ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

Illinois State Water Survey

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SWS

September 8, 2006

Ms. Patricia Nomm
Director of Environmental Health
McHenry County Department of Health
Annex A
2200 N. Seminary Ave.
Woodstock, IL 60098

Re: Linking McCullom Lake area to Ringwood groundwater contamination

Dear Ms. Nomm:

As requested, I have looked over the materials you sent to me regarding contaminated groundwater movement in the vicinity of Ringwood and the potential for such movement to have affected McCullom Lake area wells. In addition to the Rohm & Haas report (by URS, 2005), I also reviewed information related to this problem available on your website (http://www.co.mchenry.il.us/common/countydpt/health/HealthWater.asp), a 1998 Illinois State Water Survey report (*Ground-Water Studies for Environmental Planning*, Contract Report 630 by Scott Meyer), and water well records on file at the Illinois State Water Survey and Illinois State Geological Survey.

The area of interest lies between Ringwood and McCullom Lake, generally in Sections 10, 15, 16, 21, and 22 in T.45N., R.8E., McHenry County. Review of over 500 available records in these sections shows that most domestic water wells in this area are less than 400 feet deep and average between 110 and 120 feet, tapping unconsolidated sand and gravel deposits. Wells over 200 feet deep tap into the underlying Silurian dolomite bedrock. Numerous industrial and municipal wells are located in the area, all over 1000 feet deep, utilizing Cambrian-Ordovician bedrock aquifers. The contamination found in groundwater beneath the Rohm & Haas and Modine properties has been found in, and is being tracked by, specially-designed monitoring wells from 13 to 155 feet deep, tapping sand-and-gravel units of varying depth.

Many of the deeper monitoring wells and most of the domestic wells tap a sand-and-gravel aquifer under confined, or artesian, conditions. That is, the sand-and-gravel geologic unit lies beneath a confining layer of fine-grained material (i.e., clay) causing the water within the aquifer to be under pressure. This is reflected by water levels in such wells rising above the top of the aquifer. Table 1 in the URS report notes two wells as being "artesian," but what is meant is that the water pressure in the aquifer is great enough to cause the water to rise above land surface, more properly called a *flowing artesian* condition.

The determination of the direction of groundwater movement in such aquifer systems is not as mysterious as many might believe. Groundwater follows the basic laws of physics, one of the most basic being the Law of Gravity. Like surface water, groundwater moves from high to low; only for groundwater "high" and "low" are defined as *potentials* or *heads* and are analogous to "high" and "low" topographically as is done for surface water. High and low groundwater "potentials" are determined by field measurements of depth-to-water in wells that derive water from the same geologic unit (in this case, the same aquifer, see figure 1). Such depth-to-water measurements must be converted to a common base of measurement; this is done by subtracting the depth-to-water from the elevation of the measuring point, typically land surface elevation (see figure 2). The resulting groundwater potential elevations represent the height to which water levels will rise in wells tapping that aquifer. A "topographic" map of the groundwater potential surface, or potentiometric surface map, can then be created by contouring equal groundwater potentials. Groundwater flow direction will be perpendicular to the contours, following the laws of physics, moving from high potential to low potential.

Such groundwater contour maps were prepared in 1994 by Scott Meyer in his 1998 report on McHenry County and again in 2005 by URS, the consultants to Rohm & Haas. For the area in question between Ringwood and McCullom Lake, the groundwater contour maps show remarkable similarity, given that different wells were used in each study and the measurement dates were separated by 11 years (Meyer's study used existing water supply wells while the Rohm & Haas study used special monitoring wells drilled to track the contaminant plume). It is apparent from these maps and what we know about the hydrogeology of northeastern Illinois that the Fox River is a regional discharge boundary for groundwater flow in eastern McHenry County. In other words, groundwater is moving toward the Fox River; for this area, groundwater flow is to the southeast from Ringwood, not southerly or southwesterly toward the McCullom Lake area.

Natural groundwater flow can be disturbed by pumping wells. A pump in a well lowers the groundwater head (or potential) in the vicinity of the well, causing groundwater to flow to the well following the physical laws explained earlier. For a well or wells in the McCullom Lake area, one or several high-capacity wells perhaps pumping in excess of several hundred gallons per minute, would be needed to significantly disturb the natural regional movement of water depicted by the contour maps. High-capacity deep bedrock wells (>1000' deep) in the area are hydraulically separated from the shallower aquifer and groundwater potentials measured by Meyer (1998) and URS (2005). According to our records, no shallow aquifer high-capacity wells exist in the McCullom Lake area, nor have such wells existed in the past. Therefore, it is highly unlikely that the current groundwater flow direction was different in the past.

Groundwater contaminants predominantly are transported along with the groundwater in which it is dissolved – a process called *advective* transport. *Dispersion* of contaminants perpendicular to the predominant flow direction is a result of the tortuous paths groundwater (and the contaminants dissolved in the water) must follow through the porous aquifer medium. *Retardation* is the slowing of contaminant movement as a result of biological and chemical reactions that transform the contaminant into different compounds and from adsorption of contaminants to geologic materials. *Dilution* of contaminants also occurs as the contaminated water mingles with uncontaminated water. The advection of contaminants in the direction of flow plus the dispersion of contaminants perpendicular to flow, along with retardation and dilution processes, combine to create a zone of contaminated water often called a plume. The boundaries of the plume will depend on a variety of factors, largely dictated by geology, groundwater flow direction and rate (speed), and time.

Several maps within the URS report portray plume dimensions for different contaminants. The plumes were mapped by sampling monitoring wells drilled specifically to track the extent of the contaminated water. Several monitoring wells placed in the path of the moving groundwater were found not to contain contaminants. This means that the plume, controlled by the processes described above, have not reached these outer wells. In other words, the rate of contaminant movement since the groundwater was initially contaminated, perhaps decades ago beneath the Rohm & Haas and Modine properties, has not yet reached the farthest down-gradient monitoring wells.

Based on these maps, including the groundwater potentiometric surface maps and the plume configuration maps, and what is known about the regional hydrogeology of eastern McHenry County, contaminants have not reached the McCullom Lake area. Further, based on historical groundwater level data and high-capacity well operation in the area, contaminants did not reach the McCullom Lake area at some time in the past, disappear from groundwater in McCullom Lake, and then shrink back to the current plume configuration, as has been suggested by local residents. Such a phenomenon goes against the physical laws that dictate groundwater movement.

Should you have questions about this material or need additional information, please feel free to contact me.

Sincerely,

Allen Wehrmann

H. Allen Wehrmann, P.E.
Sr. Hydrologist and Director,
Center for Groundwater Science
Illinois State Water Survey

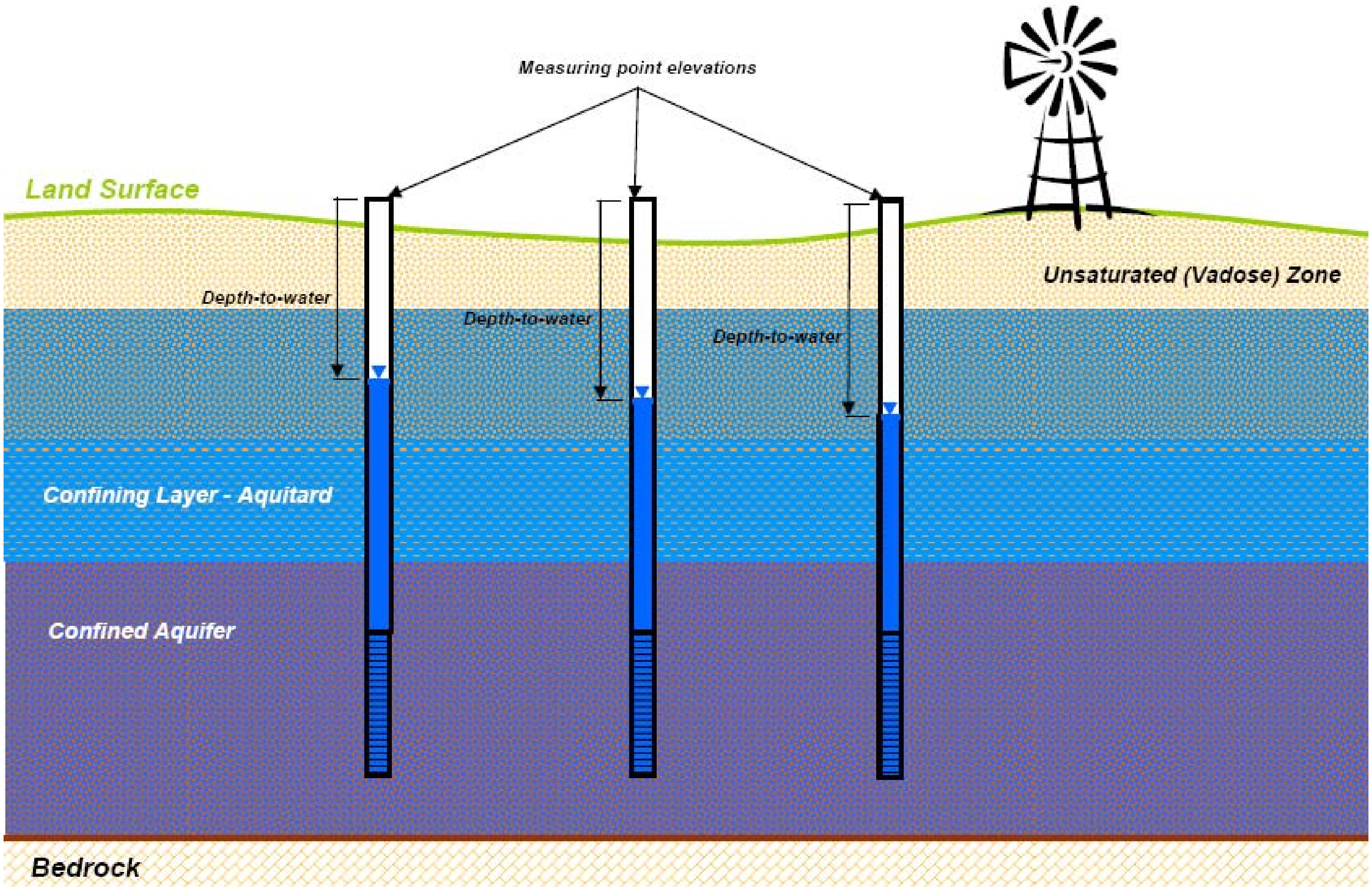

Figure 1. Measuring depth-to-water in wells below known measuring point elevations.

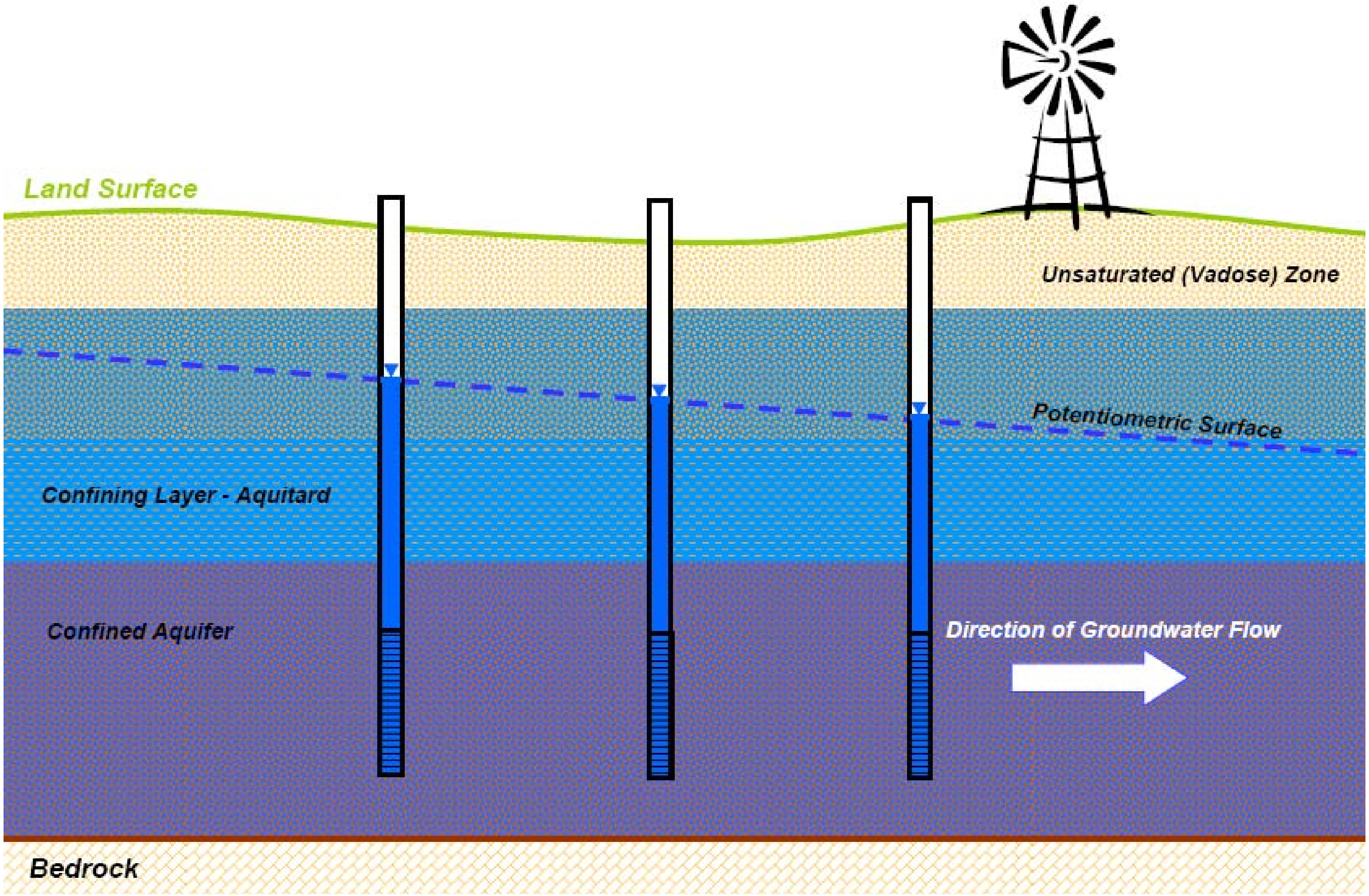

Figure 2. Potentiometric surface and direction of groundwater flow derived from depth-to-water measurements.