Technical Memorandum

To: **Village of Nelsonville Groundwater Protection Committee**
From: **Andrew Aslesen, Source Water Protection Specialist, WI Rural Water Assn.**
Date: **June 16, 2020**
Subject: **Village of Nelsonville, Groundwater Modeling (Revised)**

INTRODUCTION

In April 2020 Lisa Anderson from the Village of Nelsonville Groundwater Protection Committee contacted Wisconsin Rural Water Association to discuss concerns about elevated nitrate in many of the private wells in the village. Private wells were sampled through a county testing program in 2018 then again in 2019 during a targeted sampling event. Results of the sampling were analyzed by Peter Arntsen of Sand Creek Consultants and presented in the technical memorandum dated Sept 20, 2019. WRWA discussed with Lisa additional steps that the village could take to protect the private wells in the village. This includes developing a local groundwater flow model and developing a source water protection plan. This memo is a revised version of WRWA's original memo dated May 29, 2020. The primary revision is based on changing the estimated groundwater recharge rate from 5.7 inches/year to 10 inches/year based on feedback from the Village of Nelsonville. The revision does not appreciably change the groundwater modeling results.

PURPOSE

The purpose of this memo is to provide additional information on the local groundwater flow system near the Village of Nelsonville by presenting the results of groundwater flow modeling completed by Wisconsin Rural Water Association in March, 2020. Groundwater flow modeling was conducted to estimate the land area contributing groundwater to the 25 "source-test" wells analyzed in the Sand Creek technical memo (Arntsen, 2019).

GROUNDWATER FLOW MODELING

In the Sand Creek technical memo, groundwater flow to 25 "source-test" private wells is inferred by drawing flow lines based on mapped water table contours (Arntsen, 2019. Figure 5). To supplement the findings of Pete Arntsen, WRWA developed a groundwater flow model using the analytical element modeling software GFLOW. The analytic element model uses known water table elevations from hydrologic features and a series of mathematical equations to simulate a groundwater flow systems in two dimensions. When a pumping well is placed in the model, it uses reverse particle tracking to estimate a series of groundwater flow lines from the well backwards to their origination points. Two dimensional analytic element models are

particularly well suited for modeling simple single layer sand and gravel aquifer systems like the glacially derived sand & gravel aquifer found in central Wisconsin. Assumptions used in the model include a hydraulic conductivity (K) of 98 ft/day, porosity of 0.32, average aquifer thickness of 150 ft, average annual recharge of 10 inches/year and pumping rates for each well of 300 gallons per day.

The entire land area that contributes water to a well is known as the "Zone of Contribution" (ZOC). The groundwater flow model was used to delineate ZOCs for all 25 source-test wells in the village of Nelsonville. Along with the full ZOC, "capture zones" equal to the 5, 10, 15 & 20-year Time of Travel (TOT) were delineated. Water recharging the aquifer at the margin of the 5, 10, 15 & 20-year capture zones should take 5, 10, 15 & 20 years respectively to reach each pumping well. Within the 5-year capture zones, one year time of travel marks are included along each flow line. The final model output produced is 10 foot water table contour lines. The modeled water table contours and zone of contribution flow lines are mapped in Figure 1, with a larger scale version mapped in Figure 2.

CONCLUSIONS

The groundwater model produced water table contours similar to the water table contours mapped by the Portage County Planning & Zoning Department. Both sets of contours are shown in Figures 1 & 2 with the modeled contours shown as light blue lines and the Portage County contours shown as dark blue lines. The groundwater model's ability to produce water table contours similar to the mapped contours helps provide confidence in the model. The ZOC's produced for the 25 source-test wells in the village show groundwater coming from much the same area as the Sand Creek memo (Arntsen, 2019). This provides additional confidence in the understanding where the groundwater pumped from these wells originates from. This information can be used by the village while making decisions to help protect the groundwater aquifer that serves as their drinking water source.

FIGURES

REFERENCES

Arntsen, P., 2019. *Technical Memorandum, Evaluation of Data for "Source-Test" Private Wells*: Sand Creek Consultants report to Village of Nelsonville.

Hartman, Jeff, 2020, *Water Table Contour & Source-Test Well GIS Data*: Portage County Planning and Zoning Department, Personal Communication.

Figure 1 – Village of Nelsonville Source-Test Wells, Modeled Zones of Contribution

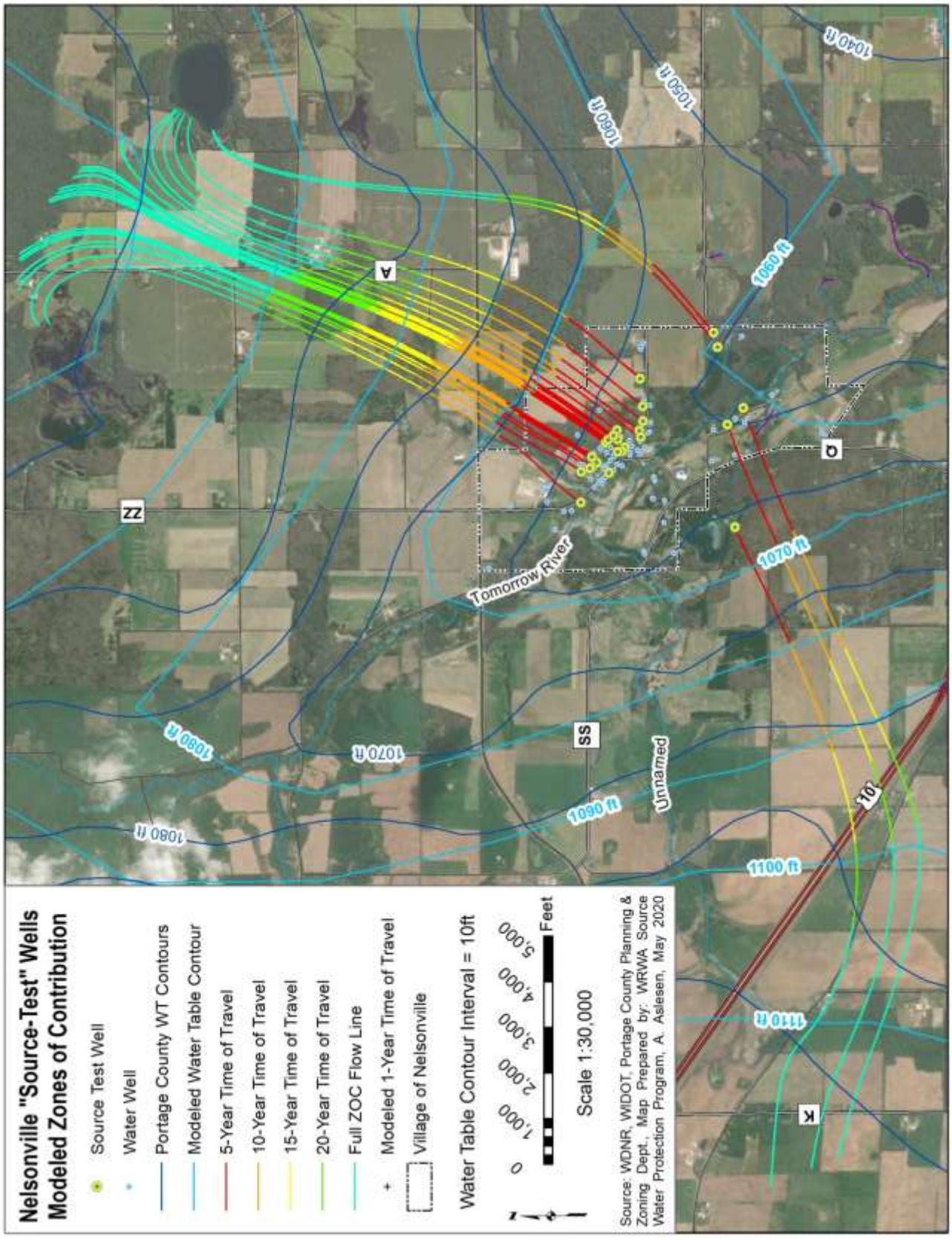

Figure 2 – Village of Nelsonville Source-Test Wells, Modeled ZOCs-Zoom