A Management Challenge: Water Quality in Residential—Neighborhood Ponds

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I've recently been musing, and that is a dangerous prospect for anybody paying attention; it places you at risk for an outburst of semi-technical, limnological verbosity. So, here goes...

Regarding programming for pond management, there is a huge body of literature targeted to small ponds and do-it-yourself management by individual property owners. Similarly, larger sites get a great deal of attention and are often actively and professionally managed by government entities—municipality, county, state, and even federal—for the benefit of the general public. Those bigger sites are often given the title of “lake” or “reservoir.” However, somewhere in between are water bodies of small to moderate size that are privately owned and managed, either spanning multiple individual lots or situated on the common property of a homeowners association (HOA). Unfortunately, the pond-management interests of stakeholders in such sites receive relatively little attention. This quarter’s article will discuss residential ponds, especially those that serve stormwater-management functions, and represents an early effort to target some material to those private pond and lake sites with multiple owners/stakeholders.

*The Nature of the Challenge*

Stormwater basins span a diverse range of form and function. The term implies a pond or basin that has been engineered and built to buffer flooding by detaining stormwater before overwhelming the capacity of local streams. Some only serve temporary water-detention and are periodically dry. Those called retention ponds (or “wet ponds”) generally maintain a permanent pool of water. Many also provide the valuable service of absorbing problematic sediment, nutrients, and other pollutants from surface runoff before they can reach natural surface waters (i.e., “water-quality ponds”). The Ohio Department of Natural Resources (ODNR 2014) summarized this function well enough:

Water quality ponds are stormwater ponds designed to treat runoff for pollutants and control increases in stream discharge and bedload transport. ... Water quality ponds remove pollutants by settling, chemical interaction and biological uptake by plants, algae and bacteria. The efficiency of settling suspended solids and the ability to treat dissolved pollutants is improved

*Continued on Page 3*
I channeled my inner-Clark Griswold, a couple weeks ago, and embarked on the all-American dream of taking a family road trip. My daughters and I didn't quite make it to Walley World, the Grand Canyon, or even Indianapolis for that matter. Instead, we stayed local and focused on the southwest part of Ohio - visiting places like Clifton Gorge State Nature Preserve, Jungle Jim's International Market, and the Cincinnati Museum Center. Rather than get ourselves into a continuous series of unfortunate scenarios, my children got a continuous earful as I related even the most unsuspecting of activities to water.

Clifton Gorge State Nature Preserve is a 2-mile stretch of the Little Miami State and National Scenic River in Greene County. It is a wonderful example of the beauty, power, and persistence of water - a deep, narrow channel of bedrock that has been cut by post-glacial flows. This location is literally made of water and didn't take much imagination for my girls to see what water is capable of doing.

Next, we visited Jungle Jim's International Market, a 200,000+ square feet supermarket in Fairfield, Ohio. It has been described as a theme park of food due to the number of unusual displays throughout the store. You can also find a gigantic produce department, live seafood tanks, and one of the largest wine selections in the United States - all of which depend heavily on... you guessed it. Water. From quantity to quality, I made sure that my daughters understood the importance of water in virtually everything we buy.

Lastly, we stopped at the Cincinnati Museum Center, a one-of-a-kind, multi-museum complex housed in the historic Union Terminal train station. The Center is home to the Cincinnati History Museum and the Museum of Natural History & Science to name just a couple. Both offer educational opportunities relating to water - from the history of Cincinnati’s growth on the Ohio River to the replica of an underground stream and waterfall. Seeing how water has influenced a large city like Cincinnati and how it continues to shape a hidden world, right beneath our feet, was a superb lesson to learn.

I admit that I am more familiar than most with the water-related themes that my family discussed during our short trip but, I never get used to just how immensely important water really is. It is a fragile and powerful resource - interconnected by many people and countless uses. I am, quite literally, a necessity for life and it is up to people like us and an organization like WMAO to help keep water-related issues at the forefront of people's minds. Thank you for being a part of the Water Management Association of Ohio!

Gotta get going, now. I have to return my cousin Eddie's RV...

“...I never get used to just how immensely important water really is. It is a fragile and powerful resource - interconnected by many people and countless uses.”
A Management Challenge; Continued from Page 1

with the addition of wetlands and permanent pools. Water quality ponds are often designed to provide
flood control by including additional detention storage above the volume specified in this practice.

...Water quality ponds are appropriate for residential, commercial and industrial areas... [and] can be
used to address water quality and stream stability concerns.

Deliberately retaining problematic sediment and nutrients from the developed landscape that a pond is
engineered to serve creates substantial management challenges by inviting issues related to cultural eutrophica-
tion. (Cultural eutrophication is an academic-sounding way of saying that a water body is hastened towards
functional old age by human activity.) Of course, eutrophication can be mitigated by implementing select
management practices. This initial article will only address permanently flooded sites, including retention or “wet
extended detention” (ODNR 2014) ponds and borrow-pit lakes.

Managing Water Quality in Retention and Other Residential Ponds

These sites are human-made and intensively managed to serve human interests, so consider managing to
deliberately and sustainably best serve the site’s intended goals and functions, even where management might
sometimes differ from the function of more natural systems.

Ohio’s standards for stormwater management, specifically section 2.6 within Chapter Two: Post-Construction
Stormwater Management Practices (ODNR 2014), offer excellent guidelines for design and construction of storm-
water ponds to both maximize effective function and manage eutrophication. ...And borrow-pit lake bathymetry is
generally outside the control of residential developers (Figure 1); glaciation certainly is (for those rare residential
developments along natural kettle lakes). Thus, instead of pond design and construction, we will discuss some
aspects of managing existing pond/lake sites.

The reduction or management of nutrient loads and sediment accumulation—the primary drivers of eutrophica-
tion on such sites—is the essence of management. Some additional maintenance may be required for pond sites
that are regulated to serve stormwater management (Table 1).

One nice feature of HOA’s regarding the management of a watershed: HOA’s typically have the ability to impose
rules over some activities of their residents and on their landscapes. Feel free to develop rules with objectives to
improve water quality or sustain the functionality of your pond/lake. It’s often a good idea to create a pond/lake
committee with the specific function of making management recommendations to the HOA at large for the pond/
lake site in general and its fisheries (if present).

Ponds accumulate sediment over time; stormwater ponds, especially so. As the stormwater-management functions
related to pond volume are lost, the pond will ultimately need to be dredged of excess sedimentation (Figure 2).
Unfortunately, moving earth tends to be an expensive proposition. Be certain your HOA is financially prepared as the need approaches, taking the disposal of dredge material into consideration. Table 1 provides some preliminary guidance for planning. You can fine-tune expectations for your site as you discover how it behaves within its unique landscape setting.

New-home builds are common features to the watersheds of new residential ponds or lakes. An HOA may want to specify requirements for sediment and waste management on construction sites within a basin’s watershed and try to impose fines for non-compliance. Some best management practices may already be required by local ordinances, so feel free to be that watchdog regarding construction around your own lake/pond.

![Figure 2: One of the Foxwood Villa stormwater ponds in the midst of a dredge operation (City of Toledo Engineering Service 2015)](image)

Phosphorus (P) is most often the most limiting nutrient in freshwater; aquatic green stuff (plants and algae) is usually “hungry” for soluble P, so relatively small increases in the availability of that nutrient can press an aquatic site towards eutrophication. An HOA can consider restricting the application of P to landscaping within a watershed. Most residential lawn fertilizers available in Ohio now deliberately omit P, but P is still available in turf-starter fertilizers. Consider only permitting the application of P to new lawns or requiring a soil test before application. Phosphorus is more soluble from pond sediments in the absence of dissolved oxygen. Consider diffuser aeration in deep water to help manage the release of excessive P from sediments.

Consider tolerating some coverage by submerged aquatic plants (the classic “seaweeds”) to both augment water quality and provide the right level of predator–prey interaction for pond fisheries. Up to 20% coverage is appropriate to most permanently inundated sites. You can find some initial recommendations for species selection and establishing beds of aquatic vegetation provided by Lynch (2006), ODNR (2014), and the Missouri Department of Conservation (2015). I intend to provide more detail on this subject with a later newsletter.

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Management activity</th>
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<tbody>
<tr>
<td>Monthly</td>
<td>Mow embankment and clean trash and debris from outlet structure. Address any accumulation of hydrocarbons.</td>
</tr>
<tr>
<td>Annually</td>
<td>Inspect embankment and outlet structure for damage and proper flow. Remove woody vegetation and fix any eroding areas. Monitor sediment accumulations in forebay and main pool.</td>
</tr>
<tr>
<td>Semi-annually</td>
<td>Inspect wetland areas for invasive plants.</td>
</tr>
<tr>
<td>3–7 years</td>
<td>Remove sediment from forebays.</td>
</tr>
<tr>
<td>15–20 years</td>
<td>Monitor sediment accumulations in the main pool and clean as pond becomes eutrophic or pool volume is reduced significantly.</td>
</tr>
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Table 1: Typical maintenance activities for water-quality ponds (from ODNR 2014). While Ohio’s stormwater standards only recommend semi-annual inspection for invasive plants, that particular activity could be almost constant as residents use the site. New invasions should be dealt with as rapidly as possible to avoid the formation of dense, monotypic stands.
Sport fisheries will be at much greater risk to winter kill in nutrient-rich, shallow ponds. Austin et al. (1996) recommend at least 25% of a pond be greater than 8 feet deep throughout most of Ohio (12 feet deep in the north of the state) to provide sufficient refuge for fish (differing slightly from recommendations in ODNR 2014). If you don’t have sufficient depth and a surface area of at least one half acre, it will be more difficult to successfully manage a self-sustaining fishery.

Choose Your Battles

The site’s primary function—especially detention of water and pollutants—must take priority if it conflicts with other intended uses, whether those other uses serve aesthetics, recreation... whatever. If the site’s design serves the surrounding landscape as intended, but the design isn’t likely to support a sport fishery, for example, don’t expect it to do so. Don’t plant ornamental woody vegetation on engineered earthen dikes or dams. Don’t plant ornamental wetland vegetation where it might clog or otherwise impede the effectiveness of an outflow structure. Etc.

Supplemental management actions should reflect compromise to at least partially recognize the expectations of each user/owner/stakeholder. Of course, doing so potentially subjects a site to the “too many cooks—spoiled broth” cliché. Once again, consider forming a designated committee to advise pond/lake management.

Management of nuisance vegetation with herbicides carries some risk and potential for liability. While herbicide applications by individual Ohio citizens within product-label guidelines are permitted on private pond sites, no individual resident should take it upon him/herself to apply herbicides to common property or a shared pond/lake. If weed management via herbicides is determined to be an appropriate action for your common property, hire a licensed applicator.

Regarding all of the above, your local Soil and Water Conservation District (SWCD) office is often a good place to check on local regulations and successful pond/lake management practices in the area. Develop a good relationship with your local SWCD staff and county’s Extension educators. ...And, as always, feel free to drop me a line with any of your specific pond-management questions.

References


Ohio Department of Natural Resources (ODNR). 2014. Rainwater and land development: Ohio’s standards for stormwater management, land development and urban stream protection, 3rd edition. ODNR Division of Soil and Water Conservation, Columbus.
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The Ohio Water Resources Center is a federally authorized center situated at The Ohio State University. We fund State relevant water related research. Below are highlights from a recently completed project conducted by Dr. Anne Jefferson, Assistant Professor in the Department of Geology at the Kent State University. If you are interested learning more about our research projects see the Ohio Water Resources Center webpage at wrc.osu.edu

The overall objective of her project titled “Characterizing stream restoration’s water quality improvement potential through hyporheic exchange enhancement” was to evaluate how stream restoration affects hyporheic exchange, and therefore water chemistry. Such understanding is crucial for deciding where stream restoration is appropriate to meet management objectives, designing restoration projects to meet those objectives, and evaluating whether restorations are successful.

Overall this study has discovered a dynamic environment in the hyporheic zone of restored streams, with changing hydraulic conductivity and strong chemical gradients. In the stream where sediment inputs were restricted by an upstream dam, hydraulic conductivity did not change at the reach scale over a 5 month period, as opposed to a stream with unrestricted sediment input where hydraulics conductivity declined over 15 months following restoration. Despite these dynamics, neither restored reach effected a change in surface water chemistry, as measured by baseflow grab samples analyzed for nitrate and other anions. Pore water collected from piezometers (Figure 1) revealed one important trend. Manganese concentrations were greatest in the head or upstream end of riffle 2 and 3, and in the middle of riffle 1, in each case as much as ten times higher than the surface water (Figure 2).

In summary, hyporheic exchange was not significant enough to modify the water quality signal resulting from upstream land use and geology. This could either be the result of insufficient hydraulic conductivity; the observed weak upwelling and downwelling; or short restored reach length. While the study was limited to two sites and approximately one year of data, the results suggest that stream restoration practices may not induce sufficient hyporheic exchange to improve downstream water quality.

Figure 1 Dr. Jefferson’s student collecting samples.

Researcher Profile: Dr. Anne Jefferson’s lab works on watershed hydrology, groundwater-surface water interactions, and landscape evolution in human-altered landscapes. Current projects focus on green infrastructure, stormwater management, and stream restoration. Much of her research is field-based, but her group also makes use of stable isotope analyses, geographic information systems (GIS), and hydrologic modeling.
Figure 2 Manganese concentrations from pore water 15–30 cm below the streambed surface at Kelsey Creek.
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