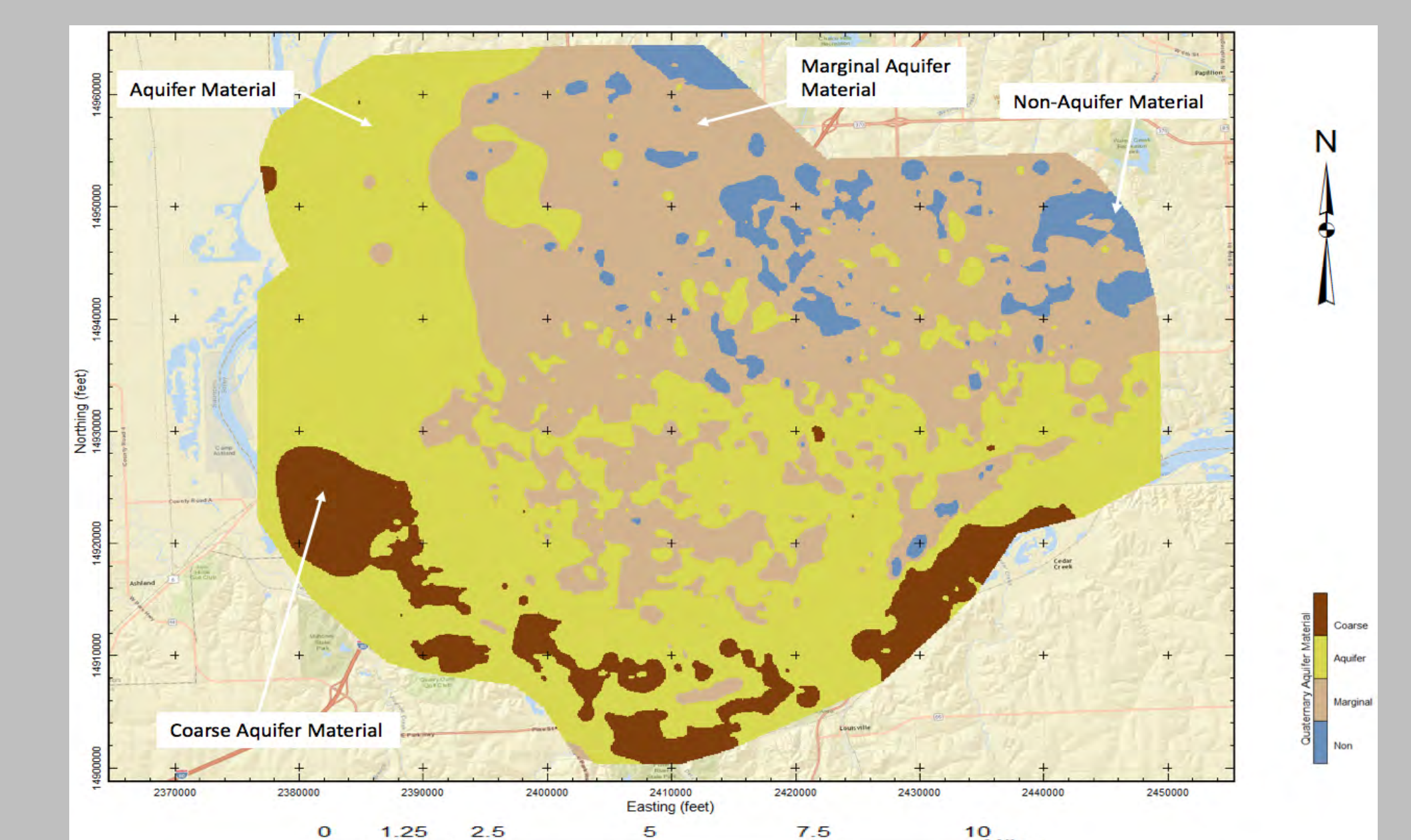


Photo of the Cretaceous Dakota Group contact with the underlying Pennsylvanian age formations



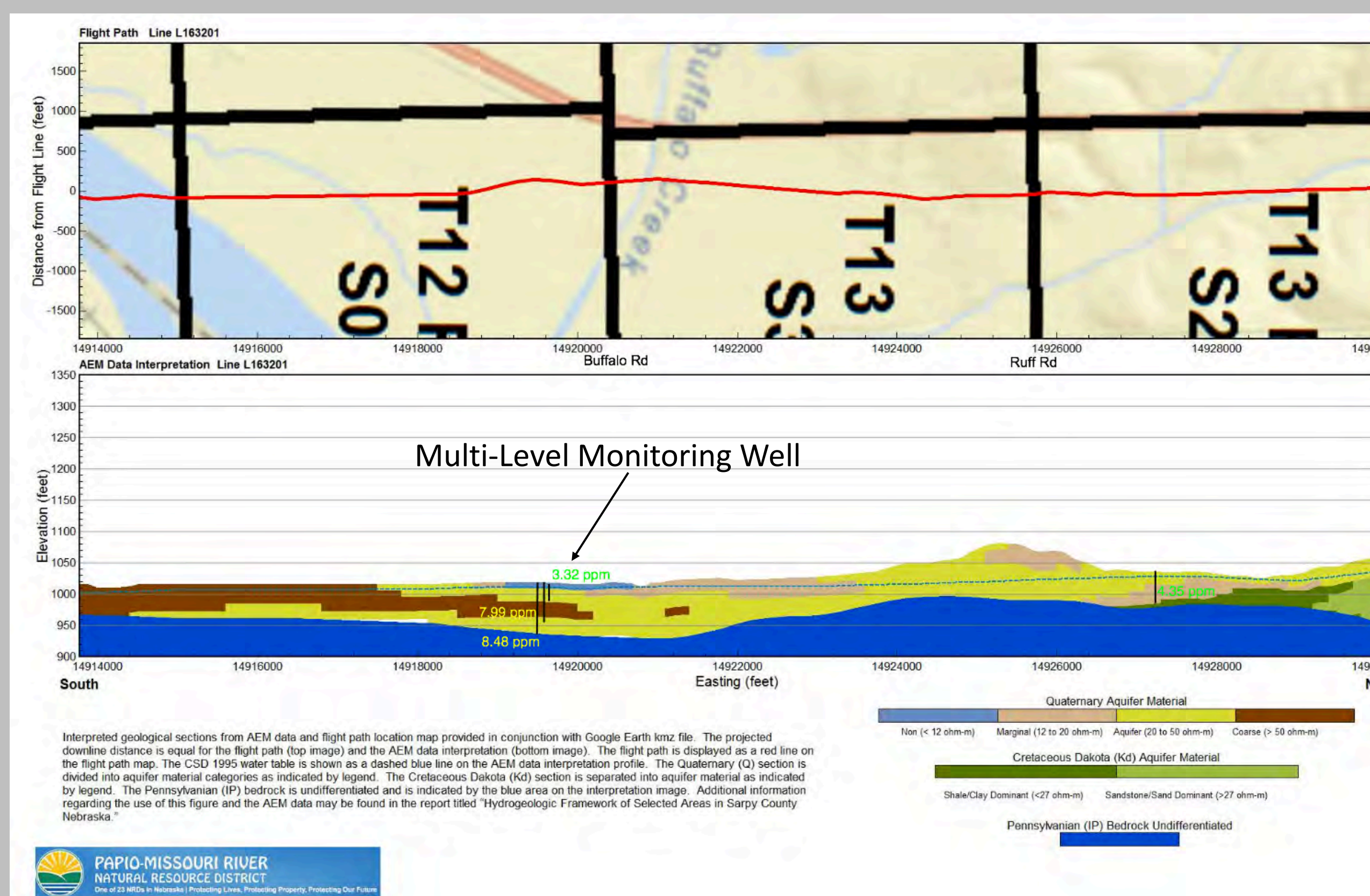
3D view looking to the northwest of the saturated Cretaceous Dakota Group (Kd) erosional bedrock remnants and the connection to the saturated Quaternary material in the Platte river.



2D view looking of the surface materials controlling recharge

Water Quality Management

AEM was used to understand the nitrate contamination within the Sarpy County area. The profile below shows the Platte River Alluvium to the west and the upland area to the east. Multi-level monitoring wells with the 2016 nitrate concentrations are related to the aquifer material pathways derived from the AEM. The low nitrate value in the upper screened interval of the multi-level well is due to reducing conditions underneath the non-aquifer material at the surface denitrifying the nitrate. The lower samples are not affected because of the stratification of the anoxic zone.

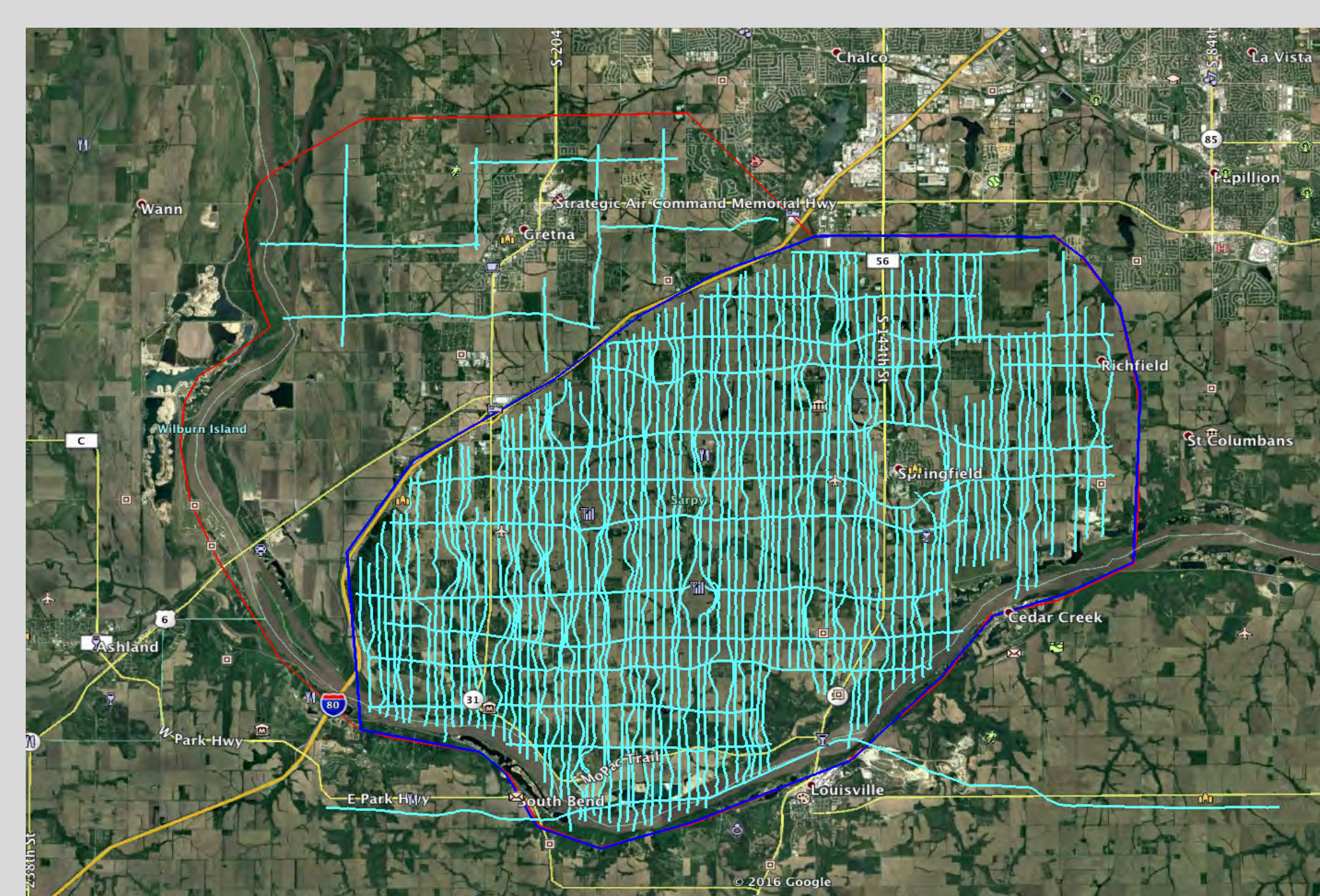
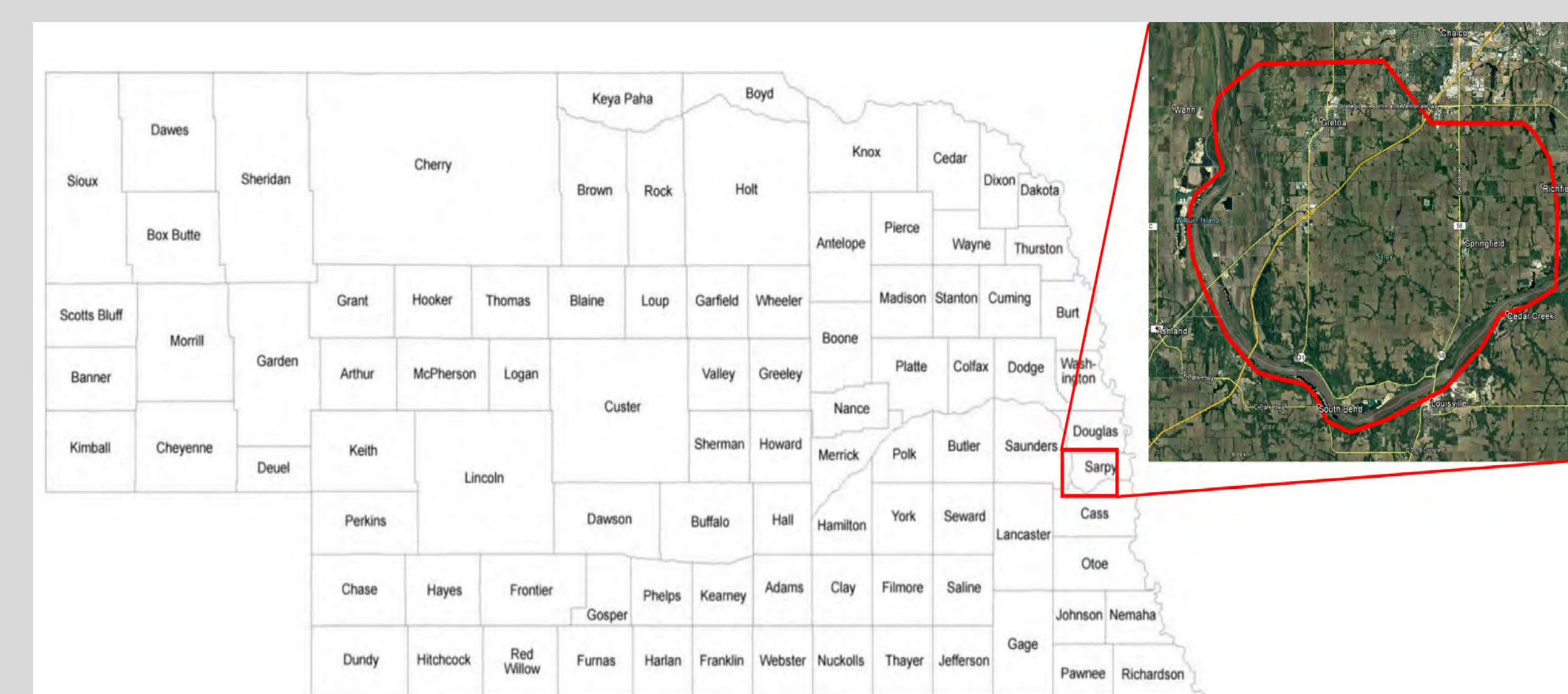


Proposed Water Quality Controls 2017

This area would potentially be in Phase II

| PROPOSED Water Quality Control Descriptions | Phase I | Phase II | Phase III |
|--|---------|----------|-----------|
| Encourage voluntary WHPA plans | X | X | X |
| Offer both rural and urban fertilizer and irrigation management "trainers" | X | X | X |
| Encourage chertigation by minimizing permit fee | X | X | X |
| Voluntary well testing ("Test Your Well" events) | X | X | X |
| MRD will specify commercial fertilizer application date restrictions | X | X | X |
| Encourage annual groundwater nitrate testing; soil sampling in root zone, and fertilizer application report through cost-share on lab analysis | X | X | X |
| Offer cost-share for well abandonment, cover crops, and/or selected BMPs | X | X | X |
| Cost-share on WHPA plans | X | X | X |
| Require fertilizer and irrigation management certification* | X | X | X |
| Cost-share on chertigation equipment or fertilizer calibration "trainers" | X | X | X |
| MRD will collect and test additional well samples (and use results for district wide assessments) | X | X | X |
| Require nitrogen management plan and annual groundwater nitrate testing, soil sampling in root zone, and fertilizer application report | X | X | X |
| MRD may conduct WHPA study and require recommended actions | X | X | X |
| No commercial fertilizer without inhibitor and/or split application | X | X | X |

Location of Sarpy County, Nebraska



Blue lines indicate location of AEM survey lines