Hydrogeology of a sand and peat aquifer, Rome Sand Plains, New York

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INTRODUCTION

The Rome Sand Plains is a mosaic of sand dunes, bogs, pine barrens, meadows, and deciduous forest that covers 16,000 acres in Oneida County, New York (Russell 1996). The area is one of the few remaining inland pitch pine barrens in the northeastern United States and is partly protected by a consortium of government agencies and conservation groups. The field site for this trip is located approximately 4 miles west of the city of Rome, New York, on Hogsback Road (Figure 1).

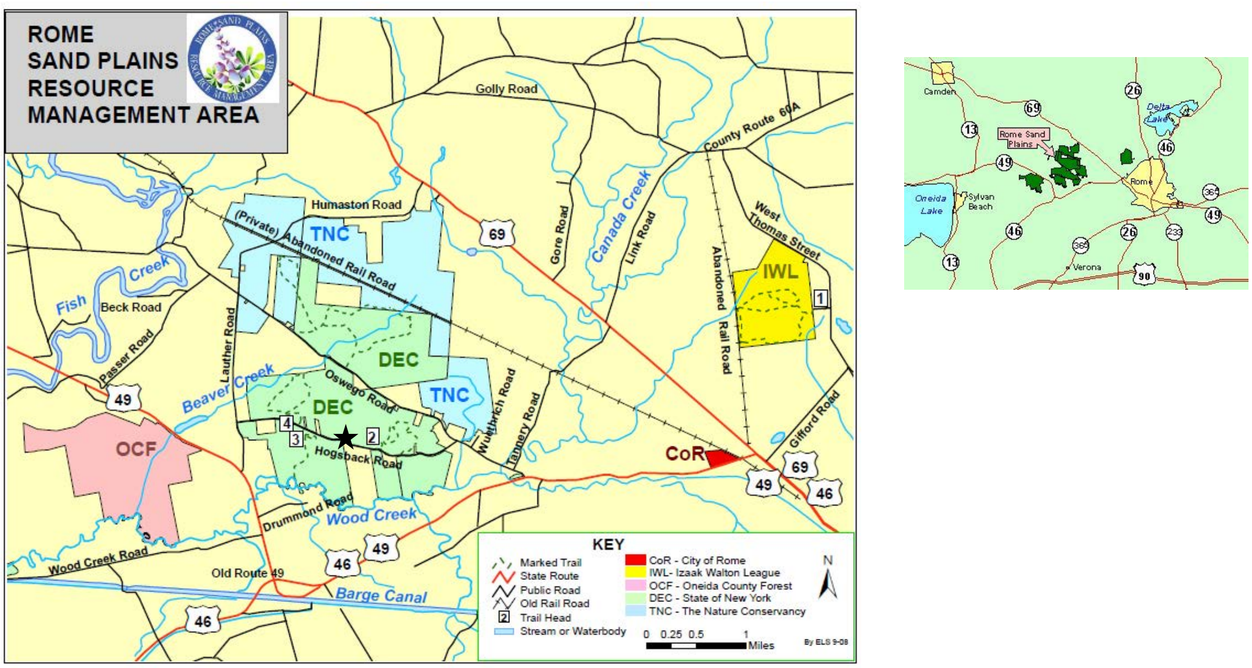

Figure 1. General location map of the Rome Sand Plains with approximate location of field site shown by the star along Hogsback Road (New York State Department of Environmental Conservation).

The field site is an area of parabolic dunes with an adjacent peat bog (Figure 2). There is approximately 50 feet of relief between the dune crests to the flat bog surfaces. The dunes were formed on what was probably a kame terrace that was about 50 feet above the surrounding lower area to the north (Eugene Domack, oral communication, 2012). When the ice melted, sand on the terrace surface was reworked by prevailing westerly winds into a series of parabolic dunes (Figures 2 and 3). The dunes are composed of fine to medium sand with a Fe hydoxide coating that gives it a yellowish color. The low areas between the dunes became bogs, partly because of a high water table that inhibited the growth of larger plants. The bogs are dominated by S*phagnum* moss and a variety of distinctive plants such as bog rosemary and leatherleaf (Russell 1996). There are also sundew and pitcher plants in some bogs, but we probably won't see any on our trip. Peat thickness ranges from less than 1 m in bogs that were mined for peat to ~8 m in undisturbed bogs. Water in the peat is acidic, with a pH of 4 to 5.

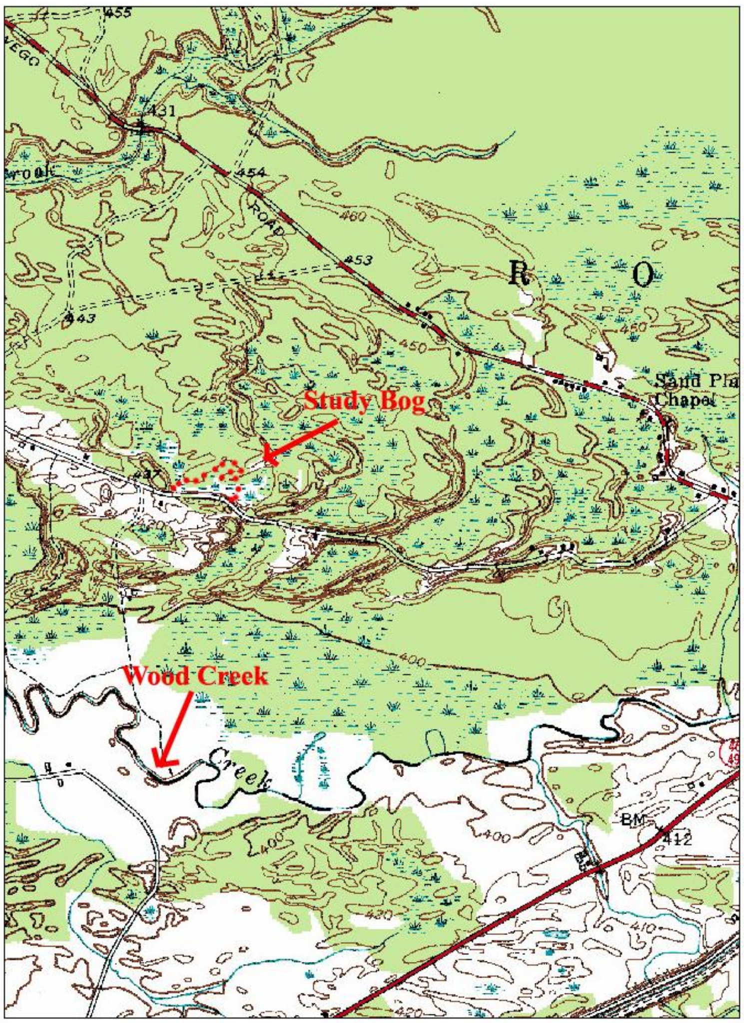

Figure 2. Part of the 1:24,000 Verona Quadrangle showing the parabolic dune area of the Rome Sand Plains.

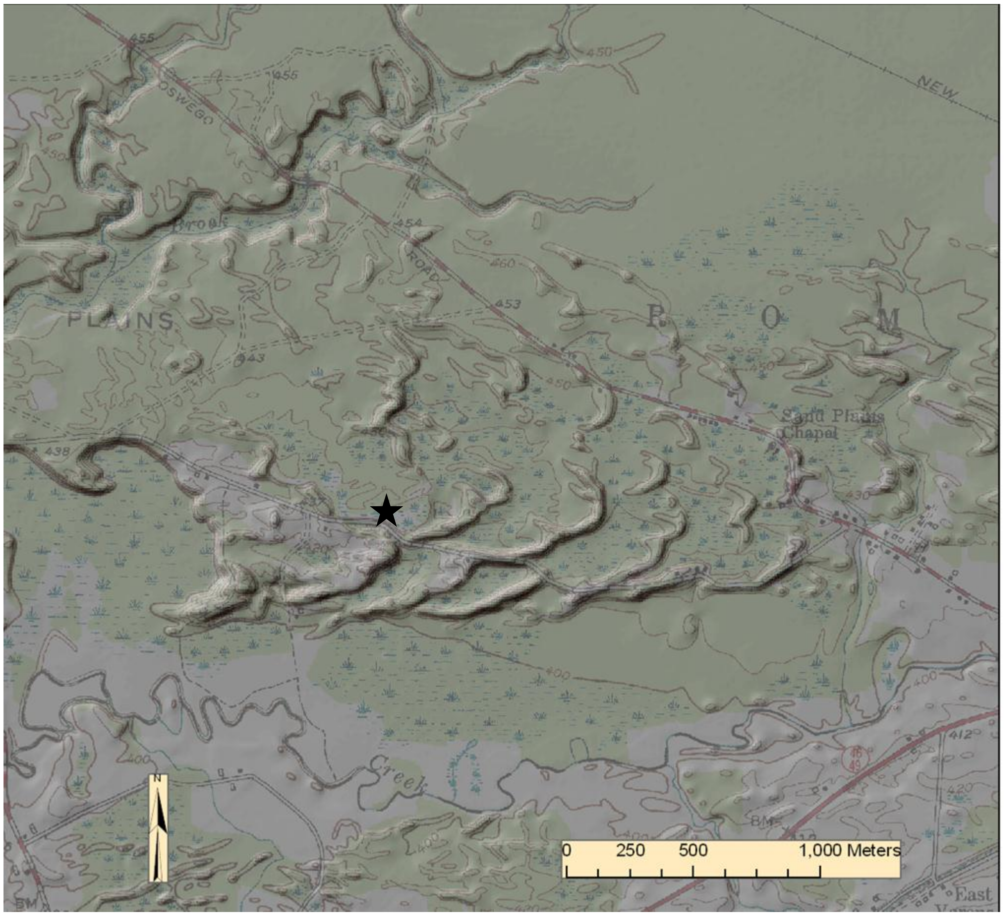

Figure 3. Composite LIDAR and topographic map showing the parabolic dunes and bogs. Study area is marked with a star.

STRATIGRAPHY

Based on dozens of hand auger borings and several outcrops and excavations, the dunes consist of uniform fine to medium grained yellowish brown sand (Brewer 2009). The soil orders in the sand areas are mostly entisols or inceptisols (young soils with little horizon development). In lower-lying areas where there is more available water and white pines grow, well-developed spodosols with prominent E horizons occur. There appears to be little or no soil development below about 1 m in the sand areas and on dune crests, which are drier, soils are even thinner.

The stratigraphy of the bogs and the sand immediately below the peat is more interesting. According to the former owner, peat in the study site bog was excavated during the 1960s for peat moss. The resulted in a relatively thin peat layer in this bog, ranging from less than 1 to about 2 m. The peat consists mostly of partially decomposed *Sphagnum* moss with the occasional branch or log. The peat is usually saturated, with the water table at or just below the bog surface. The groundwater in the peat "aquifer" is acidic, with a pH of 4 to 5. While it's very difficult to measure field Eh values, it seems that groundwater in the peat is reducing.

Immediately below the peat is a light to medium gray sand layer that is distinctly lighter in color than the unaltered sand in the dunes. I believe this represents a leached layer in which the Fe hydroxide coatings of the sand grains have been dissolved by downward moving water that contains organic acids from the partially decayed peat. This layer ranges from 5 to 30 cm in thickness.

In most borings in the bog, a discontinuous, semi-cemented, dark reddish brown sand layer that is probably an ortstein (a weakly cemented spodic horizon) lies below the gray sand layer. The cement is Fe oxide or hydroxide that is precipitated from a change in Eh conditions from reducing to oxidizing, possibly by moving into a new geochemical environment as it moves below the peat and interacts with groundwater in the sand aquifer. The sand gradually changes to the yellowish brown sand of the sand dunes below the Fe-enriched layer (Brewer 2009).

HYDROGEOLOGY

Conceptual model

My conceptual model of the sand-peat aquifer system is based on shallow wells in and near the bog from several student theses and one deeper well that was drilled as a class demonstration 50 m south of the bog. In addition, a deep excavation on the south side of Hogsback Road appears to be an outcrop of the water table in the sand aquifer.

The bog is an area of downward groundwater flow during most or all of the year when heads in the peat are as much as 25 cm higher than heads in the sand aquifer that underlies the bog. Although the peat bogs are in topographic lows, the hydraulic conductivity of the peat is very low (~1E-6 cm/s) and makes the peat behave like a slowly leaking bathtub relative to the highly permeable sand. Vertical movement of recharge from direct precipitation and the relatively small amount of runoff into the bog is inhibited in the peat and a groundwater mound forms in the peat as the water slowly moves downward. This area gets sufficient average annual precipitation (1.1 m/y) to keep the peat saturated (i.e. a groundwater mound) most of the year. The peat bogs are recharge areas, but the amount of recharge they contribute to the sand aquifer is relatively small because most recharge occurs in the sand areas where there is little runoff and the hydraulic conductivity is high. While it is possible that there are times when the head in the sand aquifer is higher than the head in the peat (making the bog a discharge area), I have never observed this.

Groundwater movement

Based on regional topography (Figure 4), head measurements in a limited number of wells and 'outcrops' of the water table, groundwater in the sand aquifer moves from north to south toward Wood Creek, the regional discharge area. However, the relationship between the sand and peat can complicate this generalization. Groundwater in the peat bogs flows radially away from the bogs and also moves downward (Figures 4 and 6). As it enters the sand aquifer, regional flow to the south is dominant.

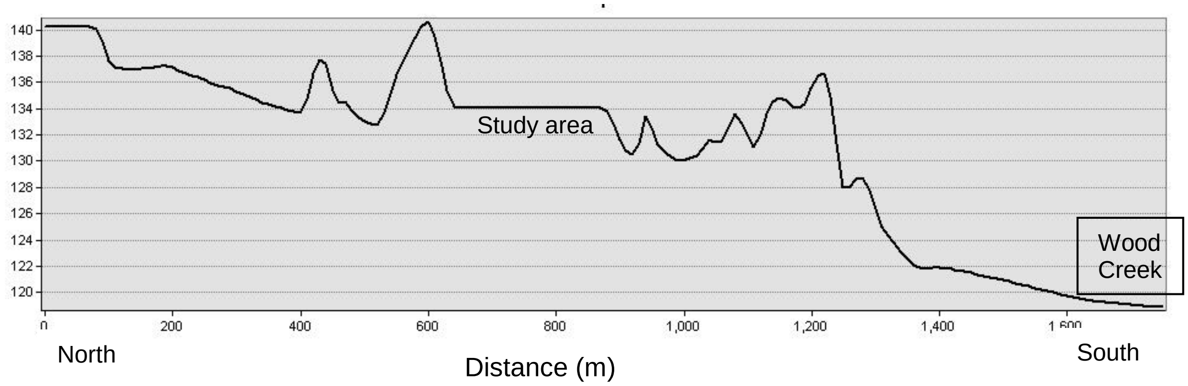

Figure 4. North – south topographic cross section through the study area to Wood Creek. Vertical scale in m.

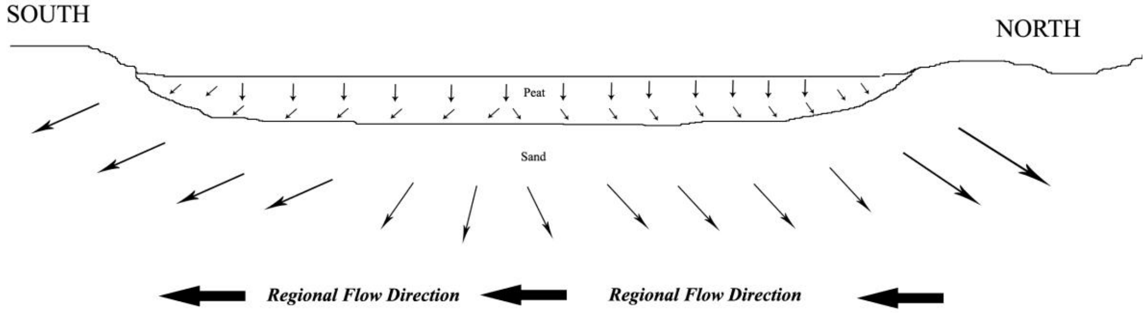

Figure 5. Schematic cross section showing downward movement of groundwater in the peat bog and southward movement of groundwater in the sand aquifer.

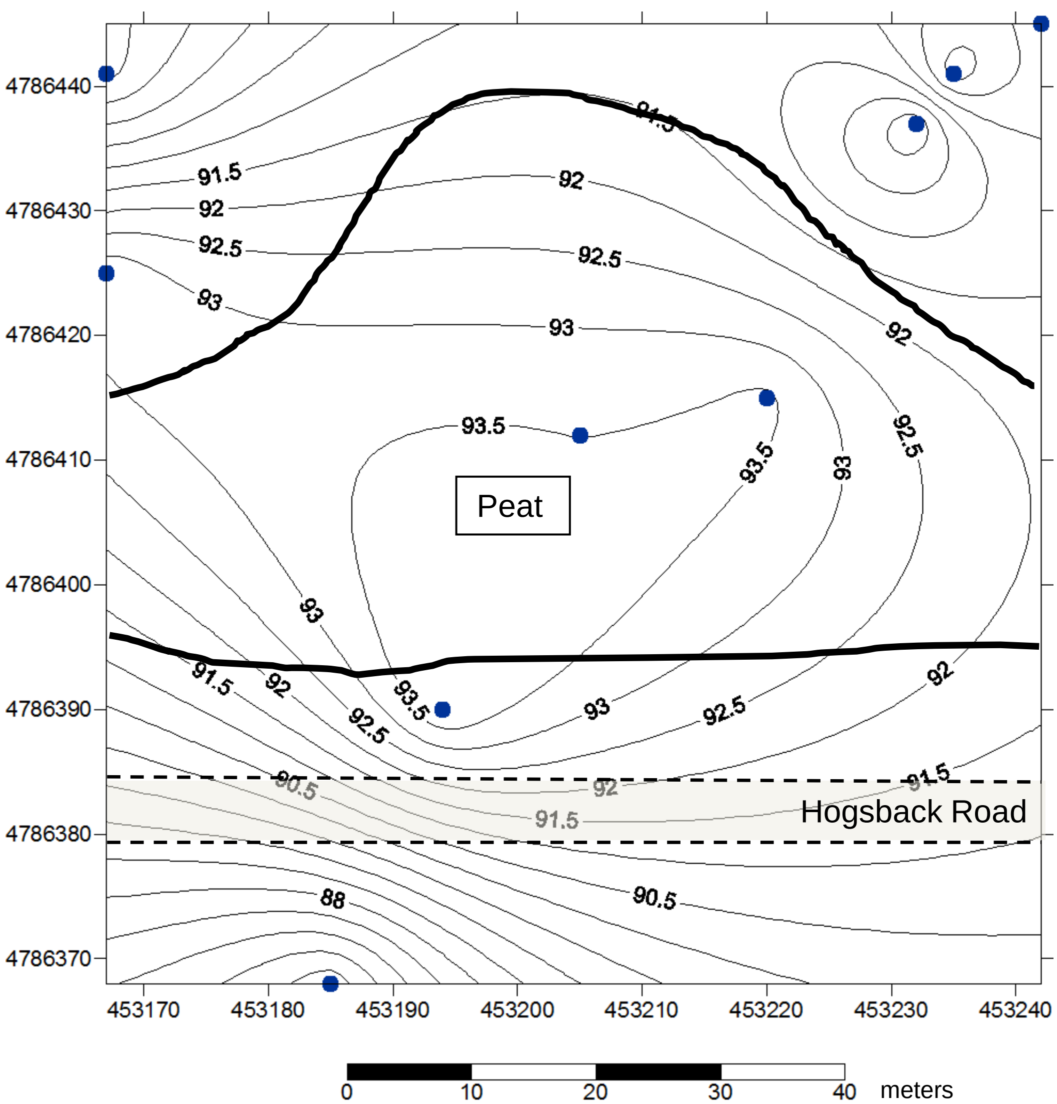

Figure 5. Surfer plot of peat and sand head values in the study area from March 2009. Dots show the location of wells. Thick solid lines show approximate boundary of the bog. Head values in m relative to a local datum on Hogsback Road of 100 m.

Shallow horizontal head gradients in the sand aquifer between Hogsback Rd and the adjacent peat bog appear to reverse depending on recharge conditions (Von Metzsch 2009). During rain events or snow melt, water entering the sand from the road makes a temporary mound adjacent to the road that produces groundwater flow toward the peat (opposite the 'regional' gradient). During dry weather, the mound disappears and the direction of groundwater flow is from the peat bog into the sand aquifer.

REFERENCES CITED

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