A Preliminary Hydrogeologic Assessment of the McNairy Aquifer in Marshall and Calloway Counties, Kentucky

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Introduction

The goal of this project is to use Kentucky Water Well Completion Records from the Kentucky Groundwater Data Repository to begin a hydrogeologic assessment of the McNairy aquifer in Marshall and Calloway Counties (Fig. 1). The McNairy aquifer is a semi-consolidated to unconsolidated sand (Fig. 2) and is part of the Mississippi embayment aquifer system (Fig. 3).

The McNairy is a confined aquifer but has a recharge zone along the eastern portion of Marshall and Calloway Counties.

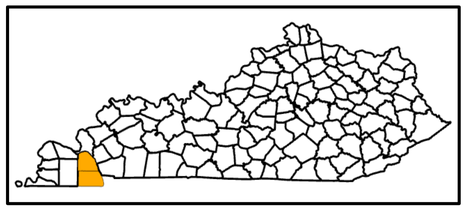

Figure 1. The location of Marshall and Calloway Counties, KY.

Figure 2. An exposure of the McNairy aquifer in southern Calloway County, KY.

Methods

Reported water well data from Kentucky Water Well Completion Reports (Fig. 4) submitted by Kentucky Certified Water Well Driller's from 1985 to present were used as follows.

1) All existing water well data for Marshall and Calloway Counties were downloaded from the Kentucky Groundwater Data Repository website.
2) Wells were filtered to remove all monitoring wells, unknown wells, and those wells without completion reports.
3) Wells were plotted using ArcGIS Pro.
4) Existing structure and isopach maps of the Midway confining unit and McNairy aquifer (Fig. 5), respectively, were used as guides to aid in identifying water wells completed in the McNairy aquifer.
5) An Excel spreadsheet, well construction and lithologic database were populated with completion record data.
6) ArcGIS Pro was used to create a groundwater elevation contour map and a structure map of the McNairy aquifer.
7) Select wells were chosen to verify surface elevation data recorded in completion reports.

System	Series	Geologic unit: Illinois	Kentucky	Tennessee	General lithology	Hydrogeologic unit[1]
Qua-ternary	Holocene and Pleistocene	Alluvium and terrace deposits	Alluvium and loess deposits	Alluvium and loess deposits	Sand, gravel, and loess	Mississippi River Valley alluvial aquifer
Tertiary	Eocene		Jackson Formation	Jackson Formation	Sand, silt, and clay	Upper Claiborne aquifer
			Cockfield Formation (Claiborne Group)	Cockfield Formation (Claiborne Group)	Clay and silt	Middle Claiborne confining unit
			Cook Mountain Formation (Claiborne Group)	Cook Mountain Formation (Claiborne Group)		
			Sparta Sand (Claiborne Group)	Memphis Sand (Claiborne Group)	Sand and minor clay. Some lignite	Middle Claiborne aquifer
			Tallahatta Formation (Claiborne Group)			Lower Claiborne–upper Wilcox aquifer
	Paleocene	Wilcox Formation	Wilcox Formation (Wilcox Group)	Flour Island Formation (Wilcox Group)		Middle Wilcox aquifer
				Fort Pillow Sand (Wilcox Group)		Lower Wilcox aquifer
				Old Breastworks Formation (Wilcox Group)		
		Porters Creek Clay (Midway Group)	Porters Creek Clay (Midway Group)	Porters Creek Clay (Midway Group)	Clay and minor sand	Midway confining unit
		Clayton Formation (Midway Group)	Clayton Formation (Midway Group)	Clayton Formation (Midway Group)		
Creta-ceous	Upper	McNairy Sand	McNairy Sand	McNairy Sand	Sand	McNairy–Nacatoch aquifer
		Nacatoch Sand	Nacatoch Sand	Nacatoch Sand		

Mississippi embayment aquifer system

Figure 3. The hydrogeologic units of the Mississippi embayment aquifer system (Lloyd and Lyke, 1995).

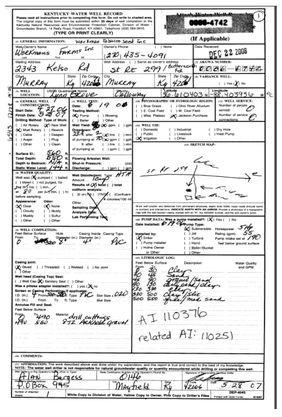

Figure 4. An example of a Kentucky Water Well Completion Report.

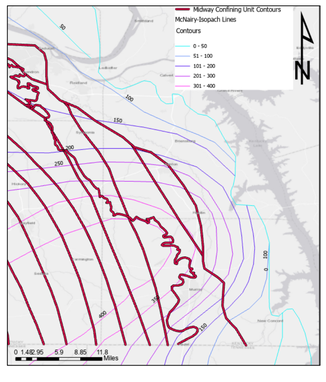

Figure 5. The Midway confining unit structure map (red) and the McNairy isopach map (varying colors). Modified from MacCary and Lambert (1962), Davis and others (1973), and Lloyd and Lyke (1995).

Figure 9. Static water level data collection using water level meter in Christian County, KY.

Results

Five hundred six water wells were identified to be in the McNairy aquifer. The water well completion reports used to make these identifications were recorded using reported data, or soft data. The legitimacy of this data is dependent upon the driller's observations being correct and accurate.

Selected water well types ranged from domestic, irrigation, municipal, and agricultural. The well point map (Fig. 6) shows the varying colors of the well points indicating the well's use or purpose. A contour map of groundwater elevation in Marshall and Calloway Counties (Fig. 7) was created from the same well points and their respective groundwater elevation values. The map indicates groundwater elevation generally decreases to the west and southwest. A structure map of the McNairy elevation created from lithologic data (Fig. 8) shows that the aquifer locally dips to the west and southwest as published in Lloyd and Lyke (1995).

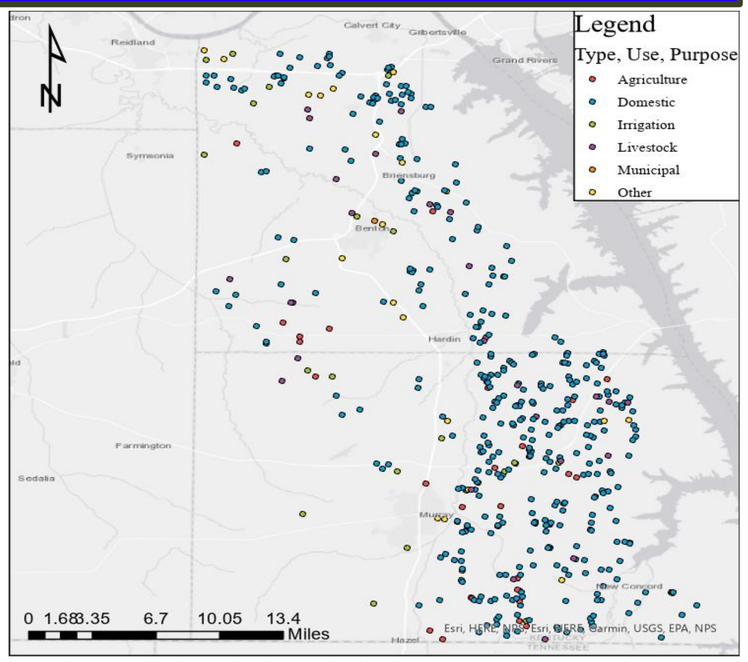

Figure 6. Water wells identified to be completed in the McNairy aquifer. Varying colors represent well's type, use, or purpose.

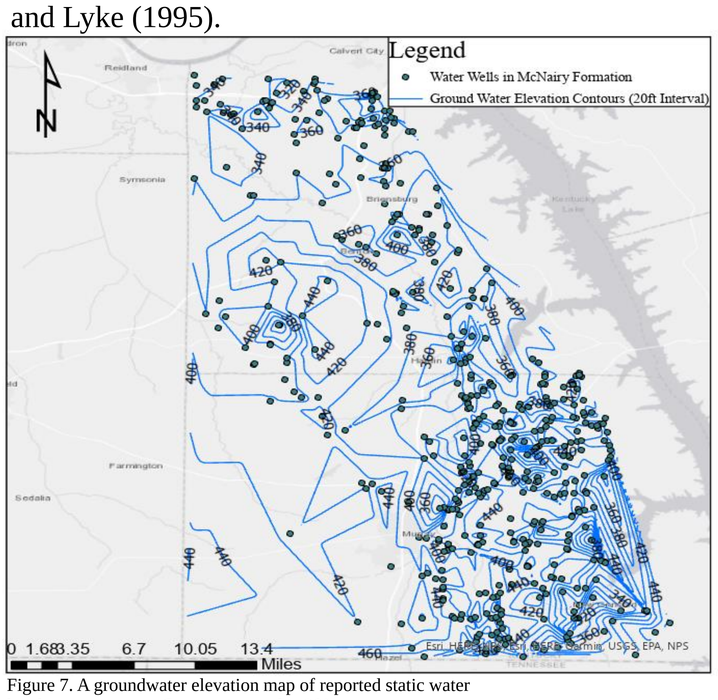

Figure 7. A groundwater elevation map of reported static water level measurements. Contour interval is 20ft.

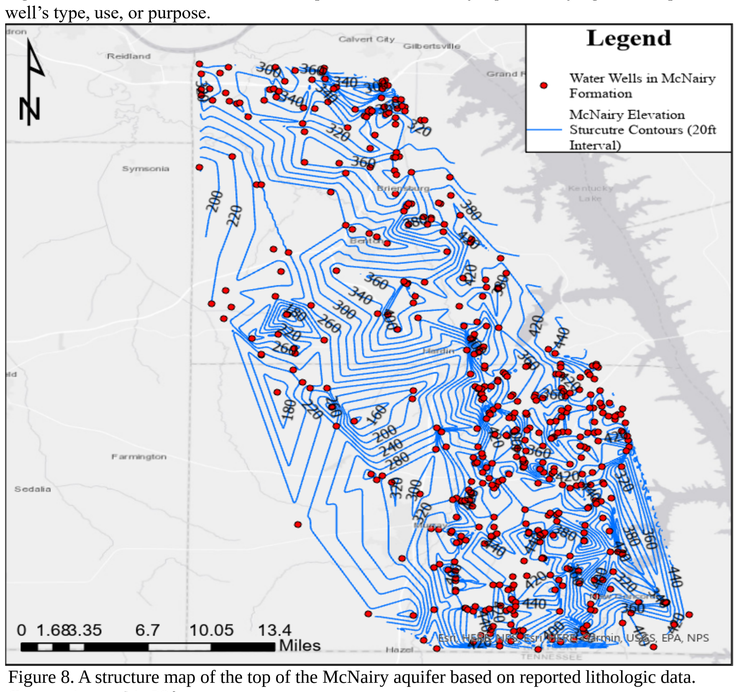

Figure 8. A structure map of the top of the McNairy aquifer based on reported lithologic data. Contour interval is 20ft.

Conclusions

Reported data from Kentucky Water Well Completion Reports were successfully used to identify water wells completed in the McNairy aquifer in Calloway and Marshall Counties. In addition, two databases were generated. One groundwater elevation contour map and one structure map of the top of the McNairy aquifer were created. Future hydrogeologic work related to the McNairy aquifer can be continued based on the work completed during this internship.

Further Research

Databases created during this internship will be used to:

1) Further develop lithologic cross sections,
2) Locate wells for synoptic water-level measurements (as seen in Fig. 9) of the McNairy aquifer,
3) Potentially locate McNairy aquifer wells to be sampled for groundwater chemistry.

References

Davis, R.W., Lambert, T.W., and Hansen, A.J., 1973, Subsurface geology and ground-water resources of the Jackson Purchase Region, Kentucky: U.S. Geological Survey Water-Supply Paper 1987, 66 p.

MacCary, L.M. and Lambert, T.W., 1962, Reconnaissance of ground-water resources of the Jackson Purchase Region, Kentucky: U.S. Geological Survey Hydrologic Investigations Atlas HA-13, 9 p.

Lloyd, O.B. and Lyke, W.L., 1995, Ground water atlas of the United States: U.S. Geological Survey Hydrologic Investigations Atlas 730-K, pp. K27-K30.

Acknowledgements

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