Cost/benefit Analysis Stormwater Detention Pond Maintenance Controls Demonstration Project

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Objective

On January 22, 2008 a panel of water quality exerts meet with Grand Haven CDD Board officers and interested HOA members to discuss present management practices and possible management alternatives for the stormwater ponds under their management. As a result of the meeting a review of landscaping guidelines was initiated and possible alternative landscaping practices proposed. A general cessation of copper sulfate treatments to reduce filamentous algal blooms in the ponds was recommended and several alternative management options were discussed. In the discussion of alternative management practices, none were clearly identified as superior and each had some uncertainty with regard to their cost and or benefit to address the issue of filamentous algae control. Therefore, it was requested that a pilot project to evaluate several alternative management practices be initiated and costs along with efficacy be evaluated. This document provides an overview of stormwater pond functions and associated management issues. It also outlines a proposal to evaluate alternative management practices discussed during the panel discussion and is offered to the CDD for consideration.

Introduction

Purpose and Function of Stormwater Ponds

Stormwater ponds are required in most developed landscapes where they provide three critical functions; 1) they help protect infrastructure from flooding, 2) they help protect downstream ecosystems from excessive changes in hydrology especially during and shortly after a storm event and 3) stormwater basins reduce water quality impacts to downstream natural ecosystems. Depending on how high the natural groundwater table is and how well soils in the area drain, stormwater basins can either be dry in between storm events, or can contain continuously ponded water. The size of a stormwater basin can vary considerably and at a minimum must attenuate for a certain volume of runoff resulting from increased impervious area due to development. However, in areas where water tables are high, stormwater ponds are often much larger then what is required for regulatory purposes. Under these circumstances the increase in size is typically due to the use of the soil excavated from the pond to raise the land elevation and reduce the potential for flooding around homes and infrastructure.

Stormwater Basins and Water Quality

An additional factor that influences stormwater pond size, and to some extent design, is the designated use of the downstream waterbody that receives discharge from the stormwater basin. Public waters of the State of Florida are classified by designated use and there are protective water quality criteria set for each of these water body types to maintain their use as a public resource. Most waterbodies are designated for support of aquatic life and for human uses such as swimming and fishing. Some waterbodies, those used for drinking water or shellfish production, have more protective criteria. The water within a stormwater pond does not have to meet any particular water quality standard; instead the function of the stormwater pond is to improve water quality so that the downstream receiving waterbody is not degraded. In most instances the stormwater pond is presumed to reduce the contaminant load entering the basin by 80%. If the water discharges to higher quality receiving water bodies then the basin design must be able to improve the water quality by 95%. In some instances, if the receiving water body is already considered impaired (i.e. not meeting its designated use criteria), then discharges of the contaminant of concern may have to be reduced even more to bring the degraded water body back into compliance with protective criteria.

Conflicting Expectations of Stormwater Basins

Because of the proximity of stormwater basins to developed areas, the aesthetic character of a basin often comes under scrutiny. It is also possible that some homes are directly adjacent to stormwater ponds and that these homes were sold as “lake front” or “water front property”. This close proximity or incomplete portrayal of the purpose/expectation of the stormwater ponds can be problematic, but not necessarily without compromise. The challenge of compromise comes to the managers that must balance stormwater pond function while still providing some aesthetic appeal. In shallow basins, transforming the pond into a wetland with native vegetation can often improve both functions of the basin as well as aesthetics. In large open water ponds the challenge is often greater because the stormwater basin has characteristics of a lake or pond and therefore the aesthetic expectation of the basin is to be a lake and to be managed accordingly. The difficulty for managers however is that stormwater basins were intended to protect downstream natural systems from undesirable impacts, yet if expectations for the stormwater pond itself have been raised to that of a natural system then there is little treatment or mitigation infrastructure to reduce contaminant loading to the stormwater pond. Therefore, to improve aesthetic expectations for the pond, management either has to move up into the watershed and reduce loading through pretreatment, landscaping practices, reduced fertilizer and pesticide use, or come up with alternative management strategies within the stormwater ponds themselves.

Filamentous Blue Green Algal Response

Plants of any kind will respond to nutrients if nutrients are the limiting resource for growth. In aquatic systems, algae (either planktonic or filamentous) makes up a large portion of the plant biomass in the water column and where light can reach the bottom of the pond or lake, rooted macrophytes can also account for a large amount of the primary productivity. Plants of all types provide the base of the food chain for macroinvertebrates, fish and other wildlife as well as a means to take up nutrients and other possible contaminates from the water column and trap them at least temporarily as a particulate in living plant tissue. Filamentous blue green algae, which are the principal plant of concern in the Grand Haven ponds, is a natural response to environmental conditions and to nutrients cycling within the pond and runoff from the landscape. From an aesthetic perspective this excessive plant growth may be unsightly and undesirable. However, from a water quality perspective, a certain amount of algae is helpful in taking up dissolved nutrients and binding them at least temporarily in plant tissue that is no longer able to infiltrate into groundwater or flow downstream to wetlands or the Intercoastal Waterway where it could trigger algal blooms in the natural communities. One significant problem with uncontrolled algal blooms fueled by excessive nutrients is that under certain environmental conditions (several cloudy days during warmer months), a large amount of the algal biomass can quickly die back resulting in a large demand for oxygen as the algae decomposes. This oxygen demand spurred by the algae die-off can compete with fish and other aquatic organisms for oxygen and cause a fish kill. Therefore, algal blooms need to be managed to prevent dynamic swings in dissolved oxygen availability, but also managed to optimize the treatment function of the stormwater basin to prevent transport of contaminants to natural waterbodies?

Managing Filamentous Algae

From an aesthetic perspective, getting rid of unsightly filamentous algae is desirable and therefore using an herbicide, in this case copper sulfate has been the conventional approach. Such an herbicide is very effective at temporarily removing algal cover and improving visual indicators of water quality now that copper conditions in the water column are toxic to algal growth. However, because the underlying mechanism that allowed algae to proliferate in the first place have not been addressed, treatments are often short lived and the algae often quickly return. In addition, algae control treatments also reduce nutrient removal capacity of the stormwater pond and any nutrients previously bound in the algae are allowed to leach back into the water column, potentially degrading water quality downstream or adding nutrients to the pond to stimulate the next algal bloom. There may also be a cumulative effect of repeat copper treatments on other aquatic plants and fauna that are rooted in or live in the sediments. Habitat provided by these plants and food provided by fauna are critical to a healthy pond expected to support a low intensity fishery. If copper concentrations accumulating in the sediments after each algae treatment increase too much, copper may become toxic to macroinvertebrates and macrophyte growth.

Multifunctional Stormwater Basins.
The opportunity exists where many stormwater basins can be designed and managed to meet regulatory stormwater quantity and quality requirements and still provide an amenity to the community. However it is important to recognize the original functional design of the basin and to promote management practices that facilitate water quality treatment over time. One of the most significant steps that a development can take in reducing contaminant loading to stormwater ponds is to shift the stormwater management focus from treatment to source control. This means evaluating landscaping practices around homes, adopting Florida Friendly landscaping practices, creating guidelines for landscape contractors who maintain common space areas and monitor implementation of guidelines. It is also important to raise homeowner awareness of the connectivity between their activities on their property and the aesthetic and water quality expectations of downstream waterbodies. In conjunction with optimizing management practices in the watershed that reduce loading to the stormwater ponds, alternative practices can also be applied in the stormwater basins to improve aesthetics while still maintaining the water quality functions of the basin.

Proposal

As mentioned in the objectives section, this proposal is the culmination of a panel discussion held January 22, 2008 with Grand Haven Board members and interested members of the community. As part of that discussion, several alternative management practices to address filamentous algal growth, fisheries production, and stormwater pond function were considered. This proposal outlines a research/demonstration plan that will test and evaluate the cost, aesthetics and functional implications of each proposed treatment alternative. The alternative treatments to be considered include: Aeration, Littoral shelf planting or floating vegetative islands, biomass removal, copper sulfate treatment and a no treatment control. Each of these treatments will be applied in a stratified random manner among the 31 stormwater ponds. Specific selection of which treatments will be applied to which pond has not been decided and will require a site visit and consultation with infrastructure managers to determine feasibility of access, pond morphology and available power for aerators. Each of the treatments is briefly explained below.

Aeration (Figure 1) **-** Aeration, as the name implies, is the addition of atmospheric air primarily to add dissolved oxygen to the water column and improve environmental conditions for fish and other organisms requiring oxygen. Depending on the type of aerator, the practice of aeration can also significantly increase the amount of vertical and to some extent horizontal circulation within the water column of the pond. The benefits of aeration are three fold. First, increased dissolved oxygen concentrations in the water column improves habitat. Second, the physical agitation of the water column and flow gradients away from the aerator can help reduce the total surface area of floating aquatic plants including filamentous algae.   Lastly, increased oxygen in the water column can change the phosphorus chemistry at the sediment water interface at the bottom of the pond. Phosphorus chemistry in a pond is complex and is influenced by many variables including the characteristics of the bottom sediment. Some compounds, such as iron if present in the sediment can bind phosphorus and make it less available for plant uptake if it is oxidized. However, if the iron becomes reduce (no oxygen) than the phosphorus can be released to the water column and potentially stimulate algal growth. If iron is present in the ponds but the pond bottoms are without oxygen, aeration could increase the phosphorus binding potential of iron thus removing more phosphorus from the water column. The drawback of aeration is cost and whether or not the added oxygen may cause some nutrients otherwise bound to organic matter in the bottom of the ponds to be released to the water column.

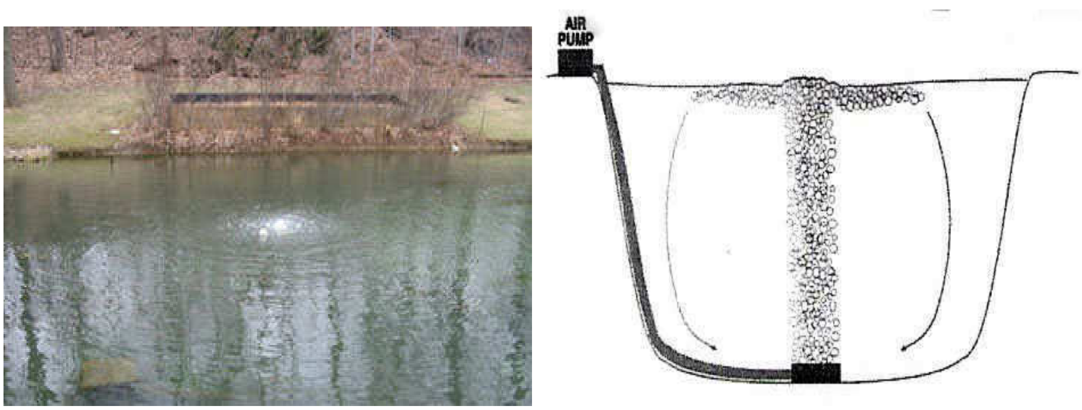

Figure 1. Photo of a pond aeration diffuser and diagram of pond cross section profile showing circulation pattern that develops due to aeration.

Littoral shelf planting (Figure 2) **-** Planting emergent vegetation along the edge of the pond simulates vegetation that would develop naturally if allowed and not disturbed by herbicide or other management activity. The shape of the shoreline will determine the extent of vegetation planting that is possible, but incorporating emergent macrophyte vegetation can do several things to improve the pond function. 1) Filamentous algae near the pond edge are less visible and therefore less of an aesthetic concern when shrouded by emergent plants that protrude above the water surface. 2) Filamentous algae that attaches to the stems of the emergent plants are less likely to move around the pond and accumulate on one side due to wind and currents. 3) Light penetration to the bottom of the pond where most filamentous algae begins is greatest in the shallower parts of the basin. If these areas are planted with rooted emergent plants, the area of the pond that would otherwise initiate the most filamentous algae should have lower light penetration to the bottom and stimulate less filamentous algal growth. 4) Vegetation along the shoreline is critical habitat for many aquatic species including a nursery ground for many fish and macroinvertebrates.

Figure 2. Picture and diagram of littoral shelf planting. Species selection varies based on desired view-shed, habitat, and climate

Floating Vegetative Islands (Figure 3) - Although application of this practice has been relatively new and a limited number of vendors and demonstration projects are available, floating vegetative islands attempt to mimic many of the same functions of littoral shelf plantings, however the islands are free floating and allowed to move about the water body driven by wind and currents. What makes this practice potentially appealing to some of the Grand Haven ponds is it would allow the functional equivalent of littoral shelf plantings in those ponds that presently have bulkheads along the shoreline and therefore no area for establishment of emergent macrophytes.

Figure 3 Example of constructed floating islands deployed in small ponds for habitat and treatment benefits.

Copper Sulfate Treatment - As a confirmation or re-evaluation of concerns raised over use of Copper Sulfate as a treatment to control algal blooms, this treatment option will be continued in several ponds. Evaluating the effects of this treatment option will also determine secondary impacts of this approach on water quality and aquatic fauna.

No treatment - This alternative will be used as a reference conditions to compare the effect of alternative treatments. The no treatment option will be monitored in the same manner as the other treated ponds, but will not be actively managed.

Monitoring and Assessment.

At present there are no identified funding sources for monitoring or assessment of the above treatments. However, several grant applications are being prepared to capitalize on the opportunity that these multiple treatment options would provide and there are good expectations that some of these grants will be supported. There will be some water quality sampling associated with the Lakewatch program, which will provide for monthly sampling at a subset of the lake treatment sites. This will not be complete for all sites but it will be a start. In addition, some of the proposed parameters for assessment could be implemented by a group of citizens as they are more qualitative and do not require a high degree of expertise just some training. When funding becomes available, the following parameters will be monitored on a one time or recurring basis

Water quality – The water column of stormwater ponds will be sample for nitrate, ammonium, total kjeldahl nitrogen, soluble reactive phosphorus, total phosphorus total suspended solids and chlorophyll content on at least a monthly basis. Discharge points to the Intercostal Waterway as well as some wetland discharges will also be monitored. Diurnal oxygen profiles will be conducted in each of the treatment lakes on a rotation basis where lakes will be monitored for a 3-5 day period. Oxygen probes will then be pulled, serviced and then redeployed in a different suite of ponds.

Sediment – A one time sampling of stormwater pond sediments will be conducted at the beginning of the treatments. Intact sediments cores will be collected and nitrogen and phosphorus sediment flux rates will be measured in response to water column aeration. Sediment grab samples will be analyzed for iron, copper, aluminum, calcium, manganese, organic matter phosphorus and nitrogen content.

Filamentous algae – Aesthetic acceptance and % shoreline cover will be visually evaluated on a monthly basis in conjunction with water quality sampling. There will also be an artificial substrate (small floating apparatus with glass slides) deployed in each treatment pond that will become colonized by filamentous algae and provide an indication of the colonization rate and productivity of algae in each pond.

Aquatic Habitat – Because of the expectation that at least some of these ponds might support a catch and release fishery, an index of biological integrity will be used to assess the stormwater ponds relative to natural systems. State wide an index called the Lake Conditions Index (LCI) for Florida is often used for this purpose. In this application a modified version of the LCI will be used to provide a quick assessment of the habitat and organisms that are present. This index will be applied in the littoral zone of each treatment pond quarterly or semi annually.

Cost – All cost associated with installation, maintenance and operation of treatments will be compiled and eventually used to select among the different treatment options.

Time Frame for Implementation

Implementation of treatments should begin as soon as allocation of treatments in each pond is decided, and equipment and installation can be conducted. Pond treatments will be randomly applied and in conjunction with infrastructure managers within one month of CDD approval of this conceptual plan. Data collection will begin as soon as resources become available.

Treatments and monitoring will persist for at least one year. Any treatment not considered viable, practical, or effective within the first year will be stopped and ponds under that treatment will either be allocated to one of the remaining 4 alternatives or if a new treatment option is identified the new alternative will be proposed to the CDD for consideration. After the monitoring period, an analysis of cost and effectiveness of the treatments will be conducted and presented to the CDD for consideration and determination of the most appropriate management alternative.