

APPENDIX H
TRANSIENT CALIBRATION INFORMATION

CALCULATING NASH–SUTCLIFFE COEFFICIENTS

For calibration of the transient model we adjusted the storage coefficients (S_v and S_s) in each zone to maximize the overall median Nash–Sutcliffe coefficient of efficiency (NS). This provided an objective summary statistic to guide the calibration process, where calculated NS values can range from negative infinity to 1, with NS values closest to 1 indicating a good fit. The change in head from January 2020 (drawdown; dh) was used as the target, rather than the absolute head elevation, since the absolute head had already been largely determined during the steady-state calibration of the K and conductance parameters. We used a simple Python code to efficiently calculate the NS for each model run.

NS is calculated for each well by (modified from Anderson and others, 2015):

$$NS = 1 - \frac{\sum_{i=1}^n |dh_m - dh_s|_i^2}{\sum_{i=1}^n |dh_m - \overline{dh}_m|_i^2}$$

where:

n is the number of drawdown observations;

dh_m is the observed drawdown;

dh_s is the simulated (modeled) drawdown; and

\overline{dh}_m is the mean of observed drawdowns.

Example:

For well 84, the first three observations are shown on table H1. If this were the whole data set, NS would be calculated as:

$$NS = 1 - \frac{0.28}{1.13} = 0.75$$

Overall, 70% of the NS values were positive, the median NS was 0.27, and the range was from -12.43 to 0.90. One drawback of the NS approach is that hydrographs with low overall amplitude (low $|dh_m - \overline{dh}_m|$) are penalized as the ratio becomes large due to a small denominator, even when the difference between observed and modeled drawdown (i.e., error) is the same.

Table H1. Example NS calculation.

Date	Observed (dh_m)	Computed (dh_s)	$dh_m - dh_s$	$(dh_m - dh_s)^2$	$dh_m - \text{Avg} dh_m$	$(dh_m - \text{Avg} dh_m)^2$
1/9/20	0.50	0.21	0.29	0.09	-0.75	0.56
2/6/20	1.25	0.93	0.32	0.10	0.00	0.00
3/11/20	2.00	1.69	0.31	0.10	0.75	0.56
Average	1.25					
Sum				0.28		1.13

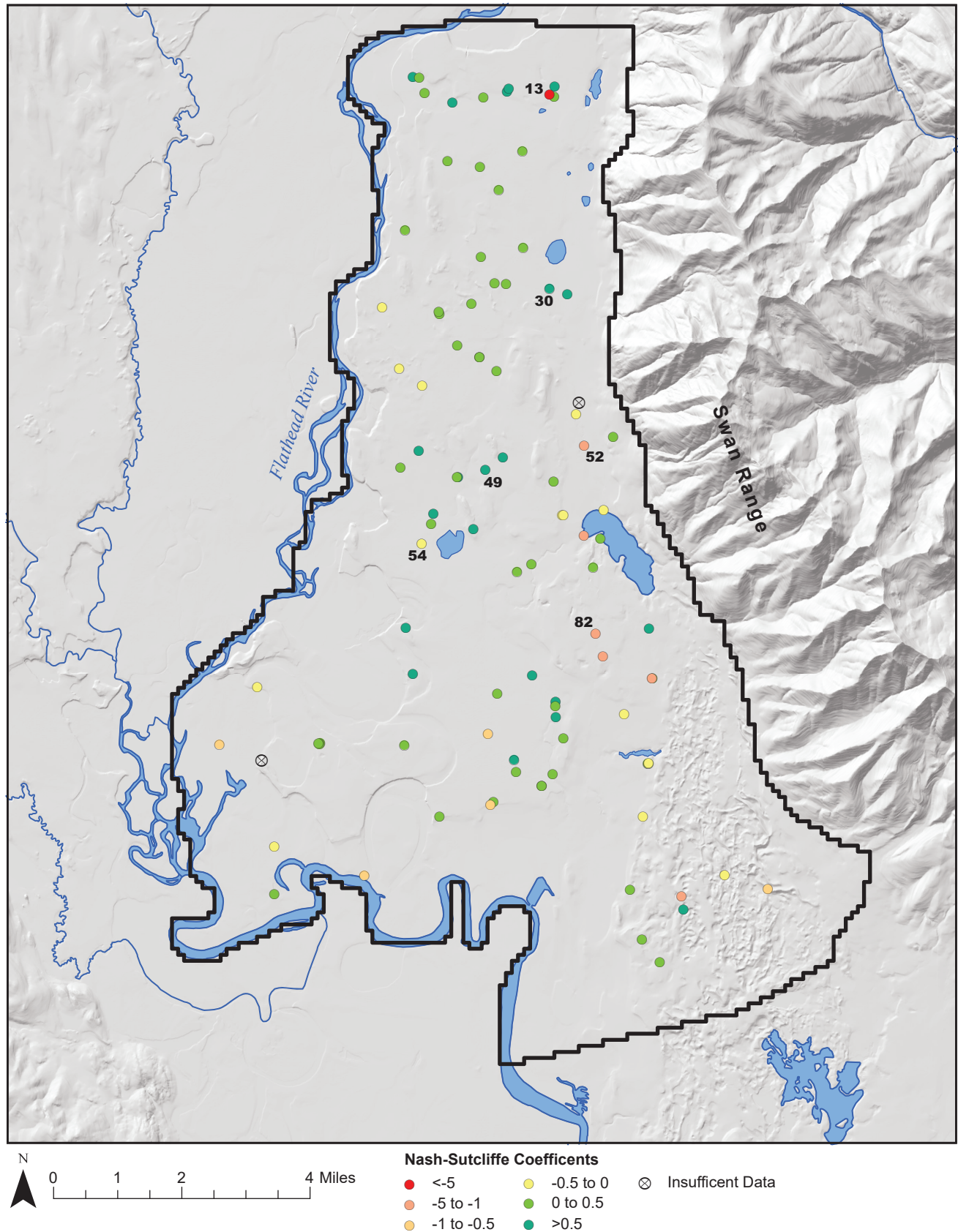


Figure H1. Nash–Sutcliffe efficiency coefficients were calculated for the observed and simulated transient drawdown data (relative to January 2020). There is no obvious geographic or stratigraphic pattern to the values. Low NS values occur within the same zone as high values, so further improvements would require changes in model construction (or zonation) rather than changes in model parameters. Hydrographs for labeled sites are shown in figures H3 and H4.

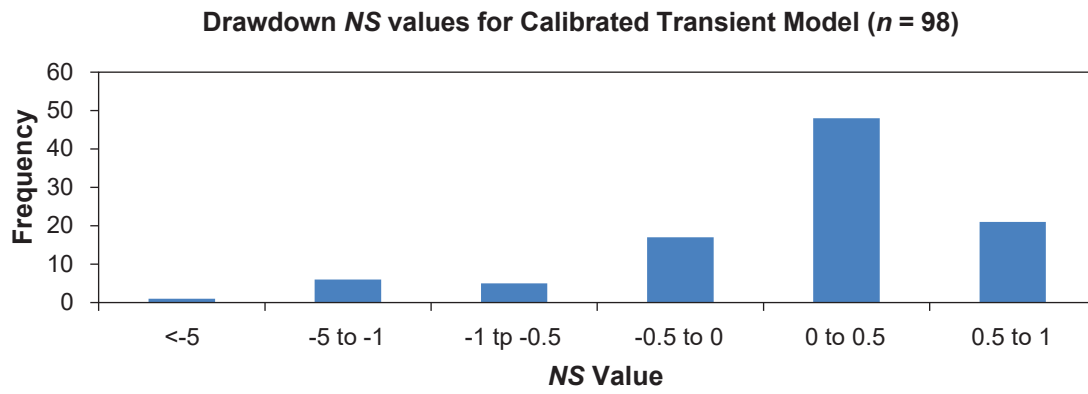


Figure H2. Nash–Sutcliffe efficiency coefficients were calculated for the observed and simulated transient drawdown data (relative to January 2020). The median value was 0.27, and 88% of values fell between -0.5 and 1.

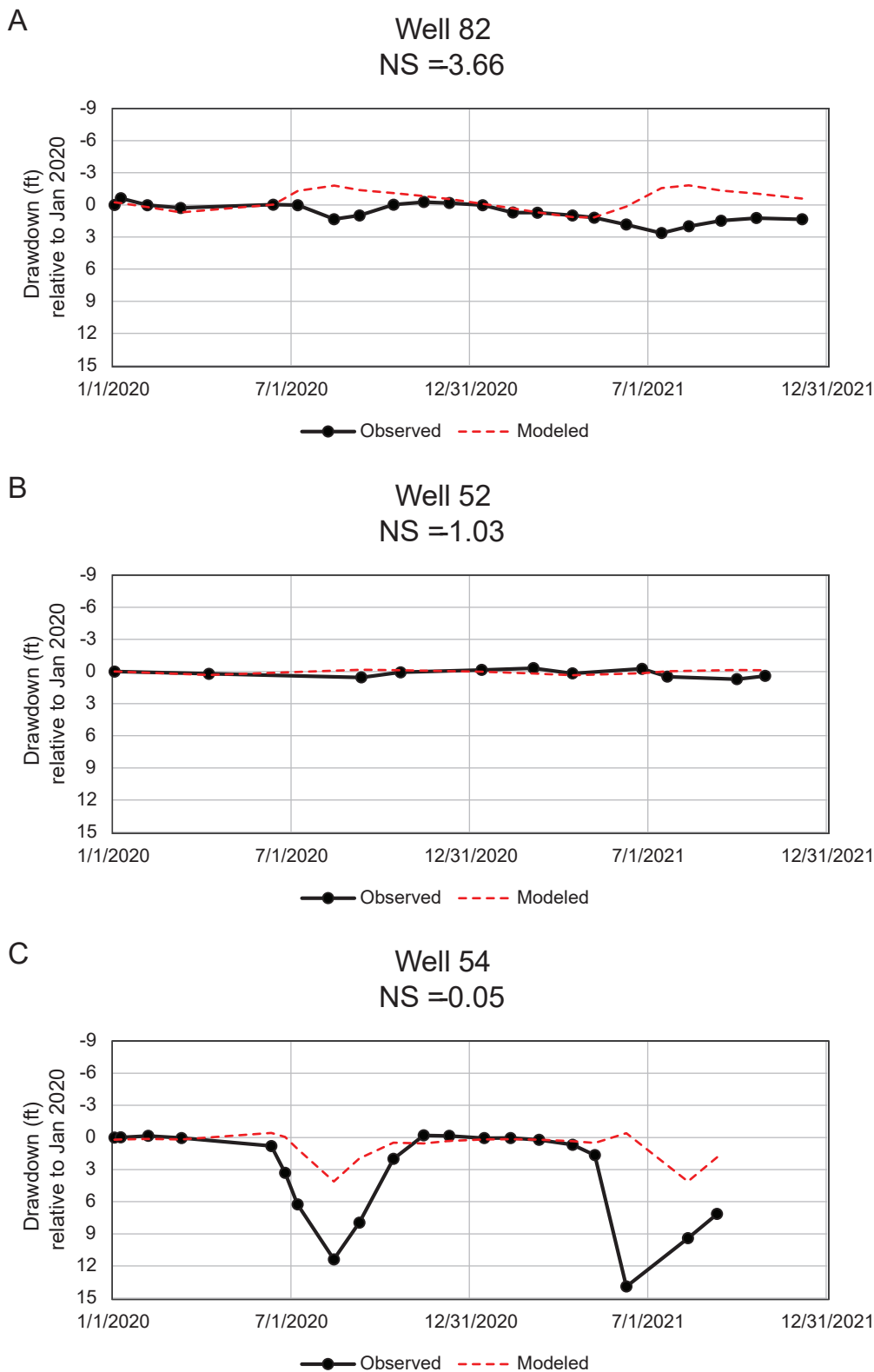


Figure H3. Example hydrographs comparing modeled to observed drawdowns (relative to January 2020), with Nash–Sutcliffe efficiency coefficients. See appendix A for well details. Locations are shown in figure H2.

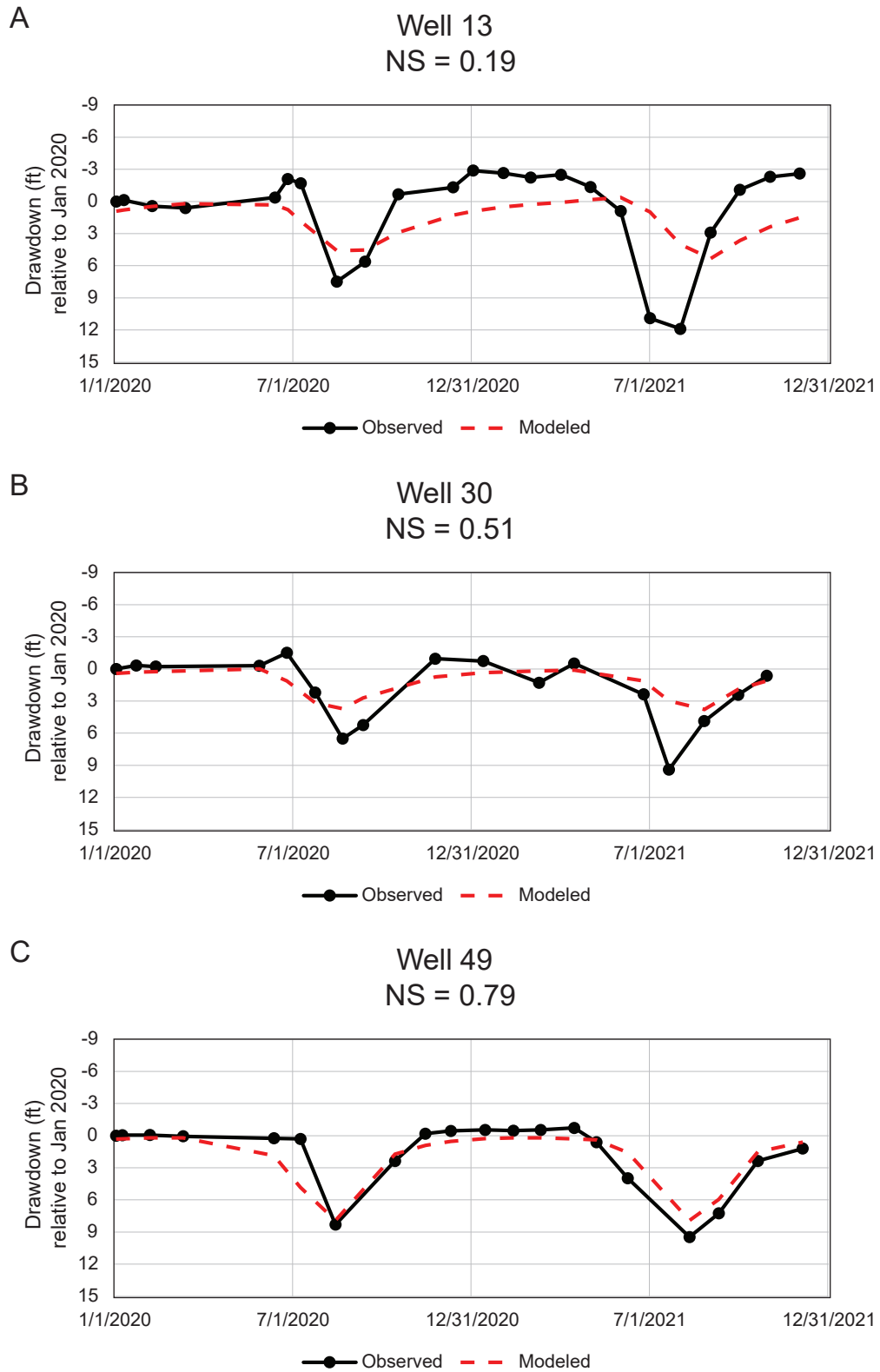


Figure H4. Example hydrographs comparing modeled to observed drawdowns (relative to January 2020), with Nash–Sutcliffe efficiency coefficients. See appendix A for well details. Locations are shown in figure H2.