To: Lisa Helmuth, WDNR, Respectfully submitted by Joy Zedler, 2402 Lalor Rd., Town of Dunn. 2 April 2015.

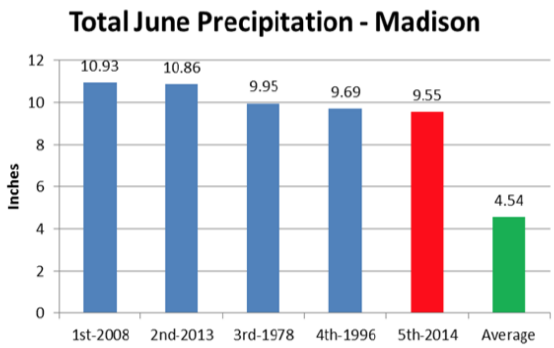
The chain of impacts that threaten Waubesa Wetlands

- **Sediment, nutrients and other pollutants flow off agricultural and developed lands and enter Swan Creek and Murphy Creek**, with net flow from Fitchburg into the Town of Dunn. As an example, Fitchburg ag land discharges runoff that is rich in sediment, N and P onto my sedge meadow, where Reed canary grass (RCG) invades along the stormwater flow path toward Murphy Creek.

- **More water runs off urban land than off agricultural land**. "Urbanization generally increases the size and frequency of floods and may expose communities to increasing flood hazards…. The hydrologic effects of urban development often are greatest in small stream basins where, prior to development, much of the precipitation falling on the basin would have become subsurface flow, recharging aquifers or discharging to the stream network further downstream. Moreover, urban development can completely transform the landscape in a small stream basin, unlike in larger river basins where areas with natural vegetation and soil are likely to be retained." (Konrad 2003).

- **Results of increased runoff** are "increased frequency and severity of flooding, decreased base flow in streams, increased erosion, reduced natural filtration of the water, and negative impact on stream health" (Frankenberger Undated).

- There is an inconsistency between Fitchburg's claim that they will reduce runoff by increasing runoff and their installation of multiple large culverts under Haight Farm Rd. to accommodate flood flows (see Memorandum from Benjamin Kollenbroich to Edmond Minihan, Town of Dunn Nov. 11, 2014). This memo indicates that DOT requested alternatives to low-flow estimates proposed by Fitchburg. The estimates in 2012 appear to be based on greater rainfall estimates. These differences need to be rectified, and the more recent, more credible estimates used to project future flooding. Please note the data below, provided by Cal DeWitt from the National Weather Service Forecast Office, July 2, 2014, for Madison, WI.



As DeWitt pointed out in his testimony to the CARPC on 9 Oct. 2014, "planning for floodwater and stormwater for this site does not take into account the actual experience—from what we actually *measure*—about the increased intensity of rainfall events over the past one or two decades." Between 1996 and 2014, June rainfall was 2.1 to 2.4 times higher than an average of 4.54 inches that represents a "climate normal."

- If excess water is not considered a problem, why is Fitchburg installing giant culverts along their boundaries? New culverts are aimed at the Town of Dunn. New installations are on Haight Farm Road (on left; photo from memo by B. Kollenbroich) and Lacy Rd.

- **Urban runoff contains contaminants**. These include sediment, pathogens, nutrients, pesticides, oxygen-demanding substances, oil and other petroleum products, and road salt. Nonpoint source pollutants "are deposited on the land through normal application of fertilizer, pesticides, and road salt; atmospheric deposition; poor disposal practices; automobile emissions; and litter. In urban areas, these pollutants are usually deposited on impervious surfaces such as parking lots and roads. Impervious surfaces that are connected to streams through a pipe (typically a storm sewer) more directly affect water quality than do pervious areas, even if equivalent amounts of a pollutant are present. How much impervious area is too much? Many people have suggested that water quality deterioration begins when 10% to 20% of the watershed area is impervious" (Frankenberger Undated).

- **Nutrients reach Lake Waubesa and can flow upstream when the lake water-level regulators sequentially lower and raise Waubesa Lake water levels.** In my tributary to Murphy Creek, I observed low water on 1 April 2015, when Lake Waubesa's water level was low and when the mouth of Murphy Creek was a mudflat (viewed from a canoe the same day). The water level will rise when Lake Waubesa is allowed to accumulate water, and some of the nutrient-rich lake water will move inland, spreading among the wetlands near the mouth of Murphy Creek, as well as and flowing upstream. This is one way that nutrients flowing down Swan Creek can disperse widely, including upstream into Murphy Creek. At the same time, Murphy Creek receives runoff from ag land upstream in Fitchburg, including the farm that discharges runoff to my small tributary. Farmers continue to cultivate patches of wetland that never produce a crop, needlessly contributing polluted runoff to Murphy Creek. Examples are visible from the Murphy Creek Bridge on Murphy Road.

- **Nutrients exacerbate the impacts of excess runoff water.** Excess stormwater runoff is a problem by itself, but it also carries excess sediment and nutrients, which cause weedy wetlands and algal blooms (Kercher et al. 2007; Lathrop 2007). Invasive plants are already present around the edges of downstream wetlands, poised to invade further, given limiting resources;

• **Nutrients help weed take over our wetlands**;
--**Cattails** invade and expand with nutrient additions; Woo & Zedler (2002) show that nutrients alone can cause cattail expansion.
--Cattails can take up P from soil in standing water and move the P into the water column (Boers et al. 2007; Doherty et al. 2014). The process is illustrated in Arboretum Leaflet 28.
--Wisconsin's **worst wetland weed**, which dominates about half a million acres of Wisconsin's mapped wetlands, is Reed Canary Grass (RCG) (Hatch & Bernthal 2008).
--RCG expands with excess water, nutrients and/or sediments (Kercher and Zedler 2004a, 2004b; Kercher et al. 2004, 2007; Green and Galatowitsch, 2002). Together, nutrients and sediment are synergistic in accelerating RCG growth and spread (Kercher et al. 2007).

• **Weeds displace native plant species**
--RCG **displaces half the species** in sedge meadows that it invades (Rojas and Zedler 2014; this paper also summarizes other data).
--Cattails displace native species to varying degrees, depending on the water depth and the strain of cattail that dominates.

• **Both N & P threaten wetlands**

- N and P cause invasive wetland weeds to expand. Boers and Zedler (2008) show that impounding water increases the uptake of P from flooded soil by cattails; this is called **internal eutrophication**.
- Green & Galatowitsch (2002) showed that **nitrogen addition increases RCG growth.**
- RCG thrives with excess water, nutrients, and sediment (especially topsoil). Kercher et al.
- RCG resists eradication (Healy & Zedler 2010); there is no easy way to control it; prevention is far cheaper.
- Swan Creek carries P and N downstream. Some say that more P comes from upstream lakes, but L Mendota and Monona are not likely responsible for all the RCG along Swan Creek and in West Waubesa wetlands.

• **Both N & P threaten lakes**

- Waubesa Lake and Wetlands are already threatened by species invasions and diversity loss. We have known since the 1960s that excess nutrients cause algal blooms in lakes, and managers have worked to reduce P inflows to lakes. Yet there are still algal blooms in our lakes. It's not enough to address just P and it's not enough to just reduce P loading.
- L.Waubesa is already highly eutrophic (Lathrop & Carpenter 2013). Being shallow, L. Waubesa may have greater internal loading, which is the remobilization of P in anoxic sediment, making it available to rooted plants, which then move the P into leaves and litter, where decomposition releases the P to the water (Loucks 1978, Lathrop & Carpenter 2013). Thus, P is not necessarily permanently stored in sediments. There is already too much P in L. Waubesa; Lathrop & Carpenter called the lake "hypereutrophic."
- Fitchburg pollutants threaten L. Waubesa wetlands by polluting the lake (via Swan Creek inflows) and via the Murphy Creek inflows (where ag land discharges nutrients + sediment onto the wetland adjacent to 2406 Lalor Road).
- Lathrop (2007) addressed the role of both N and P in eutrophying Lake Waubesa: "Finally, DRP and inorganic N concentrations since 1980 have indicated that algal growth in the Yahara lakes during July–August may have been limited by not only P, but N (especially in the lower Yahara lakes). **Aggressive programs to reduce inputs from both nutrients will be important** to prevent scum-forming blue-green algal blooms and filamentous algal growths that could become problematic once zebra mussels become established in the Yahara lakes" (p. 345). [DRP = dissolved reactive phosphorus] "Thus, N has the potential to be a limiting nutrient for algal growth during summer in the Yahara lakes given three factors: (1) little Fe is available for N_2-fixation, (2) denitrification rates are potentially strong throughout the entire eutrophic lake-river-wetland system, and (3) P loading rates are high. Indications of N limitation have occurred in the surface waters almost every summer in the lower Yahara lakes and many (but not all) summers in Lake Mendota since 1980" (p. 360). Thus, although it is uncertain when and where N limits or N+P co-limit algal blooms; both are indicated for L. Waubesa (Lathrop 2007). Lathrop (2007) continues: "The eutrophic Yahara lakes could be another system where **reducing both P and N inputs from the watershed would have short-term and long-term benefits** for controlling summer blue-green algal blooms" (p. 361).

- Lewis and Wurtsbaugh (2008) reviewed bioassays by many investigators in many lakes over 30 years and found that "N is at least as likely as P to be limiting to phytoplankton growth." They list several flaws that have led to "an unrealistic degree of focus on phosphorus as a controlling element." See also Lewis et al. (2011).
- N can trigger **toxic algal blooms**, especially bluegreens that cannot fix their own N (Paerl 2015). Example: Lake Erie recently had a toxic algal bloom that could poison those who drank its water. L. Erie had bluegreen algal blooms before the toxic bloom, but managers did not adequately address the issues identified by the IJC (2014) report on L. Erie. L. Waubesa could also develop a toxic algal bloom (with accumulation of microcystin or other cyanobacterian toxins). Nitrogen, not P, likely stimulated that bloom, because the alga that bloomed was *Microcystis,* which does not fix its own N and hence responds to N loading from other sources (Paerl 2015).
- One **death** in Wisconsin was caused by a bluegreen algal toxin according to the coroner's report; the victim was a Cottage Grove teenager.

•**The irreplaceable Waubesa Wetlands** are gems that require extra precautions—higher standards and enforcement of clean water requirements. High-quality wetlands cannot accommodate low-quality inflows without converting to weeds.

What is needed?
• **Planners need to predict impacts of climate change *correctly***: Runoff problems will worsen with more intense more frequent extreme runoff events (NOAA IJC 2014). We look to CARPC and WDNR to protect the maximum quality and extent of L. Waubesa wetlands, including at least a 300-foot buffers around stormwater reduction facilities to handle future extreme events. The wetland west of Larsen Road needs to be mapped at its largest extent and area correlated with the rainfall history that was responsible. I have seen this "lake" full of

muddy water--enough to overflow into the ditch (before a drainage channel was dug). It almost overflowed Larsen Road. Future rainfall will have larger, more frequent extreme events. If records or aerial photos are not sufficient to identify the highest water level, staff could use the elevation of the road to map the "lake's" perimeter. This would suggest future flood levels under agricultural land use. Future water levels would be higher from increased runoff with urban hardscape. A 300-ft buffer would be needed as a safety factor where the downstream wetlands are irreplaceable wetland gems.

What will reduce impacts?

• Studies of small watersheds near the Twin Cities led Detenbeck et al. (1993) to conclude that "In both urban and rural landscapes, wetland extent can counteract the nonpoint source loadings of nitrogen, phosphorus, sediment and lead and thus help to maintain lake ecosystem health" (p. 57). Detenbeck et al. (1993) offer the following advice for small watersheds near Minneapolis/St. Paul: "Wetlands should be preserved throughout the watershed, but when nonpoint source loading to a lake within the watershed is a problem, restored or created wetlands could be sited strategically in the lower reaches of a watershed close to the lake of interest. Natural wetlands situated closest to surface waters should receive special protection. Replacement of drained or filled wetlands in areas away from surface waters in the watershed will not achieve the same reduction in nonpoint source loadings to a lake. Although our results suggest that seasonally-flooded streamside wetlands or wet meadows are less effective than cattail marshes in reducing total phosphorus loadings to downstream lakes, these wetlands contribute to lake color, and thus may moderate the response of downstream lakes to a given level of loading by limiting transparency." (p. 58 in Detenbeck et al. 1993).

• Restore wetlands upstream of Waubesa Lake, e.g., west of Larsen Rd. and along Swan Creek. Let ecohydrologists and biologists design restoration efforts so that wetlands can remove N and P. Engineering models ignore the biotic components that actually add N and P to the water. Such models do not include "internal eutrophication," which is the uptake and transport of nutrients from wetland soil to the water column (Loucks 1978). Still, restoration of selected wetlands will only reduce inflows; not eliminate inflows.

What's the solution: Every upstream property owner/manager must take responsibility for sediments, N and P, and other pollutants and make sure none leaves his/her land.

Relevant references:

Boers, A., R. Veltman, and J. B. Zedler. 2007. *Typha x glauca* dominance and extended hydroperiod constrain restoration of wetland diversity. *Ecological Engineering* 29:232-244.

Costanza, R., R. de Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O-Neill, J. Paruelo, R. Raskin, P. Sutton, and M. van den Belt. 2014. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.

Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. Changes in the global value of ecosystem services. *Global Environmental Change* 26:152–158. (update of the 1997 valuations)

Detenbeck, N., C. A. Johnston, and G. J. Niemi. 1993. Wetland effects on lakewater quality in the Minneapolis/St. Paul metropolitan area. *Landscape Ecology* 8(1):39-61.

Doherty, J. M., J. F. Miller, S. Prellwitz, A. M. Thompson, S. Loheide, and J. B. Zedler. In press. Bundles and tradeoffs among six wetland services were associated with hydrologic regime. *Ecosystems* 17(6):1026-1039..

Frankenberger, J. Undated. Land use and water quality. Stormwater for the Future. https://engineering.purdue.edu/SafeWater/watershed/landuse.html#top

Frieswyk, C. B., and J. B. Zedler. 2007. Vegetation change in Great Lakes coastal wetlands: Deviation from the historical cycle. *Journal of Great Lakes Research* 33:366-380.

Green, E. K. and S. M. Galatowitsch. 2001. Differences in wetland plant community establishment with additions of nitrate-N and invasive species (*Phalaris arundinacea* and *Typha* × *glauca*). *Canadian Journal of Botany* 79:170–178.

Green, E. K. and S. M. Galatowitsch. 2002 Effects of *Phalaris arundinacea* and nitrate-N addition on the establishment of wetland plant communities. *J. Applied. Ecology* 39, 134–144.

Hall, S. J., and J. B. Zedler. 2010. Constraints on sedge meadow self-restoration in urban wetlands. *Restoration Ecology* 5:671-680.

Hatch, B., and T. Bernthal. 2008. Mapping Wisconsin wetlands dominated by reed canary grass (*Phalaris arundinacea* L.): A landscape level assessment. Final report to the US EPA, Region V, Grant #96544501-0.

Healy, M.G., and J. B. Zedler. 2010. Setbacks in replacing *Phalaris arundinacea* monotypes with sedge meadow vegetation. Restoration Ecology 18: 155-164.

Herr-Turoff, A., and J. B. Zedler. 2005. Does wet prairie vegetation retain more nitrogen with or without *Phalaris* invasion. *Plant and Soil* 277:19-34.

IJC (International Joint Commission). 2014. A balanced diet for Lake Erie: Reducing phosphorus loadings and harful algal blooms. Repoert of the Lake Erie Ecosystem Priority. ISBN: 978-I-927336-07-6.

Kercher, S. M., A. Herr-Turoff, and J B. Zedler. 2007. Understanding invasion as a process: The case of *Phalaris arundinacea* in wet prairies. *Biological Invasions* 9:657-665.

Kercher, S. M., and J. B. Zedler. 2004a. Multiple disturbances accelerate invasion of reed canary grass *(Phalaris arundinacea* L.) in a mesocosm study. *Oecologia* 138:455-464.

Kercher, S. M., Q. Carpenter, and J. B. Zedler. 2004. Interrelationships of hydrologic disturbances, reed canary grass *(Phalaris arundinacea* L.), and native plants in Wisconsin wet meadows. *Natural Areas Journal* 24:316-325.

Kercher, S. M., and J. B. Zedler. 2004b. Flood tolerance in wetland angiosperms: a comparison of invasive and noninvasive species. Aquatic Botany 80:89-102.

Konrad, C.P. 2003. Effects of urban development on floods. USGS Fact Sheet 076-03. http://pubs.usgs.gov/fs/fs07603/

Lathrop, R. 2007. Perspectives on the eutrophication of the Yahara lakes. Lake and Reservoir Management 23:345-365.

Leaflet #10. Why are wetlands so valuable? Online at uwarboretum.org/research – publications menu.

Leaflet #27. How ponded runoff and invasive cattails reduced wetland ecosystem services in three experimental wetlands. Online at uwarboretum.org/leaflets or go to research – publications menu.

Leaflet #28. How ponded cattail marshes can export phosphorus: A conceptual model. Online at uwarboretum.org/leaflets.

Leaflet #36. A wetland ethic. Online at uwarboretum.org/leaflets or go to research – publications menu.

Lewis, W. M. , W. A. Wurtsbaugh, and H. Paerl. 2011. Rationale for control of anthropogenic nitrogen and phosphorus to reduce

eutrophication of inland waters. *Environmental Science and Technology* 122(7):717-730.
Lewis, W. M. & W. A. Wurtsbaugh. 2008. Control of lacustrine phytoplankton by nutrients: Erosion of the phosphorus paradigm. *International Review of Hydrobiology* 93:446-465.
Loucks, O. 1978. Looking for surprise in managing stressed ecosystems. BioScience 35(7):428-432.
Paerl, H. 2014. Algal blooms: Noteworthy nitrogen. Science 346(6206):175.
Rojas, I. M., and J. B. Zedler. 2014. Online. An invasive exotic grass reduced sedge meadow species richness by half. Wetlands Ecology and Management.
Woo, I., and J. B. Zedler. 2002. Can nutrients alone shift a sedge meadow towards the invasive *Typha x glauca*? *Wetlands* 22:509-521. (Selected by D. Wilcox as one of the top papers he accepted to the journal in his 20-year position as editor).
Zedler, J. B., and S. Kercher. 2004. Causes and consequences of invasive plants in wetlands: Opportunities, opportunists, and outcomes *Critical Reviews in Plant Sciences* 23:431-452.