Title: **Knowledge Development for Groundwater Withdrawal Management around the Little Plover River, Portage County Wisconsin**

Project I.D.: DNR project # 196

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Background/Need: Groundwater pumping in the central Wisconsin area has long been estimated to adversely affect streamflows and the levels of groundwater and streams. Recent flow impairments for the Little Plover (stream reaches went dry) were hypothesized by some to be caused by drought and/or by pumping. The work performed here clarifies the role of drought and pumping for the Little Plover, and by extension sheds light on pumping effects on central Wisconsin water resources.

Objectives: The project objective was to gain an understanding of the role of groundwater pumping on Little Plover River discharges, project what discharges would be in the absence of pumping, and develop knowledge and tools for advancing a groundwater management in the vicinity of the Little Plover River.

Methods: Little Plover discharges in the absence of pumping and amounts of "missing" discharge were estimated quantitatively through statistical methods and groundwater flow modeling. Expected present-day discharges of the Little Plover were determined by comparing Little Plover flows during the gauged period (1959-1986) to other nearby gauges and extrapolating relationships into the future.

A groundwater flow model was developed using MODFLOW to determine diversions from the Little Plover River by agricultural, municipal, and industrial wellheads. Model scenarios were run with 2005 and 2006 pumpage assumptions.

Current climate data including NOAA records of temperature, precipitation, and drought indices for Central Wisconsin were compared to Little Plover low flows from USGS gauging station data from 1960 through 1986 record at Hoover Rd.

Results and Discussion: Precipitation, drought index, and discharges in reference streams indicate near average conditions prevailed from 2000 through 2004, and moderately dry conditions (about a 10 year return period) prevailed in 2005-7. Conditions much drier that recent ones prevailed during parts of the 1959-1986 historical record (during which Little Plover discharge was continuously monitored) without the extreme low flows that have been observed in 2005-7. These qualitative measures indicate that recent weather alone does not adequately explain the record low flow conditions in the Little Plover River

Statistical analyses discern missing discharge beginning in about 1973. (Pumping diversions were likely occurring earlier, but were not discernable as the Little Plover flow record did not encompass a period where groundwater pumping was totally absent.) By 1986, about 2.2 cfs of discharge was missing. Statistical approaches also indicate missing discharges at Hoover Rd. were 3.9 - 5.0 cfs in May-August 2005 and 3.4 cfs in 2006. For comparison, the actual discharge of the Little Plover at Hoover

was frequently below 4 cfs during these times, so diverted flow was often greater than actual flow.

Groundwater flow modeling approaches agreed well with statistical ones, indicating on average 3.2-5.4 cfs of discharge at Hoover Rd. is diverted by current groundwater pumping (the range is due to uncertainties in average irrigation amounts). Groundwater flow modeling is also able to apportion pumping diversions to individual sectors and individual wells. Village of Plover pumping prompted the single largest diversion, about 1.2 cfs for 2004 to 2006, Del Monte industrial pumping annual diversions peak at about 0.38 cfs at Hoover Rd. every year and then diminish. Annually, this diversion averages only about 0.2 cfs. Whiting municipal and industrial pumping divert about 0.57 cfs at Hoover. Irrigation diversions are only roughly known due to grower uncertainty regarding average irrigation amounts. Assuming a range of 2 to 6 in of consumptive use on irrigated lands, irrigation diversions average 1.1 to 3.3 cfs at Hoover, but peak annually at 1.7 to 5 cfs. About 40% of irrigation diversions originate from within 0.5 miles of the Little Plover, 58% from within 1.0 miles, and 82% from within 2.0 miles. About 18% or irrigation diversions originate from beyond 2 miles.

Conclusions/ Implications/ Recommendations:

Recent Little Plover flows would be robust (though a little below average) in the absence of groundwater pumping, with a minimum discharge of about 6.5 cfs at Hoover Rd. Groundwater pumping however captured roughly 3-5.4 cfs of this amount, causing the extreme low flow conditions and dry stretches. No evidence exists suggesting that Little Plover discharges will return to some sort of "normal" without groundwater pumping management.

The Little Plover situation bears out the earlier work of other researchers (Weeks et al., 1965; Weeks and Stangland, 1970) that uncontrolled groundwater pumping in the Wisconsin central sand plain would impact surface waters deleteriously. We recommend an expanded analysis of pumping impacts on central sands surface waters for input into management and policy decision making. This analysis includes the details of groundwater use, improved stream discharge measurements, and expanded use of groundwater flow models.

Related Publications: none

Key Words: pumpage, groundwater withdrawal, high capacity wells, groundwater management

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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, and is available electronically at: http://www.uwsp.edu/cnr/watersheds/Reports_Publications/reports_publications.htm