Considerations for Protection of Water Resources in the Marcellus Shale Gas-Play Area of New York State

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Results from an aquifer-mapping study

of the Susquehanna River valley in eastern Broome and southeastern Chenango Counties, New York, include a conceptual model of groundwater flow and considerations for the protection of water resources in light of impending natural-gas resource development in the region.

Groundwater Resources

The stratified-drift aquifer in the Susquehanna River valley is the primary groundwater resource for public, commercial, and industrial supply. Resource potential of stratified drift and alluvium in most tributary valleys appears limited due to thin saturated thickness. The fractured-bedrock aquifer provides water supply for low-density residential development in the uplands, upland valleys, and in the Susquehanna valley. Residential wells are typically completed with open-ended casing (not screened) where completed in sand and gravel. If there is insufficient saturated sand and gravel in valley locations, wells are completed in bedrock beneath the stratified drift

Conceptual Model of Groundwater Flow

Precipitation that infiltrates into the subsurface (recharge) is the ultimate source of groundwater throughout the study area.

Recharge is favored in upland areas where bedrock is exposed or mantled by thin till deposits and in valleys where permeable (stratified) glacial deposits occur at land surface. Stratified deposits of the Susquehanna valley-fill aquifer receive natural recharge from one of three sources: (1) direct infiltration of precipitation into permeable glacial deposits in or along the sides of the valley, (2) groundwater flow toward the valley from adjacent hillslopes, and (3) infiltration of streamflow from tributaries as they cross alluvial fan deposits in the valley.

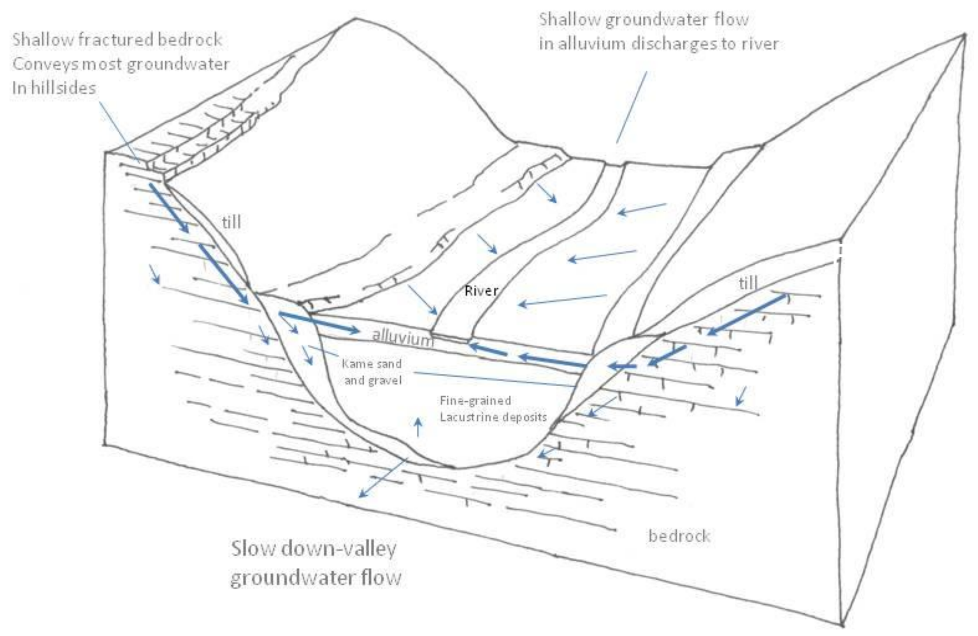


Figure 1. Conceptual block diagram of groundwater flow in the Susquehanna valley-fill aquifer

Groundwater exits the flow system:

(1) through subsurface discharge to tributary streams and the Susquehanna River – topographic low points in the landscape,
(2) from springs, where groundwater flow is directed to land surface by impervious zones in bedrock or glacial deposits, and
(3) as groundwater flow downvalley within the Susquehanna valley-fill aquifer beyond the study area.

Shallow, unconfined groundwater flow

Shallow, unconfined groundwater flow within the Susquehanna River valley is predominantly from the valley walls toward the river with a gentle downvalley component, dependent on local valley floor gradients and topography. This part of the flow system is likely the most active, as direct groundwater recharge, and groundwater inputs from hillsides and streams that traverse alluvial fans must be conveyed to the river (under natural conditions).

Groundwater flow at depth in confined aquifers

Groundwater flow at depth in confined aquifers is much less active, primarily because downvalley discharge to the river must pass through fine-grained lacustrine deposits and because these deposits are limited in thickness and distribution (see figure above). Groundwater flow in unconfined valley segments is likely more active than in confined segments. Pumpage from deep confined parts of the aquifer will increase groundwater flow rates and induce additional recharge from hydraulically connected unconfined zones of the aquifer system.

Considerations for Aquifer Protection

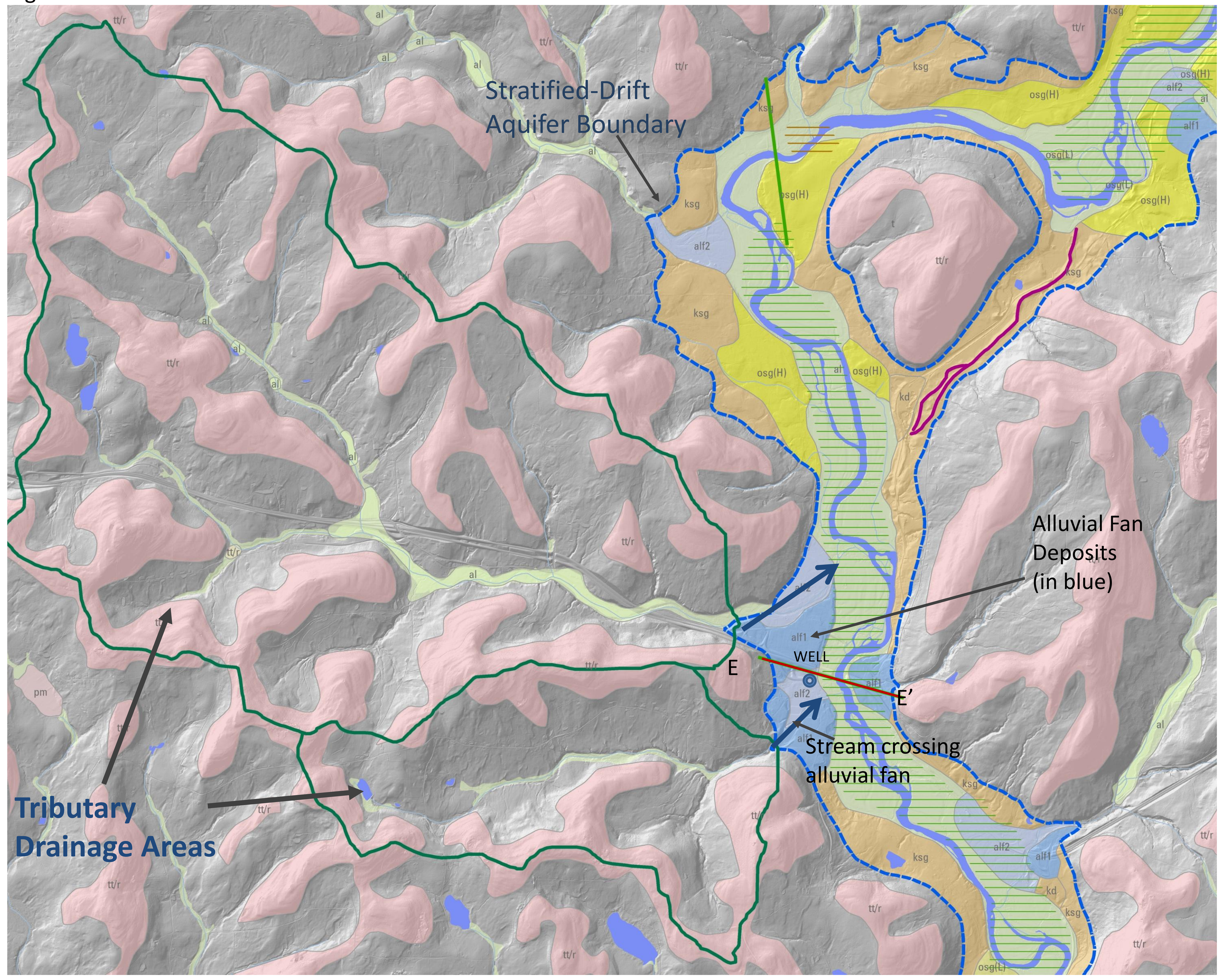
Aquifer protection in the study area is a critical need in light of impending natural gas drilling in this part of New York State. Aquifer protection efforts can first focus on currently used water resources, and information provided in this report can be used to prioritize protection of largely unused areas with the most favorable aquifer characteristics.

Upland watersheds that contribute water to the stratified-drift aquifer

Infiltration (loss) of streamwater as tributary streams cross alluvial fans in the main valley is a source of recharge to the stratified-drift aquifer (figures 2A, 2B). If water quality in those streams is compromised by activities in the upland watershed, groundwater quality in the valley may, in turn, be degraded.

Therefore, the maintenance of good water quality in the upland watersheds that give rise to these streams is an important aspect of aquifer protection beyond the bounds of the stratified-drift aquifer. This is particularly important at locations such as Windsor, Afton, and Bainbridge, where public-supply wells tap deposits that underlie, or are adjacent to, alluvial fans. Public-supply springs, used by the Village of Afton, likewise derive some water from adjacent uplands. Examples of contributing upland areas are delineated on figure 2A. Upland areas adjacent to the Susquehanna valley also provide recharge to the aquifer through surface runoff or subsurface flow down hillsides (see figure 1).

Figure 2A.



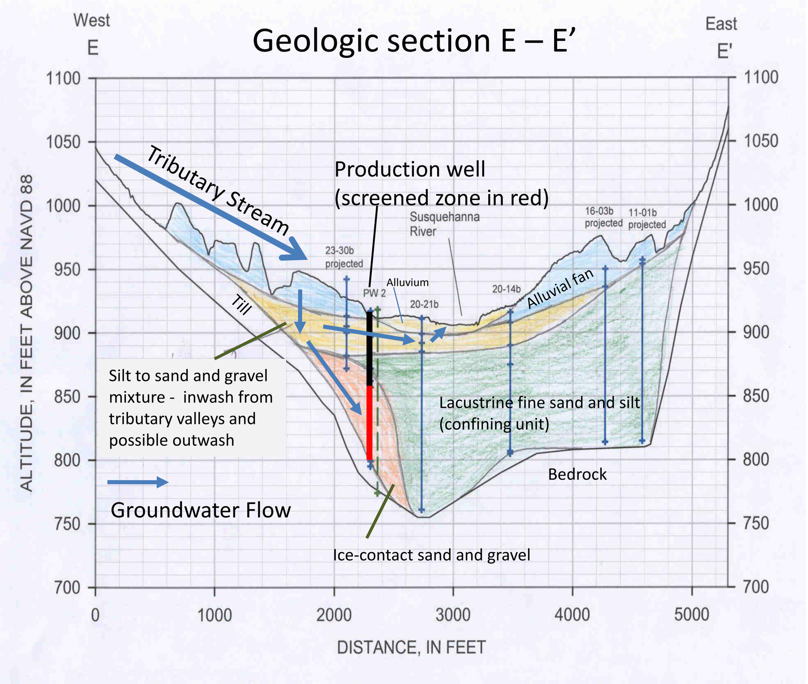


Figure 2B.

Map Units
al - alluvium
alf - alluvial fan
kd - kame delta
ksg - ice-contact (kame) sand and gravel
osg - outwash sand and gravel
t - till
tt/r - thin till or bedrock
horizontal green stripes – lacustrine silt and clay in subsurface
horizontal brown stripes – lacustrine fine sand in subsurface

Upland areas of thin till over bedrock

Groundwater supplies of domestic wells completed in bedrock in upland areas are most susceptible to contamination from activities in upgradient areas with thin till or exposed bedrock (figure 3). Contamination in these areas would migrate downslope in the shallowest, most permeable bedrock (upper 100-150 ft). Therefore, avoidance of activities that could potentially affect groundwater quality in areas of thin till or exposed bedrock in favor of areas with thick till (≥50 ft) can minimize adverse effects on local groundwater resources.

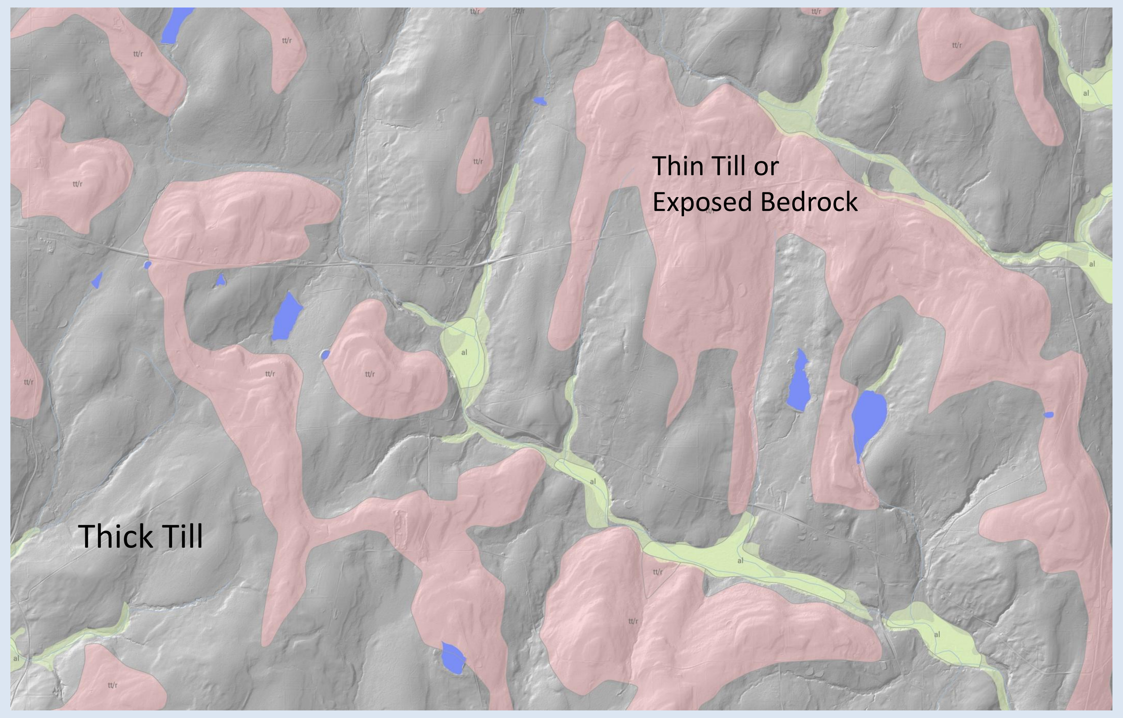


Figure 3.