Delineation of the Fair Haven Wellhead Protection Area

Steven Winkley, P.G.
New York Rural Water Association (NYRWA)
May 13, 2022

Aquifer Data

NYRWA analyzed data from the October 27, 2021 step-drawdown pumping test conducted on a six-inch diameter test (TW-1) drilled at the Village of Fair Haven well field. Analysis of data from this test indicates that the calculated transmissivity of the aquifer ranges from 3,456 ft^2/d to 7,843 ft^2/d, with a geometric mean value of 5,830 ft^2/d (see Table below).

Transmissivity is the capacity of the aquifer to transmit water. With a saturated aquifer thickness of 35 feet at TW-1, the mean hydraulic conductivity of the sand and gravel aquifer was calculated to be 166.6 feet/day. This value is consistent with published values for sand and gravel. The storativity values calculated in the aquifer adjacent to the well field are consistent with that of a confined aquifer. The well log for TW-1 indicates 14 feet of fine-grained sand, silt, and clay of a glaciolacustrine origin overlying the sand and gravel aquifer.

Well(s)	Method	Transmissivity - ft^2/d	Storativity - dimensionless
All	Distance-Drawdown	6,521.7	0.0001
TW-1	Residual Drawdown	3,456.2	
TW-1	Time-Drawdown (first step)	7,843.1	
Dug Well	Time-Drawdown (first step)	6,535.9	0.0040
	Geometric Mean	5,830.3	0.0006

Mean Hydraulic Conductivity = 166.6 ft/d

Table 1: Calculated Aquifer Parameters from Well TW-1 Step-Drawdown Test

Zone of Contribution Determination

The primary zone of the wellhead protection area is the zone of contribution. This is the portion of the sand and gravel aquifer where all recharge and ground water flows directly toward the pumping well(s). In a setting such as Fair Haven's well field, where there is a pronounced regional hydraulic gradient (i.e. slope to the aquifer potentiometric surface), the zone of contribution does not equal the area where water levels are lowered by pumping (an area referred to as the zone of influence).

The chief method NYRWA used to define the zone of contribution was the multiple wells WHPA module of the USEPA's wellhead analytic element model (WhAEM). Data and output from this

module is depicted on Figure 1. Input data for the model included the ambient flow which is the mean transmissivity (5,830 ft^2/d) times the regional hydraulic gradient (0.00178). The regional hydraulic gradient was taken to be one-half the gradient of the unnamed tributary of Sterling Creek which flows north-northwest immediately east of the well field. The direction of the ambient flow field (110 degrees) is based upon the regional topographic and surface water gradient.

The pumping rates used in the multiple wells WHPA module simulation are the NYSDEC maximum permitted rates for the well field: 500 gallons per minute (gpm) for Well 1 and 250 gpm for Well 2. The aquifer thickness is based upon the geologic log for well TW-1. The travel times for the modeled groundwater flow lines to the pumping wells on Figure 1 are based upon 5 years (1,825 days).

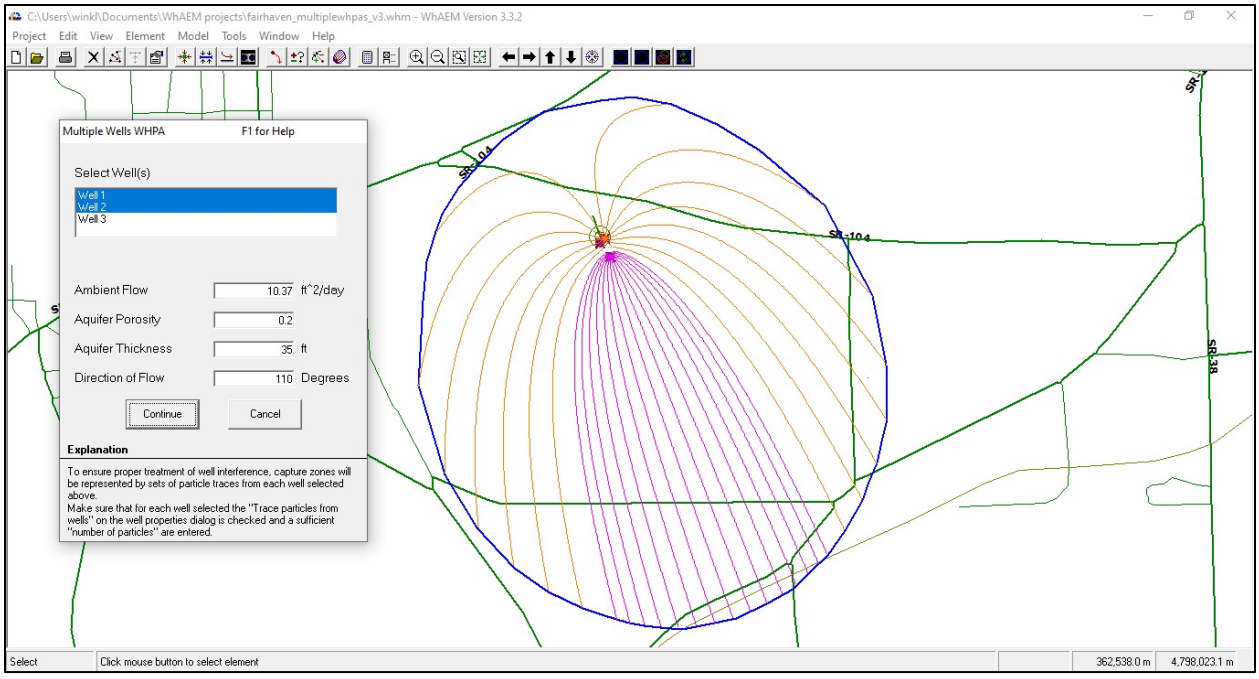

Figure 1: Multiple Wells WHPA Module Input and Output

The outer boundary of the modeled 5-year time of travel groundwater flow lines to Well 1 and Well 2 was then superimposed over the sand and gravel aquifer boundaries as mapped by NYRWA based upon surficial geologic mapping by the New York State Geological Survey, topographic expression, and available water well data in the area (see Figure 2). The southeastern boundary of the zone of contribution was taken to be the topographic drainage divide between northwest and northeast draining areas (Figure 2). Highly detailed two-foot topographic contours derived from 2018 LiDAR data were used to define this topographic divide. The aquifer's potentiometric surface is assumed to be a subdued replica of the land surface topography. The zone of contribution totals 404.4 acres.

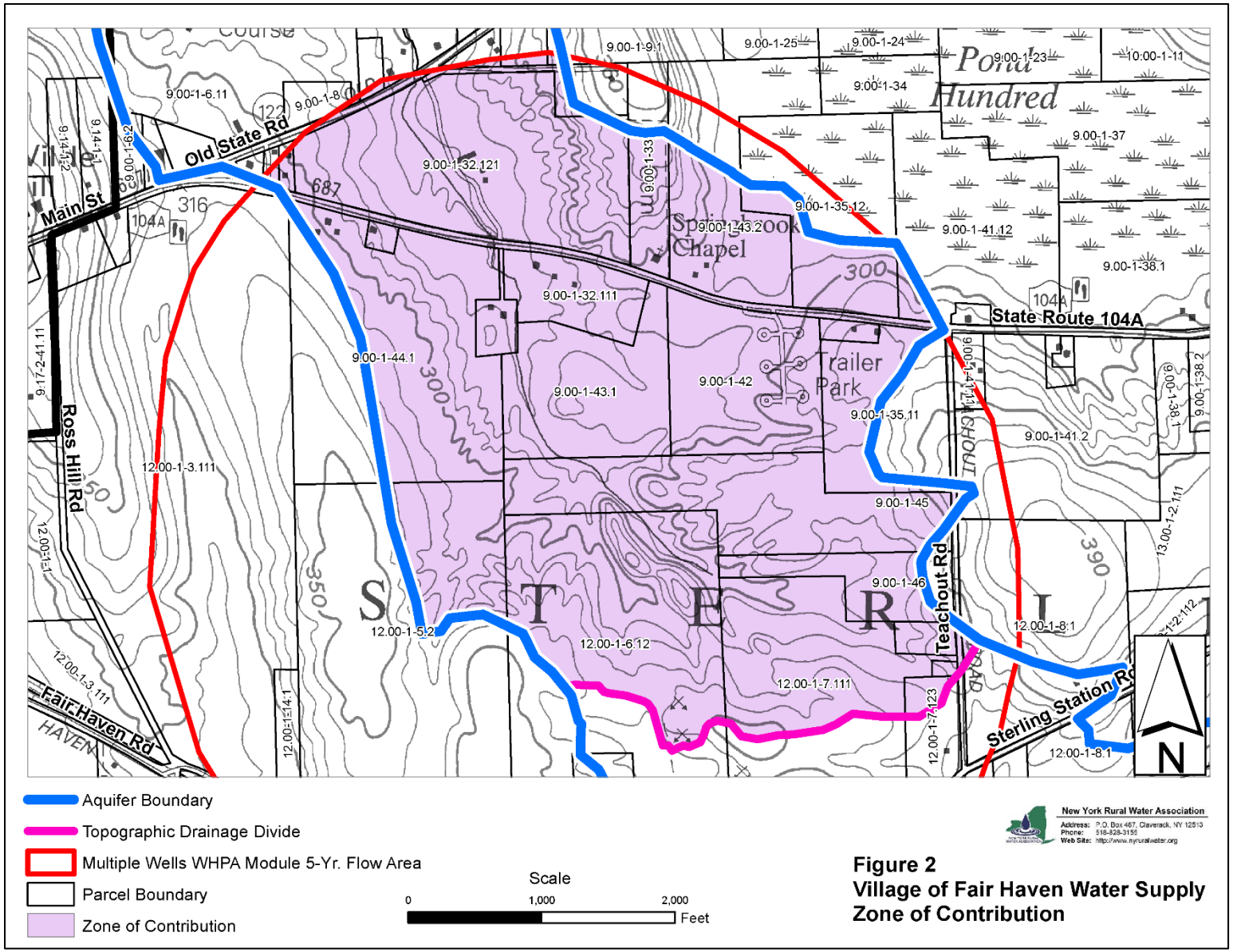

Figure 2: Zone of Contribution

Direct Runoff Zone

The secondary zone of the wellhead protection area is the direct runoff zone. This consists of non-aquifer areas where surface water directly runs off into the zone of contribution. It largely consists of till-covered hill sides (drumlins) that border the valley in which the sand and gravel aquifer occurs. Two-foot topographic contours were also used to define this zone. Figure 3 shows the direct runoff zone, which consists of three separate areas totaling 109.4 acres.

The resultant 513.8 acre (0.8 square mile) wellhead protection area is shown on Figure 4.

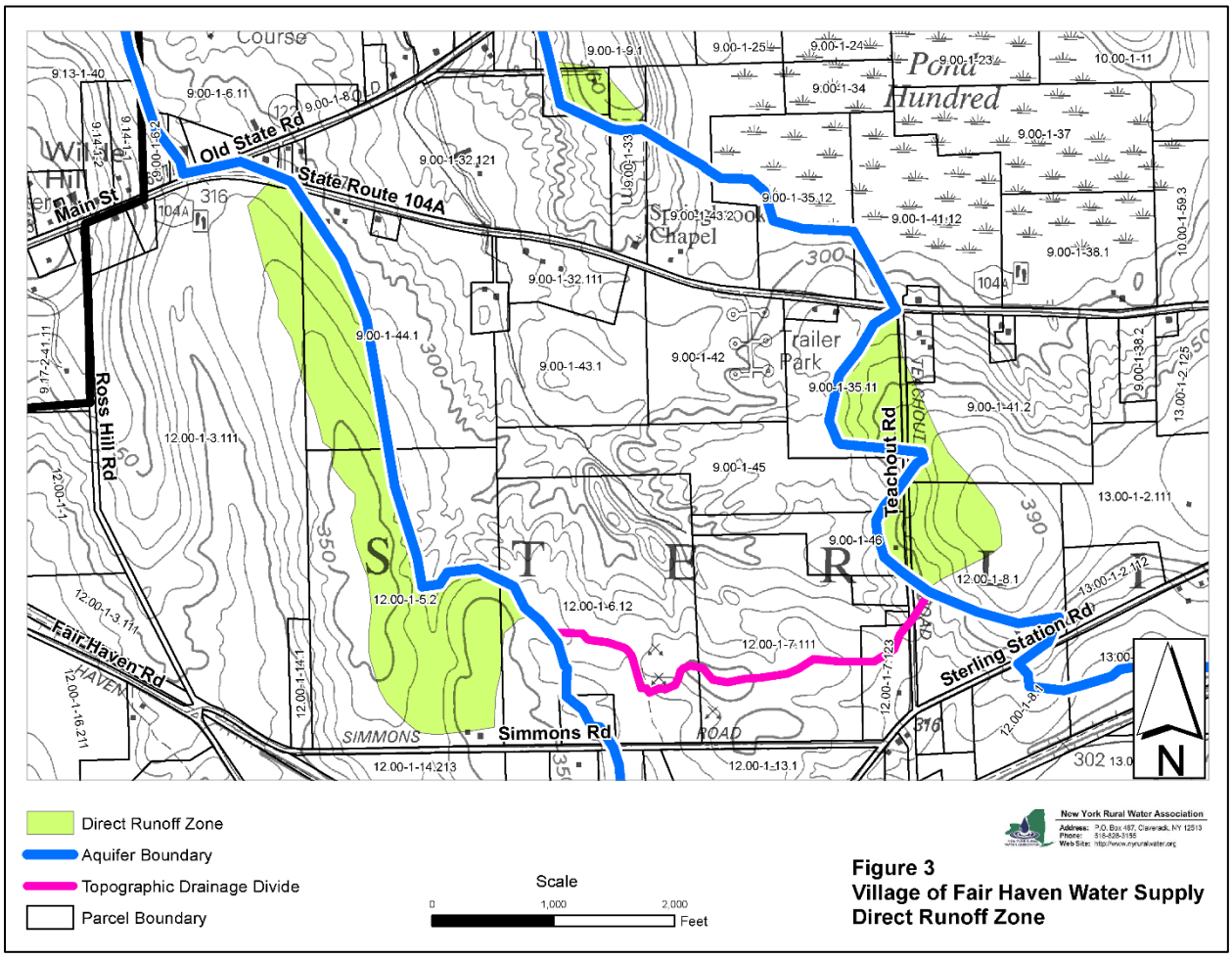

Figure 3: Direct Runoff Zone

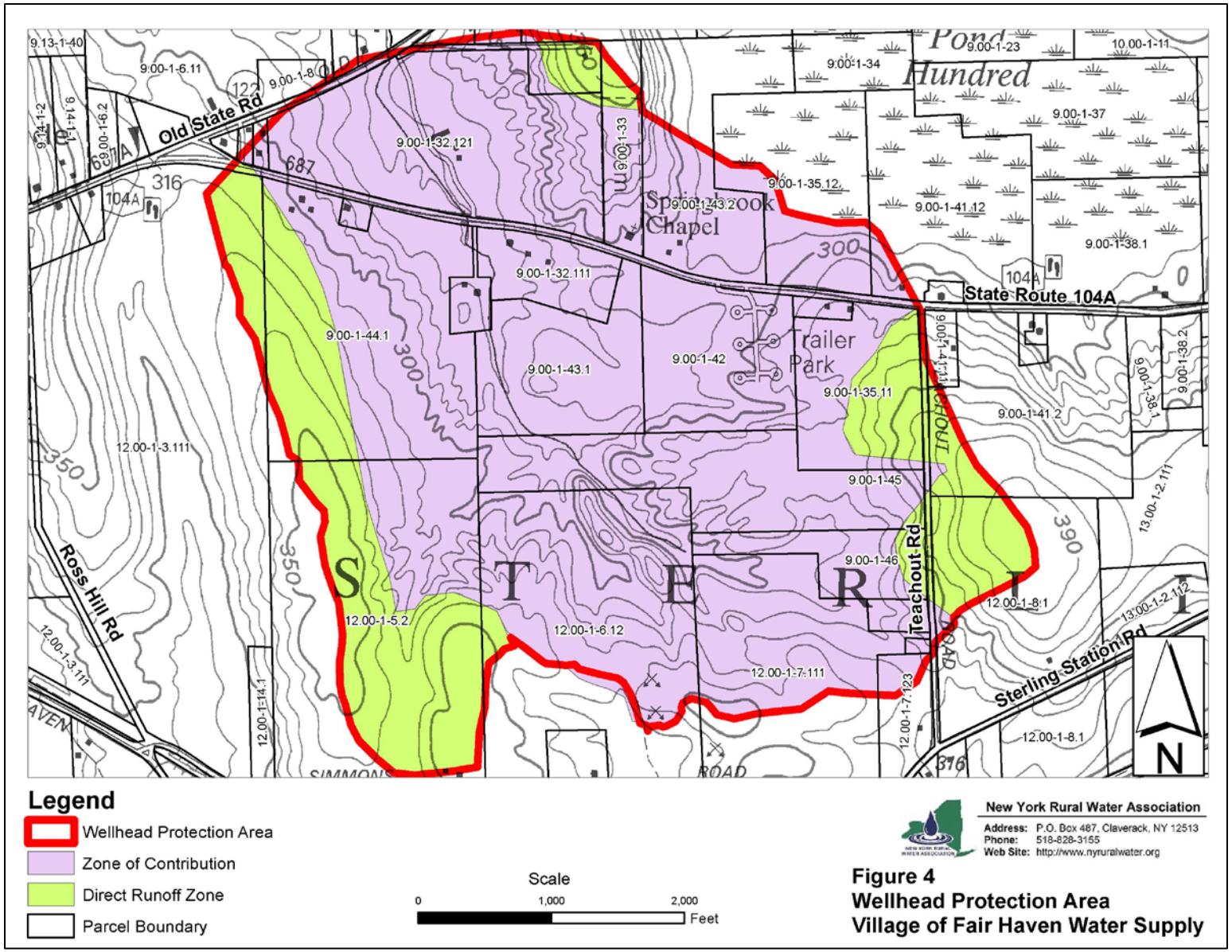

Figure 4: Wellhead Protection Area