Title: **Groundwater-Surface Water Interactions in the Nine Springs Watershed**

Project I.D.: DNR Project # 137

Investigators:
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Background/Need:

Increased pumping to meet municipal water needs has resulted in lower water tables and consequently lower and more variable groundwater inputs to many natural systems. The effects of reduced inputs in urban and urbanizing areas is believed to be great, but has not been generally quantified. In order to establish the relative effects of changes to groundwater-fed systems such as springs and wetlands, it is necessary to quantify the role of groundwater in maintaining them as healthy ecosystems. With this information, informed judgements regarding the trade-offs between increased pumping and system function can be made.

Objectives:

- Instrument representative sites in Nine Springs basin
- Develop baseline data for evaluating groundwater function
- Evaluate the function of groundwater in several spring and wetland systems
- Refine an existing model to better reflect conditions in the basin
- Use project results to estimate future impacts to Nine Springs systems

Methods:

Two field sites within the Nine Springs watershed have been established and instrumented with monitoring wells and mini-piezometers. The Gunflint Trail field site is located in the western part of the watershed and represents one of the few remaining areas of high quality sedge and wet meadow. There are several small spring complexes in addition to one large spring at this site, which has been instrumented with a weir and rain gage. The Syene Road field site is located south of Nine Springs Creek in the central part of the watershed (Figure 4). It contains both sedge meadow that is in transition from a high-quality to degraded state and severely degraded sedge and wet (fresh) meadow. There are several small springs and one large spring at the Syene Road site, which has been instrumented with a weir. An experimental wetland restoration project is also being developed on the degraded sedge meadow portion of the site (hereafter referred to as the experimental site or plot).

Results and Discussion/Conclusions/Implications/Recommendations:

The hydrologic regime of the drained wetland at the Syene Road experimental site shows qualitative differences with that observed in the relatively healthy sedge meadow on the Gunflint Trail site. Subsurface drainage has resulted in water table levels in the Syene Road site that are considerably lower than those on the Gunflint Trail site. The water levels decline more quickly in the summer time, resulting in much shorter times in which the water table remains near the surface in the growing season. Additionally, the area above the water table that maintains near saturated conditions is considerably reduced in the drained (tiled) wetland, likely due to structural changes in the peat brought about by increased aeration of the upper levels after drainage. The net result is that after early season flooding the water content in the rooting zone is lower in the drained wetland than in the undrained sedge meadow through most of the growing season. Instead of the nearly saturated conditions that tend to occur in the upper 0.5 feet (0.15 m) of the undrained sedge meadow, the drained wetland has much drier soils for essentially the entire summer. These relatively drier late growing season soil conditions may be a key to

the dominance of reed canary grass in the drained wetland, and its lack of dominance in the undrained wetland.

On the basis of geochemical and isotopic results, it appears that both local groundwater flow through the unconsolidated surficial materials and intermediate groundwater flow through the shallow bedrock units are critical to the maintenance of the wetlands and springs in the Nine Springs watershed. We are less able to determine the relative importance of regional groundwater input to the system. Unfortunately, we had very few sampling points where we could monitor groundwater that may have a regional geochemical signature (geochemical Group III). However, we expect that regional groundwater does have an important, but as yet undetermined role in the Nine Springs system. A significant result that indicates that the regional flow system may play an important role in the Nine Springs system is that both of the large springs that were monitored have stable flow regimes that exhibit little or no measurable recession at all times of the year, even during long summer dry periods. Further study will be necessary to confirm our findings and conclusions regarding the source of groundwater discharging to the Nine Springs wetlands and springs.

Groundwater modeling results suggest that the proposed 2020 pumping scheme may result in a reduction of the volume of groundwater discharging to Nine Springs Creek. The model is not capable of simulating the response of the wetland water table and/or individual springs. However, on the basis of our comparative hydrology discussion, any reduction in the volume of groundwater discharging to the wetland system may have detrimental effects on the diversity and/or restoration potential of the wetland vegetative communities, particularly in the areas where subsurface drainage has already resulted in water table levels that are considerably lower than those in the undrained (untiled) wetlands.

Related Publications:

Swanson, S.K. and Bahr, J.M., *March 1999*, Determining Source Waters for Springs in the Nine Springs Watershed, American Water Resources Association, Wisconsin Section and Society of Environmental Toxicology and Chemistry, Midwest Chapter Annual Meeting Abstracts.

Swanson, S.K. and Bahr, J.M., *October 1998*, Balancing Municipal Groundwater Withdrawals with Groundwater Inputs to an Urbanizing Watershed, Geological Society of America Abstracts and Programs, Annual Meeting, Toronto, Ontario.

Schwar, M.T., Potter, K.W., Swanson, S.K., and Bahr, J.M., *May 1998*, Maintaining Water Supply to Groundwater-fed Aquatic Systems, Supplement to EOS, 79(17), S75.

Key Words: groundwater, geochemistry, springflow, wetland hydrology

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Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin – Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069.