Ohio EPA

# Point Source & Urban Runoff Nutrient Workgroup

Final Report and Recommendations

**8/8/2012**

# Contents

Preface……1

Acknowledgements……..2

Executive Summary and Recommendations……..3

Attachment A - Participant List

Attachment B – Issue Papers

Attachment C - Recommendations and Comments  Submitted by Interested Parties

# Preface

The Point Source and Urban Runoff Nutrient Workgroup was developed as a part of Ohio EPA's *Nutrient Reduction Strategy Framework for Ohio's Waters*. This workgroup was tasked with creating recommendations to:

- Identify actions that can be taken immediately to reduce phosphorus loadings from publicly owned wastewater treatment plants (POTWs), direct and indirect industrial sources and urban storm water;
- Identify future steps that would improve the cost-effectiveness of point source nutrient controls and urban nonpoint source nutrient reduction strategies; and
- Identify the likely roadblocks and potential solutions for achieving the overall nutrient load reduction targets set for Ohio lakes and rivers.

The workgroup meet five times from January through May of 2012. The list of members is located in Attachment A. Agendas, meeting minutes and other materials used by the workgroup are available from Ohio EPA, Division of Surface Water upon request.

The following executive summary provides a brief summary of the overall approach this workgroup feels should be undertaken to address nutrient issues in Ohio.

# Acknowledgements

Ohio EPA acknowledges and thanks all workgroup members for their time and participation at the meetings and for contributions to this report. An extra measure of appreciation is extended to the sub-group chairpersons and principle authors of each issue paper.

**Subgroup 4**
*Thomas J. Kutcher, P.E.*
Assistant Superintendent-WWT
Metropolitan Sewer District of
Greater Cincinnati

**Subgroup 5**
*Richard Reed, P.E.*
Project Manager
CTI Engineers, Inc.

**Subgroup 6**
*Robert E. Ashton*
Regulatory Compliance Advisor
Department of Public Utilities
City of Columbus, Ohio
Association of Ohio Metropolitan
Wastewater Agencies

**Subgroup 7**
*Jim Troike*
Medina County Sanitary Engineer
Medina County, Ohio

*Phil Cummings*
Superintendent
Medina Co. Liverpool Wastewater
Treatment Plant
Medina County, Ohio

**Subgroup 8**
*William J. Meinert, P.E.*
Vice President
O'Brien and Gere
Bowie, Maryland

**Subgroup 9,3,15**
*Rob Reash*
Consulting Environmental Specialist
American Electric Power

Subgroup 10
*Guy Jamesson, P.E.*
Principal Consultant
Malcolm Pirnie/Arcadis US, Inc.

**Subgroup 11**
*Elizabeth Toot-Levy*
Senior Environmental Specialist
Northeast Ohio Regional Sewer District
Association of Ohio Metropolitan
Wastewater Agencies

**Subgroup 13, 14**
*Adam Sackenheim*
Regulatory Compliance Manager
Butler County Water and Sewer Department
Butler County, Ohio
Association of Ohio Metropolitan
Wastewater Agencies

**Subgroup 16**
*Kristen Kubitza, MPA*
Director of Water Policy & Outreach
Ohio Environmental Council

**Subgroup 20**
*Jeff Brisker*
President, Your Lawn Inc.
Ashville, Ohio

*Gina Zirkle*
Scientist, Environmental Stewardship
The Scotts Miracle-Gro Company
Marysville, Ohio

*Key Recommendations*

1. *Ohio EPA should develop a state-wide nutrient mass balance sheet that accounts for point and non-point sources of nutrients.*
2. *Ohio EPA should encourage and promote operational experimentation at wastewater treatment facilities aimed at achieving low cost nutrient removal.*
3. *Wastewater treatment plant owners should be prepared to determine cost effective means to achieve lower effluent limits wherever facilities are shown to be significant contributors to nutrient enrichment.*
4. *State government should appoint a panel of economic, financial, and policy experts to consider options for funding the implementation of Ohio's nutrient reduction strategy.*
5. *Ohio EPA should publish an annual report on nutrient loadings and resulting water quality conditions in our lakes and rivers.*
6. *Ohio EPA should integrate watershed management and green infrastructure planning with Ohio's nutrient reduction strategy.*

## Executive Summary and Recommendations

The Workgroup distilled the ideas, meeting discussions and issue papers into five key recommendations summarized in the sidebar on this page. The following text provides more details about each recommendation.

*Ohio EPA should develop a statewide nutrient mass balance sheet that accounts for point and nonpoint sources of nutrients.*

An effective and equitable nutrient reduction program for the state of Ohio should be developed based on comprehensive and accurate data on the nutrient loadings from all point and nonpoint sources. To this end, the workgroup recommends that Ohio develop a statewide nutrient mass balance that examines both point and nonpoint sources of nutrients to Ohio's watersheds. This is necessary to determine appropriate reductions for all sources and to enable cost-benefit assessments to determine the most environmentally effective and economically feasible mechanism for the state to reduce nutrient loading to watersheds.

According to water quality data from both the U.S. Geological Survey (USGS) and Ohio EPA, the majority of nutrient pollution impairing Ohio's waterways is generated by runoff and ground water leaching from agricultural lands. In many watersheds, point sources (including wastewater treatment plants) account for limited contributions to the overall nutrient load.

The *Ohio Lake Erie Phosphorus Task Force Final Report* (April 2010) indicates that all Ohio point sources contribute approximately 800 metric tons of phosphorus per year to Lake Erie; this includes wastewater treatment plants including bypasses and combined sewer overflows, direct discharging industrial facilities and home sewage treatment systems.. The overall loading of phosphorus to the Lake Erie system is believed to be more than 9,000 metric tons per year. Therefore, Ohio's point sources are responsible for less than 10 percent of the phosphorus discharged into Lake Erie and wastewater treatment plants are responsible for 6.5 percent (585 metric tons per year) of the total phosphorus load into Lake Erie.

Lacking more site-specific data for the rest of the state, it is reasonable to assume that point sources are responsible for a small fraction of the nutrient impairments in the Ohio River drainage basin as well. Such an assumption is consistent with the analyses of contributing sources of nutrient loadings conducted in the Mississippi-Atchafalaya drainage basin. For example, the National Association of Clean Water Agencies' report *Controlling Nutrient Loadings to U.S. Waterways: An Urban Perspective* (October 2011) states, "In a recent analysis of widespread hypoxia (severe oxygen depletion) in the Gulf of Mexico, which drains 40% of the land mass in the U.S., NOAA concluded that because nutrient inputs were so highly dominated by agricultural sources, even if the highest level, tertiary, was installed at every municipal treatment plant in the basin, it would reduce nitrogen loads by only a few percent to the Gulf of Mexico with little to no effect on hypoxia. (See page 15: ***http://www.nacwa.org/images/stories/public/2012-03-06wp.pdf***).

While the Ohio River basin covers approximately two-thirds of the state's entire surface area, public awareness of excessive nutrient impacts in this drainage network is considerably less than for water bodies located within the Lake Erie drainage basin, and in Lake Erie itself. Clearly, nutrient-caused or nutrient-related adverse effects on water quality are not limited to the Lake Erie basin. To move forward with an effective and equitable statewide nutrient reduction strategy, data must be collected and analyzed from all point and nonpoint sources across the state and used to develop a statewide nutrient mass balance that indicates the magnitude of nutrient loadings to the water of the state by each source.

*Ohio EPA should encourage and promote operational experimentation at wastewater treatment facilities aimed at achieving low-cost nutrient removal.*

While the overall benefit is likely to be minimal, all point sources of nutrients into the aquatic ecosystem should pursue feasible low cost options or "low hanging fruit" for reducing nutrient loads in their discharges. This must be done on a site specific basis because each wastewater treatment plant is bound by different constraints, including but not limited to: influent flow characteristics, current

treatment process design, current permit constraints, level of in-house expertise, staffing levels, facility size and financial abilities.

To assist in this process, Ohio EPA should promote operational experimentation aimed at nutrient reduction (i.e. biological nutrient removal (BNR)and chemical treatment) at all Ohio facilities, and promote the transfer of BNR technologies and 'know-how' to smaller facilities in Ohio. Assistance needs to include a process to incentivize operational experimentation at POTWs, and/or voluntary adoption of nutrient removal technologies. Incentives may include delaying or eliminating a "hard" permit limit in exchange for voluntary/early adoption of nutrient removal treatment or offering temporary discharge (NPDES) permit "relief" or violation waivers. Waivers could consist of the removal of concentration and/or loading limits for the defined experimental period for parameters likely affected by operational adjustments aimed at nutrient removal.

Financial assistance such as grants should be included to cover the costs of increased sampling and analysis, and/or treatment evaluation studies. Other financial considerations include (1) providing zero/low interest loans from the Water Pollution Control Loan Fund or other existing sources to promote and incentivize the design and construction of nutrient removal technology in public projects and (2) giving priority in Ohio's Clean Water Act 319(h) grant program to storm water control projects that most effectively reduce urban nutrient runoff to the waters of the state.

*Wastewater treatment plant owners should be prepared to determine cost effective means to achieve lower effluent limits wherever they are shown to be significant contributors to nutrient enrichment.*

If the statewide nutrient mass balance indicates that point sources are causing or contributing to nutrient impairments in a particular watershed, additional nutrient reductions may be warranted. Nutrient reduction often requires substantial changes in treatment technologies and operations at publically owned wastewater treatment plants and other point sources. Nutrient removal challenges can be significant and diverse. One constraint on the feasibility of meeting a level of nutrient removal is cost. The most successful nutrient removal programs include a funding mechanism that reasonably matches the costs to the benefits for the affected ratepayers.

Certain existing wastewater treatment technologies are more conducive to nutrient removal retrofit than others. Effective and efficient nutrient removal requires knowledgeable operators trained in nutrient removal for their facilities, influent wastewater characteristics, and sludge disposal requirements. Nutrient removal requires a holistic approach; for example, design and operation must consider solids handling and plant recycle systems.

It is also important to consider that incremental reduction in total nitrogen and/or total phosphorus at very low levels can result in a net increase in the release of greenhouse gases. Ten-States Standards and state-by-state regulations governing wastewater treatment (and biosolids) do not include sufficient information regarding biological nutrient removal technologies, and do not cover innovative approaches such as nutrient recovery from side streams or sludge. The constraints can be overcome in many

instances, and there are often benefits of implementing nutrient removal, beyond a higher quality effluent. For example, biological nutrient removal can provide additional process stability and result in operations and maintenance savings.

From a regulatory standpoint, nutrients affect water bodies differently than toxics and, aside from ammonia; there is no immediate impact on the water body. Therefore, nutrients should not be characterized as toxic as they do not cause a direct stress to the aquatic environment. Nutrient enrichment will lead to aquatic growth that impacts the watershed over a long period of time. Applying daily, average weekly or average monthly permit limits to these parameters would appear to be needlessly cautious if it can be shown that the Lake Erie watershed and the Ohio River basin respond to nutrient inputs in similar manners to the Chesapeake Bay.

*State government should appoint a panel of economic, financial and policy experts to consider options for funding the implementation of Ohio's nutrient reduction strategy.*

Ohio POTWs and their business, institutional, and individual ratepayers are carrying substantial financial burdens due to the billions of dollars these utilities have spent over the last three decades to improve and protect water quality in Ohio. These utilities will spend billions of additional dollars in the next several decades to meet existing obligations under the Clean Water Act. These funds are generated almost entirely by wastewater utility rates. In some cases, rates are among the highest in the country and are approaching the limits of the financial capability of the communities in which these utilities operate. In addition, publicly owned storm water utilities anticipate regulatory mandates that will require additional substantial increases in wastewater and storm water utility rates. Given these financial burdens, imposing the full cost of installing nutrient removal technologies and storm water controls to reduce urban nutrient runoff on publicly owned wastewater and storm water utilities and their ratepayers may create a significant threat to the fiscal sustainability of Ohio's urban communities, may place Ohio's urban communities at a competitive disadvantage with urban communities in other states, and may impair Ohio's ability to attract and retain business investment.

For these reasons, funding for nutrient removal from point sources and urban nonpoint sources in Ohio should not rely entirely on publicly owned wastewater and storm water utilities and their ratepayers. Rather, it should be broad-based and where appropriate, assessed and implemented in the context of integrated wastewater and storm water planning. To address these issues, Ohio should establish a panel of economic, financial and policy experts that will address approaches to funding the implementation of Ohio's Nutrient Reduction Strategy and that will consider the following:

- The economic costs that will be imposed upon publicly owned wastewater and storm water utilities, industrial sources, household sewage treatment system (HSTS) owners, urban commercial and institutional property owners, agricultural producers and other impacted parties by the implementation of Ohio's Nutrient Reduction Strategy.

- Economic, social and environmental cost-benefit assessments that justify the costs of implementation of Ohio's Nutrient Reduction Strategy based upon the statewide and watershed water quality benefits. This would be measured by the probable percent change in the number of impaired river and stream miles or lake and reservoir acres and by other appropriate measures.
- The financial capability of Ohio's urban communities to meet mandates that may result from the implementation of Ohio's Nutrient Reduction Strategy.
- Broad based funding sources, such as the state's general obligation bonds, that could provide grants or zero-interest loans to cover an appropriate portion of the costs of installing nutrient removal technologies at POTWs and of installing urban storm water controls that will reduce nutrient run-off.
- Broad based funding sources to provide homeowners with failing HSTSs financial assistance in replacing or upgrading their systems.
- Tax or other incentives to assist industrial sources in meeting the cost of installing nutrient removal technologies and to assist local governments and urban commercial and institutional property owners in meeting the cost of installing state mandated storm water controls.

*Ohio EPA should publish an annual report on nutrient loadings and resulting water quality conditions in our lakes and rivers.*

Once a statewide nutrient mass balance is developed, Ohio EPA should develop a sustainable mechanism to keep the data current. Current data will allow for constant review of nutrient issues in the State and a method to report progress in implementing point and nonpoint source nutrient controls. To achieve this, Ohio EPA should develop, at a minimum, the following:

- Issue an annual report on nutrient loadings in Ohio, based on the Lake Erie basin and the Ohio River basin. The Chesapeake Bay Foundation "2010 State of the Bay" report is an example. Ohio's report could include:
    - Mass Loading comparison for last year and previous years ;
    - Number of permitted POTWs by flow class with limits and change from last year ;
    - Number of permitted POTWs by flow class with monitoring and change from last year;
    - Water quality achieved with such limits (compliant stream miles vs. non-compliant miles);
    - For permitted POTWs:
        - Actual vs. Design Flow
        - Percent of Process Tankage and Equipment used to achieve current levels
        - Actual discharge levels vs. permitted discharge level
        - Type of process utilized to achieve nutrient limits
        - Cost of operating with nutrient limits(energy, chemicals and labor costs expressed as dollars per million gallons)
        - Sludge dewatering and disposal options used

    - Develop a public presentation on enhancing Ohio's water quality through nutrient loading reductions
        - PowerPoint
        - Present at applicable conferences and organizations around Ohio
        - Show at State Fair booth and other outreach events, etc.
        - Expert speaker references
- Develop a marketing strategy to inform the public about the goods things Ohio's water quality professionals and communities are doing to enhance Ohio's water quality
    - Use a professional marketing company
    - Produce and purchase TV ads
    - School and Organization marketing
    - Posters for student projects/education workbooks and brochures ('Making a Difference')
- All POTWs (whether or not with nutrient limits) should develop:
    - Posters
    - Brochure to 'Learn More How your Community can Participate'

*Integrate watershed management and green infrastructure planning with Ohio's nutrient reduction strategy.*

Point source nutrient controls at POTWs will not solve Ohio's nutrient problems. Solutions must integrate overall watershed management efforts that include green infrastructure.

Impervious surfaces prevent precipitation from both evaporating and infiltrating into the ground. As a result, precipitation runs across these impervious surfaces, collecting a variety of pollutants before discharging into waterways. The pollutant laden storm water degrades water quality and results in unnatural flow regimes that result in the loss of sensitive faunal species, the increased dominance of pollution tolerant species, increased algal biomass, and increased dominance of eutrophic algal species. Research shows that storm water and CSOs contains a variety of pollutants including: phosphorus, nitrogen, oxygen depleting substances, sediment, suspended solids and toxic chemicals among others.

Green infrastructure is a flexible, decentralized storm water management approach that utilizes natural processes to both reduce the volume of storm water runoff and treat storm water. Green infrastructure can be used by implementing practices that preserve, restore or create vegetated areas and natural corridors such as conservation easements, riparian buffers, green roofs, trees, rain gardens, bioswales and permeable pavement among others.

Data from a meta-analysis of best management practice (BMP) research indicates that many storm water BMPs are able to reduce the percent of precipitation runoff by 40-90 percent. They also can remove 25-75 percent of total phosphorus and remove 20-60 percent of nitrogen. Furthermore, an economic analysis of the green infrastructure program in Milwaukee, Wisconsin revealed that the current economic benefit from the existing green infrastructure is $2.2-$2.3 million a year. To increase the green infrastructure program in Ohio the following should be considered:

- Eliminate state barriers (e.g. funding policies and structures) to funding green infrastructure projects
- Change financing structure to incentivize green infrastructure
- Develop and adopt “Bright Green “project ranking criteria
- Offer education and outreach to POTWs, municipalities, nontraditional partners and general public
- Collect data on effectiveness of green infrastructure in Ohio

# Attachment A - Participant List

| | |
|---|---|
| **Association of Ohio Metropolitan Wastewater Agencies (AOMWA; large facilities)** | |
| Elizabeth Toot-Levy | NEORSD |
| Adam Sackenheim | Butler County |
| Robert Ashton, Columbus | Columbus |
| **Environmental Groups** | |
| Kristen Kubitza | Ohio Environmental Council |
| Kristy Meyer | Ohio Environmental Council |
| Anthony Sasson | The Nature Conservancy |
| **Ohio Utility Group** | |
| Rob Reash | AEP |
| Cheri Budzynski | Shumaker |
| **Coalition of Ohio Regional Districts (CORD)** | |
| Eric Luckage | Albers & Albers LLP |
| **Ohio Chamber of Commerce** | |
| Charlotte Hickcox | Ohio Chamber of Commerce |
| Aaron McCoy | Campbell Soup |
| **County Commissioners Association of Ohio (CCAO)** | |
| Jim Troike | Medina Co Engineer |
| Phillip Cummings | Medina Co. Sanitary Eng. |
| Joshua Hahn | CCAO |
| **Ohio Lawn Care Association** | |
| Jeff Bisker | Your Lawn Care Co. |
| Gina Zirku | Scotts |
| **Ohio Water Environment Association (OWEA; smaller facilities)** | |
| Tom Kutcher | Cincinnati MSD |
| Ed Drobina | City of Pickerington |
| Brandon Fox | Fairfield County |
| Chuck Bauer | Clark County Utilities |
| **Engineering Design / Legal Consulting firms** | |
| Guy Jamesson | Malcolm Pirnie, Water Division of ARCADIS |
| Stephen Samuels | Ice Miller LLP |
| William J. Meinert | O'Brien & Gere |
| Richard W. Reed | CTI Engineers, Inc |

| **Ohio Manufactures Association (OMA)** | |
|---|---|
| Frank L. Merrill | Bricker & Eckler LLP |
| Kevin Schmidt | OMA |
| **Ohio EPA** | |
| George Elmaraghy | Chief, DSW |
| Paul Novak | Manager, Permits Section |
| Jason Fyffe | Supervisor, Storm Water Section |
| Bob Miltner | Scientist, Ecological Assessment Section |
| Mike Gallaway | Manager, Central District DSW |
| Dan Dudley | Manager, Standards Section |
| Rick Wilson | Scientist, Nonpoint Section |
| Gary Stulfauth | Scientist, Permits Section |

# Attachment B – Issue Papers

# SUBGROUP 4

# POINT SOURCE/URBAN RUNOFF NUTRIENT WORKGROUP

# METHOD TO REPORT PROGRESS IN IMPLEMENTING PS CONTROLS

# Point Source/Urban Runoff Nutrient Workgroup

## Subgroup #4: Method to report progress in implementing PS controls

### Background and Objectives:

"Nutrient pollution is a major water quality problem in Ohio and throughout the nation" (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). While phosphorus, as opposed to nitrogen, is usually the more critical nutrient of concern in fresh water systems in Ohio, control of both is essential for the restoration and maintenance of intended uses for the state's waters. In Ohio, both point and non-point sources contribute to nutrient enrichment. Point source nutrient loads come primarily from municipal wastewater treatment facilities (i.e. POTWs); non-point source nutrient loads come primarily from agricultural activities. Both must be sufficiently controlled if water quality improvements are to be realized.

Ohio EPA desires to find cost-effective means to reduce the delivery of nutrients present in point source effluents and non-point source runoff (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). For many years now and in an effort to control point source effluents, Ohio EPA has included nutrient discharge limits in NPDES permits for some POTWs. Ohio EPA intends to add nutrient limits into many other NPDES permits for POTWs once more comprehensive regulatory mechanisms are in place to allow for such additions. In the interim, Ohio EPA is seeking, among other things, a method to report progress in implementing Point Source controls.

### Recommendations:

- Annual Report on nutrient loadings in Ohio, based on the Lake Erie basin and the Ohio River basin. Refer to the Chesapeake Bay Foundation "2010 State of the Bay" report as an example. Report could include:
    - Mass Loading comparison for last year and previous years
    - Number of permitted POTWs by flow class with limits and change from last year
    - Number of permitted POTWs by flow class with monitoring and change from last year
    - Water Quality achieved with such limits (compliant stream miles vs. non-compliant miles)
    - For permitted POTWs:
        - Actual vs. Design Flow
        - Percent of Process Tankage and Equipment used to achieve current levels
        - Actual discharge levels vs. Permitted discharge level.
        - Type of process utilized to achieve nutrient limits
        - Cost of operating with nutrient limits ($/MG)
            - Energy costs
            - Chemical costs
            - Labor costs
        - Sludge dewatering and disposal option used

- Public Presentation on Enhancing Ohio's Water Quality through Nutrient Loading Reductions
    - PowerPoint
    - Given at applicable conferences and organizations around Ohio
    - Run as Kiosk at State Fair, etc.
    - Expert Speaker references
- Marketing Strategy to Inform Public about the Goods things Ohio's Water Quality Professionals and Communities are doing to Enhance Ohio's Water Quality
    - Professional marketing company
    - TV ads
    - School and Organization marketing
        - Posters
        - Student projects/education workbook
        - Brochure: 'Making a Difference'
    - All POTWs whether or not with Nutrient Limits
        - Poster
        - Brochure to 'Learn More How your Community can Participate'

# SUBGROUP 5

# NEED FOR SEASONAL OR ANNUAL LOADING TARGETS AND PERMIT LIMITS FOR NUTRIENTS

**Subgroup #5: Need for Seasonal or Annual Loading Targets and Permit Limits for Nutrients**

**What is the issue?**

At present, NPDES permits issued by the Ohio EPA are based on maximum and minimum daily concentrations as well as average weekly and average monthly concentrations and loads. These limits have been based on controlling toxics to water bodies. In general toxics are those parameters that cause direct stress to the aquatic environment or cause a depletion of dissolved oxygen in a water body which in turn causes a stress to the aquatic environment.

Nutrients (nitrogen and phosphorus) should not be characterized as toxics based on the above definition since they do not cause a direct stress to the aquatic environment. Applying daily, average weekly or average monthly limits to these parameters would appear to be needlessly cautious. Issuing NPDES permits with seasonal or annual concentration and loading limits for nutrients may be sufficient to protect aquatic environments.

**What are the factors to consider?**

**The Difference between Toxics and Nutrients**

Based on a WERF Nutrient Removal webinar presentation (October 5, 2011) given by David L. Clark of HDR Engineering, nutrients differ from toxics in the following ways: For nutrients, aside from ammonia, there is no immediate impact on the water body whereas toxics (chlorine, metals, organics) can have acute and chronic impacts on aquatic life. Nutrient enrichment will lead to aquatic growth that impacts more of the watershed whereas toxics impact more of the mixing zone as well as the watershed. Algal responses are over a longer time period.

A permit designed to protect the short term impacts as well as the long term impacts to a water body would preserve the intent of the permit. If nutrients are generally long term responses as a result of algal responses it would make sense to evaluate this load over a longer time period. The case can be argued as to why limit a parameter to a shorter time period than what the detrimental impacts on the receiving water would be.

**In-stream Water Concentrations**

As shown in "The Trophic Index Criterion" presentation (Bob Miltner's presentation to the group of March 20, 2012) the importance of the reduction of concentrations in streams greatly affects the resultant improvements in stream biological health. It is the concentrations (toxics or nutrients) in the stream that provide the basis for water quality improvements. Given that target in-stream water quality concentrations provide a basis for improvements and that point source loadings are developed based on those water quality targets, issuing discharge permits with concentration and loading limits appear to be needlessly cautious. The modeling of water bodies include in-stream water quality concentrations, receiving stream low flow discharge rates, maximum point source loadings, and receiving stream parameters such as mixing zone criteria, channel slope, sediment response, etc. Whether it is toxics or nutrients that are applied

from a point source it is the load on the receiving stream that matters. As long as loadings are kept below the maximum (based on water modeling), concentrations and flow rates from the point sources could vary. Since modeling of receiving streams already includes low flow discharges, the possibility of higher concentrations from point source discharges (due to their own lower than design discharges) should not produce adverse effects in the receiving stream.

**Wet Weather Flows**

As stated at the beginning of this paper, nutrient enrichment will lead to aquatic growth that impacts more of the watershed whereas toxics impact more of the mixing zone as well as the watershed. Algal responses are over a longer time period.

The performance of wastewater treatment facilities will vary depending on the amount of hydraulic stress placed upon a facility. Rainfall events as well as snowmelts will deliver more water to a treatment facility than under dry weather conditions. This additional flow can hydraulically stress a facility and degrade performance. The temporary treatment performance reduction (in nutrients) should not affect the receiving water body (as long as maximum nutrient loads are not breached) since algal responses are over a longer period of time. With a permit based on annual or seasonal loadings, these temporary nutrient load increases could be absorbed by a water body (assuming better treatment plant performance during dry weather periods) without causing stress. The annual or seasonal based loading criteria would also give treatment facilities some leeway in their permit to negotiate the wet weather situations without violating their discharge permit. Keeping a discharge permit for nutrients based on average weekly or average monthly concentrations and loads (short time period impacts) would not be prudent due to the longer term nutrient impact on the receiving body of water.

**Current Treatment Technology**

With the current state of treatment technology for nutrient removal, results will vary by season especially in areas such as Ohio in which water temperatures over the year change dramatically. The removal of nitrogen from a wastewater discharge is through biological means. During periods of colder water temperatures, the metabolic rates of bacterial organisms are slower which reduces the efficiency of the process. With phosphorus removal (whether biological or chemical), the majority of the phosphorus is tied up within the solids. During periods of colder water temperatures, solids do not settle as well within clarifiers. With the addition of more solids discharging over a weir in a clarifier, the amount of phosphorus is also increased. The addition of tertiary filtration can recover the cold water inefficiency of clarifiers by capturing the solids discharged over the clarifier effluent weir to a point. Should the solids captured within the tertiary filtration process be limited to oxygen, phosphorus can be released from the solids, become soluble, and travel through the tertiary filtration process and back into the final effluent discharge to the receiving water body.

Due to the potential inefficiencies of treatment processes during colder weather, a case could be made that seasonal limits should be implemented for nutrient permit limits. The downside to

a seasonal permit limit is the lack of control in regulating the temperature of the water to be treated. The changes in water temperature are affected by spring and fall time temperatures as well as the amount of snow received over the winter months and effects of snow melt. To overcome this lack of control, an annual load limit would appear to be beneficial.

**USEPA Acceptance**

The acceptance by USEPA for NPDES permits to be issued based on annual loadings for nutrients has previously been discussed. In a USEPA Memorandum dated March 3, 2004 from James A. Hanlon, Director, Office of Wastewater Management to Jon Capacasa, Director, Water Permits Division, EPA Region the subject of basing NPDES permit effluent limits for nitrogen and phosphorus on annual limits as opposed to daily maximum, weekly average or monthly average limits was discussed. Within the memo, Mr. Hanlon states that he finds permit limits expressed as an annual limit would be appropriate and conclude that it is impracticable to express limits as daily maximum, weekly average or monthly average limits for the Chesapeake Bay watershed. The memo discusses the applicability of the annual loading with achieving compliance with water quality standards, the nutrient dynamics of the Chesapeake Bay and its tidal tributaries, and why it is impracticable to express permit limits for nutrients on a daily, weekly or monthly basis. The memo concludes with recommendations for implementing an annual limit.

If Ohio EPA can show that the Lake Erie watershed and/or the Ohio River watershed responds to nutrients in the same way that the Chesapeake Bay watershed has, it would appear that USEPA would be in favor of annual loading limits for nutrients for watersheds in Ohio. This would also draw the same conclusion in the Hanlon memo that it would be impracticable to express limits as daily maximum, weekly average or monthly averages as currently required in the NPDES permit criteria for POTWs.

It should be noted that applying annual or seasonal loading criteria might not apply to the protection of smaller scale/local/nearfield situations like streams where they are effluent-dominated, especially during warm weather low flows. As the 2004 Hanlon memo states, “Shorter averaging periods might be appropriate and necessary to protect against local nutrient impacts in rivers or streams.”

**Summary**

Nutrients affect water bodies differently than toxics. For nutrients, aside from ammonia, there is no immediate impact on the water body whereas toxics (chlorine, metals, organics) can have acute and chronic impacts on aquatic life. Nutrient enrichment will lead to aquatic growth that impacts more of the watershed whereas toxics impact more of the mixing zone as well as the watershed. Algal responses are over a longer time period.

For the issuance of individual NPDES permits, if it can be shown that the Lake Erie watershed and/or the Ohio River watershed responds to nutrients in the same way that the Chesapeake Bay watershed has, Ohio can show that applying daily, average weekly or average monthly limits to nutrients (nitrogen and

phosphorus) is impracticable and should not be a criteria of NPDES permits. With nutrients affecting far field aquatic environments, temporary increases and/or decreases to nutrient loadings to receiving water bodies should be acceptable since it is the longer term impact that matters.

Applying concentration and loading limits to discharge permits appears to be unnecessary since the load of the nutrient pollutant and not the concentration has been determined by water quality modeling to be acceptable based on in-stream water concentrations.

Current treatment technologies are affected by seasons as well as wet weather events and the performance can be temporarily degraded. If nutrients are truly far-field related impacts and not near-field related impacts to water bodies, these temporary increases and/or decreases in nutrient loadings to water bodies should not be detrimental. Allowing annual or seasonal loading limits would allow treatment facilities to overcome the seasonal and wet weather periods without violating their NPDES discharge permits without impact to the receiving water body.

**Recommendations**

It is this subgroup's opinion if it can be shown that the Lake Erie watershed and/or the Ohio River watershed responds to nutrients in the same way that the Chesapeake Bay watershed has, nutrient related NPDES permit discharge limits should be based on annual or seasonal loadings.

Applying annual or seasonal loading criteria to all discharges might not apply. The protection of smaller scale/local/nearfield situations such as for streams that are effluent-dominated, especially during warm weather low flows may need shorter averaging periods.

**Sources of Information Used**


- USEPA Memorandum dated March 3, 2004 from James A. Hanlon, Director, Office of Wastewater Management to Jon Capacasa, Director, Water Permits Division, EPA Region. Subject: Annual Permit Limits for Nitrogen and Phosphorus for Permits Designed to Protect Chesapeake Bay and its tidal tributaries form Excess Nutrient Loading under the National Pollutant Discharge Elimination System

- WERF Nutrient Removal Webinar dated October 5, 2011 presented by David L. Clark, HDR Engineering. Presentation Title: Managing Water Quality – Translating Research to Practice

# SUBGROUP 6

# OHIO EPA POINT SOURCE/URBAN RUNOFF NUTRIENT WORKGROUP

# FUNDING APPROACHES (STATE INITIATIVES) SUB-WORKGROUP

# Subgroup 6: Final Draft (May 11, 2012)

**Ohio EPA Point Source/Urban Runoff Nutrient Workgroup**
**Funding Approaches (State initiatives) Sub-Workgroup**

Recommendations of the Funding Approaches (State Initiatives) Sub-Workgroup: Funding Approaches to Nutrient Reduction from Point Sources and Urban Non-Point Sources in Ohio

## I. Introduction

### A. Publicly Owned Wastewater and Storm Water Utilities

Publicly owned wastewater utilities in Ohio and their business, institutional, and individual ratepayers are carrying very substantial financial burdens due to the efforts of these utilities to improve and protect water quality in Ohio. Over the last three decades, publicly owned wastewater utilities have spent billions of dollars to meet Clean Water Act (CWA) requirements, and will be spending billions more in future years to improve water quality and deliver vital services to their communities. These funds have been and will be generated for the most part by wastewater utility rate increases paid by households and businesses, many of whom are already paying some of the highest rates in the country. In some cases, these rate increases are approaching the limits of the financial capability of the communities in which these utilities operate. In addition, publicly owned storm water utilities anticipate future regulatory mandates that will require substantial increases in storm water utility rates.

In view of the existing financial burdens being carried by publicly owned wastewater and storm water utilities in Ohio, imposing on these utilities and their ratepayers the full cost of installing nutrient removal technologies, and of storm water controls to reduce urban nutrient runoff, may create a significant threat to the fiscal sustainability of Ohio's urban communities. In addition, ever increasing sewer and storm water utility rates may place Ohio's urban communities at a competitive disadvantage with urban communities in other states and may impair Ohio's ability to attract and retain business investment. For these reasons, funding approaches to nutrient removal from point sources and urban non-point sources in Ohio should not rely entirely on publicly owned wastewater utilities and their ratepayers, but should be broad-based and where appropriate assessed and implemented in the context of integrated wastewater and storm water planning.

B. Industrial Sources

Businesses in Ohio operate in highly competitive international markets and in some cases face significant challenges in accessing capital and credit, particularly in the current economic climate. Businesses operating industrial wastewater plants or that are discharging to publicly owned treatment works (POTWs) are concentrated in economic sectors of significant importance to Ohio's economic well-being, such as manufacturing and energy. Moreover, businesses operating industrial wastewater plants or discharging to POTWs are concentrated in Ohio's metropolitan areas, which are the engines of economic activity in Ohio. Accordingly, funding approaches to the implementation of Ohio's Nutrient Reduction Strategy for point sources and urban non-point sources should consider the economic and financial challenges faced by businesses operating industrial wastewater plants or discharging to POTWs.

C. Household Sewage Treatment Systems

Failing Household Sewage Treatment Systems (HSTS) may be significant contributors to nutrient run-off in some of Ohio's metropolitan areas. Upgrading or replacing HSTSs to meet Ohio's HSTS design and siting criteria is costly and may be beyond the financial capability of some homeowners. Funding approaches to the implementation of Ohio's Nutrient Reduction Strategy should also consider mechanisms for providing financial assistance to homeowners for upgrading failing HSTSs.

II. Recommendations

Providing informed and competent recommendations on approaches to adequate and equitable funding for nutrient removal and reduction from point sources and urban non-point sources in Ohio requires the consideration of complex economic, financial, and policy issues. Such an effort is beyond the capability of the Point Source/Urban Runoff Nutrient Workgroup. Accordingly, the Funding Approaches Sub-Workgroup recommends the following:

A. The State of Ohio establishing a panel of economic, financial, and policy experts, that includes stakeholder representatives, to address approaches to funding the implementation of Ohio's Nutrient Reduction Strategy and to consider the following:

1. The economic costs that will be imposed upon publicly owned wastewater and storm water utilities, industrial sources, HSTS owners, urban commercial and institutional property owners, agricultural producers, and other impacted parties by the implementation of Ohio's Nutrient Reduction Strategy.

2. Appropriate cost-benefit assessments to justify the costs of implementation of Ohio's Nutrient Reduction Strategy based upon the statewide and watershed water quality benefits as measured by the probable percent change in the number of impaired river and stream miles or lake and reservoir acres and by other appropriate measures. Such cost-benefit assessments should employ a triple bottom-line analysis that accounts for economic, environmental, and social costs and benefits.

3. A meaningful assessment of the financial capability of Ohio's communities to meet mandates that may result from the implementation of Ohio's Nutrient Reduction Strategy. Such financial capability assessments should include, among other appropriate factors, the following:

- Quantifying all relevant economic factors impacting financial capability, including housing burden, state and local tax burden, impacts on business competitiveness, projected population and employment trends, poverty and low income populations, community construction impacts, availability of local contractors, construction inflation, and historical water quality investments;

- Considering projections of wastewater rate increases and anticipated benefits over a range of implementation periods;

- Considering projected capital expenditures required of effective wastewater agencies due to new regulation, aging infrastructure and other applicable requirements;

- Existing and anticipated local poverty levels that prevail across wastewater agencies' service areas, and opportunities to mitigate disproportionate impacts of water quality program financing on the economically disadvantaged;

- Regional implementation logistics and impacts on local construction markets of multiple major sewer collection system rehabilitation programs; and

- Identification and prioritization of environmental investments that are projected to yield the highest environmental returns.

5. Broad based funding sources, such as the state's general obligation bonds, that could provide grants to cover an appropriate portion of the costs of installing nutrient removal technologies at publicly owned wastewater treatment plants and of installing urban storm water controls that will reduce nutrient run-off.

6. Broad based funding sources to provide homeowners with failing HSTSs financial assistance in replacing or upgrading their systems.

7. Tax or other incentives to assist industrial sources in meeting the cost of installing nutrient removal technologies and to assist local governments and urban commercial and institutional property owners in meeting the cost of installing state mandated storm water controls.

8. Evaluation of other states' and/or provinces' funding approaches to nutrient reduction and provide recommendations based on the history of programs that have been successful.

C. Ohio EPA giving priority in Ohio's Clean Water Act 319(h) grant program to storm water control projects that most effectively reduce urban nutrient runoff to the waters of the state.

D. Ohio EPA providing zero interest or low interest loans from the Water Pollution Control Loan Fund or other existing sources to immediately promote and incentivize the design and construction of nutrient removal technology in public projects and give loan priority to projects that include biological nutrient removal or other nutrient reduction technologies.

F. Ohio EPA evaluating the legal and legislative changes that are needed to allow public funds for the upgrade or replacement of failing HSTSs in rural areas.

# SUBGROUP 7
# DISPOSAL OF BIO-SOLIDS, USE OF LAND APPLICATION, THE VALUE OF P AND N AS PLANT NUTRIENTS SUMMARY

**Issue 7 Disposal of biosolids**

Workgroup Lead: Jim Troike

Recommendations

1. Incorporate biosolids into soils during application or as rapidly as possible after surface applications.
2. Limit the application of phosphorus to the crop nutrient need.
3. Investigate if a soil testing requirement for cation exchange capacity would be an appropriate step in managing phosphorus application rates on land where biosolids are disposed.
4. Consider the addition of aluminum to the list of metals covered under Ohio's 503 regulations.
5. Strengthen testing requirements under Section 503 to ensure the that most limiting factor on the land application of biosolids are known and adhered to.

# Disposal of Bio-solids, Use of Land Application, the Value of P and N as Plant Nutrients

## Summary

While waste water plants are being asked to squeeze out every last milligram of phosphate from their effluent, the whole effort is nullified if sludge is over applied or erosion is allowed to carry particulate to neighboring ponds and streams. Sludge application can be conducted in an environmentally sound manner if we better apply known science and assure proper application methods.
Standard conservation practices prevent particulate runoff of phosphorus from sludge application sites and should be encouraged in the farming community. Retaining soluble forms of phosphorus on application sites requires balancing application rates with the soils ability to precipitate phosphorus and the crops nutrient need. This paper encourages the use of soil Cation Exchange Capacity (CEC) for site specific determination of phosphorus retention capacities as a means of assuring that phosphorus is not over applied with excess soluble phosphorous subject to site exodus through storm water runoff. Additionally, rapid incorporation is suggested as a means of integrating soil particles with phosphorous to speed the precipitation process and bind phosphorous in a particulate form.

## The Issue:

Nutrient runoff from farm fields encourages algal growth in streams and lakes resulting in eutrophication and in some cases the development of toxic algae strains. Assuring that nutrients removed from waste water are not re-introduced to the environment through sludge disposal methodologies is essential.

## Targeting Phosphorous over Nitrogen:

Nitrogen in sludge appears as nitrates, ammonia or other organic nitrogen forms. Nitrates are highly soluble with little affinity to attach to soil particles. Therefore they penetrate into sub soils readily. Ammonia does attach to soil particles where bacteria in the soil break it down to nitrates. Because of it's high solubility, nitrogen should be applied to fields just before planting.

Because typical sludge phosphorous to nitrogen ratios are high, nutrient loading rates are likely to be met for phosphorous well in advance of that for nitrogen. This is memorialized in Ohio's sludge regulations and the Missouri Agriculture Extension Services use of phosphorous as the limiting nutrient for calculating application rates.

http://extension.missouri.edu/explorepdf/agguides/soils/g09183.pdf In addition, all of the best management practices to prevent the loss of phosphorous also apply to nitrogen. For these reasons, we will focus on phosphorous as the nutrient of concern in sludge land application.

Phosphorus as a nutrient:

Scientific America reports that there is a dwindling supply of phosphorus in the United States and the acquisition of major phosphorus supplies by China. (http://www.scientificamerican.com/article.cfm?id=phosphorus-a-looming-crisis) Phosphorus is a mined mineral and, as a result of environmental concerns, there is less being produced due to a reduction in demand. As such, the nutrient value of sewage sludge will become more important as the limited supply of phosphorus becomes more acute.

In soils, Phosphorus is either bound in precipitated form to metals or minerals in the soil or is present in a soluble, plant available form. In sludge land application, the concern for nutrient run off is the susceptibility of soluble phosphorus to be carried off site in runoff water or for precipitated phosphorus to be carried off with soil particles through erosion. As soil phosphate levels approach the maximum precipitating or binding capacity of the soil, conservation measures used to reduce particulate losses become increasingly important for retaining phosphorus on the field. (http://www.sera17.ext.vt.edu/Documents/P_Index_for_%20Risk_Assessment.pdf) Therefore, all fields used for sludge application should use common conservation practices such as setbacks, grassed waterways and crop rotations.

Sludge Benefits:

Studies conducted at the University of Florida indicate that the fibrous material in sludge helps to precipitate phosphorus, binding it in particulate form. (http://news.ufl.edu/2006/05/09/biosolids/) A distinction should be made between the application of liquid sludge and sludge that has a density of greater than 15 percent. Research has shown that the application of dry sludge has a greater effect at reducing phosphorus runoff than liquid sludge. (http://www.ncbi.nlm.nih.gov/pubmed/11215651) With this binding capability, the study showed that sludge releases only about half of the soluble phosphorus that commercial fertilizers do. The study also found that there is a wide variation in the soluble fraction of phosphorus available in various types of sludge.

As different types of sludge react differently with different soil types, the effect of the soil/sludge blend on phosphorus retention and plant available (soluble) phosphorus needs to be considered. It may be recommended that a detailed evaluation of the amount of phosphorus available from a specific sludge be paired with crop nutrient requirements and

existing soil phosphorus levels to determine an application rate that will not result in the loss of soluble the fraction during rain events.

Phosphorous Loss Mitigation:

The loss of soluble phosphorus from fields can be mitigated by limiting the amount applied to fields to that which can be bound in particulate form plus that which would match the seasonal need of the crop. The Cation Exchange Capacity (CEC) and the pH of soil may be used together as one way to measure the soils ability to retain precipitated phosphorus. The CEC is measure of a soils ability to hold cations. A higher CEC indicates a higher capacity of the soil to bond positively charged metal or mineral ions that form precipitates with negatively charged phosphorus ions. Raising soil pH with lime will raise the CEC and provide more ions to precipitate phosphorus. However a neutral pH is favored to avoid metals toxicity in plants. Sludge application increases the CEC of the soil/sludge mix by adding organic material or humus that increases available negative charges. In addition, the humus reduces phosphorus leaching from fields by increasing soil tilth and reducing the impact of heavy rainfall on soil erosion.
http://en.wikipedia.org/wiki/Cation-exchange_capacity.

Soil testing for Phosphorus concentration and CEC should be conducted for each field where sludge is to be applied. Ohio EPA had required CEC testing as a means of assessing metals accumulation in soils prior to the 503 regulations being implemented. OEPA should review whether or not implementing this testing would be beneficial for regulating phosphorus application. Testing would address many of the concerns about land application presented by the Sierra Club in their guidance on Land Application. (http://www.sierraclub.org/policy/conservation/LandApplicationSewageSludge.pdf)

Incorporation:

It would seem important to thoroughly mix soil and sludge for two reasons. First, mixing will bring phosphorus into contact with soil particles enhancing precipitation and binding phosphorus to a particulate. Proper erosion control will maintain the particulate on-site.

Second, mixing soil and sludge will bring soluble phosphorus into contact with plant roots where it will be utilized by the plant. Left on the surface of the ground, soluble phosphorus is susceptible to runoff and is not in close enough proximity to roots to be utilized.

As incorporation can only be accomplished during certain times before and after the planting season, allowing for soil incorporation would likely increase the need for sludge storage. It may be important to provide financing or to otherwise enhance municipal

treatment plants ability to construct additional storage and odor control facilities.

Metal Precipitate Sludge vs. Biological Sludge:

Economically, it is more cost effective for a small municipality to dispose of sewage sludge through land application. There is a large capital investment required to be able to dispose of sludge using other means (IE: landfill/mono fill). At the same time, small facilities are much less likely to have industry that would contribute toxic materials or heavy metals that would be less environmentally friendly to the farmland that the sludge is spread on. Ohio Pretreatment regulations have also assisted in limiting metals and toxins in sludge. This would make sludge from these small communities more attractive for it's nutrient value.

Aluminum and iron salts are commonly used precipitate and remove phosphorus in settling basins. The land application of these sludge's will add additional metals to soils which may become toxic to plants at a pH less than 5.5 or above 7. (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC439893/pdf/plntphys00307-0181.pdf). Using these metal salts, phosphorus is bound to the metal as a precipitate and should not contribute to nutrient enhancement in runoff water unless erosion occurs. (http://senr.osu.edu/images/OSU_NPDES_CuyahogaFalls0509.pdf) Metals accumulation on fields is regulated by the 503 regulations but should be modified to include aluminum. These sludge's are then limited for land application by the amount of metals accumulating in the soils and the need to maintain a slightly acidic soil pH to maintain healthy plant growth.

Waste water plants biologically removing phosphorus will produce sludge with un-precipitated or soluble phosphorus. Calculating application rates would then be based on the volume of phosphorous in the sludge, the soils capacity to precipitate phosphorus and the crop nutrient need. These sludge's should be incorporated into soils quickly to precipitate the phosphorous to it's fullest before the occurrence of any rain events.

Monitoring:

Whereas 503 regulations call for some sampling along with nutrient need/availability analysis, there is little monitoring being conducted to verify that these practices are being carried out consistently. A strengthening of the testing requirements in 503 along with monitoring of applicators to ensure that application rates do not exceed what is necessary to meet the most limiting factors outlined in 503. In addition, confirmation that nutrients are not running off application sites should be verified by sampling storm water runoff from field tile and ditch lines where sludge was applied.

# SUBGROUP 8

# CONSTRAINTS ON THE FEASIBILITY OF MEETING A LEVEL OF NUTRIENT REMOVAL (NR)

**Subgroup #8 - Constraints on the Feasibility of Meeting a Level of Nutrient Removal (NR)**

**The Issue**

The removal of nitrogen from wastewater is by biological means. The removal of phosphorus from wastewater can be by either biological or chemical means, or both. Filtration can remove particulate form of both. The removal of phosphorus from the plant is through wasting biomass and disposing of the biosolids, since the phosphorus is contained within the (chemical treatment) inert solids or the (biological treatment) stabilized biosolids.

NR often times requires changes in the physical, chemical, and/or biological treatment facilities and operating techniques at a POTW – if not also the solids handling systems (to effectively waste the nutrients as part of sludge disposal).

NR challenges can be significant and diverse. During periods of colder water temperatures, the metabolic rates of bacterial organisms are slower which reduces the efficiency of the process. With phosphorus removal (whether biological or chemical), the majority of the phosphorus is tied up within the solids. If solids do not settle well within clarifiers, more solids discharging over the weir in a clarifier releases more nitrogen and phosphorus to downstream facilities or the effluent. The addition of tertiary filtration can bolster the performance of clarifiers by capturing more of the solids.

**Potential Constraint**s

- A constraint on the feasibility of meeting a level of nutrient removal is **cost**.
    - Meeting higher levels of effluent quality will involve, in the vast majority of cases, additional **capital** to install and/or **O&M** to operate.
        - This analysis is on a case-by-case basis, since it depends on the current level of treatment required by NPDES Permit, types of existing liquid and solids treatment systems, and current %-of-design loading conditions.
            - If a POTW is operating near its rated loading capacity and not already achieving full Nitrification (suggesting, simply, adequate or nearly adequate process tankage), and limited or no operating efficiency gains can be achieved with NR retrofit, the POTW or its owner might need to trade plant capacity for NR upgrade – or expend significant capital to achieve NR (often a case-by-case analysis is needed to assess).
    - The cost of implementing Biological Nutrient Removal (BNR) levels (defined as total nitrogen (TN) 8-10 mg/L, total phosphorus (TP) 1-1.5 mg/L) can be breakeven or a net (annualized) savings, depending upon the baseline condition, method(s) employed for BNR, and degree of flexibility in permitting or seasonal operation (degree of required redundancy and system complexity).
    - The most successful NR programs include a funding mechanism that reasonably matches the costs to the benefits for the affected ratepayers.

        - There are often diminishing returns with POTW NR. Often times, plant size is used as the cutoff, recognizing the limited effectiveness (loading) of smaller facilities and, sometimes, additional challenges in implementing NR.
- **Certain existing wastewater treatment technologies are more conducive to NR retrofit than others**. For example:
    - Aerated and facultative lagoons are generally ineffective – incompatible solids management approach, limited treatment compartmentalization, very long hydraulic and solids retention times, limited to no aeration control, generally less effective clarification
    - High-rate biological treatment systems (short hydraulic retention times, often also with short solids retention times) may have inadequate tankage to achieve Nitrification. Nitrification (at least partial) is required before Denitrification can occur to achieve TN removal.
        - A majority of the NR may, instead, need to occur as part of solids handling systems (NR modifications or technology retrofits).
- Effective and efficient NR **requires knowledgeable operators trained in NR for their facilities, influent wastewater characteristics, and sludge disposal requirements**.
    - Not all operators at a POTW need to know all aspects of NR theory, practice, and operation. However, key process decision-makers and chief operators should. Often times, instilling the knowledge and understanding is a lower incremental cost for medium (say, 1-10 MGD Average Daily Flow (ADF) rating) and large-size (say, 10+ MGD ADF rating) facilities, compared to small (less than, say, 1 MGD ADF rating) plants.
    - Since the majority of nitrogen and phosphorus in a NR facility ends up being contained in the stabilized sludge (chemically-fixed and/or bio-available), the performance of NR must consider disposal constraints – such as phosphorus application or loading rates for sludge land application sites, including metals associated with Chem-P removal.
- **Colder wastewater temperatures limit the ability of NR systems**. Generally, summer NR is more effective than winter NR operation.
    - More chemicals (coagulant and/or supplemental carbon) are often required to maintain similar NR removal levels in the winter.
- Dissolved oxygen (DO) is critical to Nitrification. However, **DO can reduce the effectiveness of BNR and biological phosphorus removal (BPR)**. Equipment modifications and controls upgrade are often needed to monitor and adjust DO levels on a daily and weekly basis – if not by shift or hourly for advanced or enhanced NR levels, depending upon plant conditions.
    - In NR, BOD removal can be in Anaerobic/Anoxic (unaerated) or Oxic (aerated) conditions.
    - In order to promote the conversion of Nitrate ($NO_3^-$) to nitrogen gas ($N_2$) (removal, to atmosphere), the (free, soluble) DO level must be near non-detectable to allow certain NR microorganisms to be present in higher fractions – which occurs if the oxygen contained within Nitrate is, instead, utilized (energy, growth).
- Other wastewater characteristics can limit or inhibit NR. For example:

    - Low influent alkalinity (without sufficient supplemental feed) can limit or acutely or chronically inhibit Nitrification.
    - Volatile fatty acids (VFAs) naturally form in most sanitary sewer systems. VFAs can be enhanced within the POTW in certain liquid or solids treatment systems. VFAs are the food source for Phosphorus-Accumulating Organisms (PAOs). Low VFA concentration in the influent can limit the effectiveness of "enhanced" BPR.
    - Bio-P removal is more efficient if nitrates, produced by nitrification (ammonia conversion to nitate), are removed or reduced to BNR levels – in advance or by treating the internal recycle or RAS (pre-anoxic, or enlarged anaerobic / anoxic zone).
- **NR requires effective Secondary Clarification**. Removal of solids results in the removal of nutrients, both in the form of particulate TN or TP and biomass that are part N and part P (a portion of the biomass is periodically wasted from the biological treatment system to solids handling). Inadequate clarifier surface area (measured by solids loading rate and surface overflow rate), clarifier depth (minimizing the vertical distance between sludge blanket levels and overflow weirs), and operational challenges such as filamentous (floating) bacteria can lead to more solids reaching downstream facilities or the effluent.
- NR requires a holistic approach. NR design and operation must consider solids handling and plant recycle systems. **The strength or nature of recycle streams** from inefficient or ineffective sidestreams **or solids treatment** (inefficient or ineffective from a NR standpoint) **can significantly influence NR effectiveness**.
    - For example, anaerobic digestion decant or sludge dewatering filtrate that follows anaerobic digestion often contains high concentrations of Ammonia, if not Ortho-P as well. These loads may need to be equalized, aerated, and/or pretreated before combining with liquid treatment systems to not cause frequent, periodic, or intermittent NR performance excursions.
    - Septage receiving can introduce periodic spikes or imbalances in nutrient levels.
    - Landfill leachate can affect NR if an appreciable percentage of influent wastewater.
    - Certain types of industries can introduce non-biodegradable fractions of nitrogen (often times assessed by inspecting the influent TKN:Ammonia-N ratio and effluent speciation of TN (ammonia, nitrate, org-N). Typically, this is not a concern unless the industrial contribution is a significant percentage of the influent loading and the POTW's goal is advanced or enhanced NR levels, where this non-biodegradable fraction results in a higher percentage of the TN remaining in the plant effluent.
- **A facility that is optimized for BPR or enhanced BPR may be limited in its ability to remove TN**.
    - Expanding upon a point made above regarding Bio-P (BPR), PAOs compete with other mixed liquor microorganisms for the various forms of "food" in the wastewater. PAO number and activity can be limited by the presence of Nitrates. Nitrates are formed as part of Nitrification (Ammonia converted to Nitrate). Therefore, enhancing the release and luxury uptake of phosphorus through the biological treatment system requires at least partial removal of Nitrates (adding a Denitrification treatment step) to allow more BPR.

        - The biological treatment system must be significantly larger to include Nitrification and Denitrification.
    - If a facility is not required to Nitrify (no Ammonia limit or no TN goal), the biological treatment system will often be sized with a short detention time in the Oxic (aerated) zone (Anaerobic-Oxic configuration) so as to not promote Nitrification after BOD removal in the combined An-Ox process.
    - Note that for very low TN effluent goals, secondary release of Ammonia and/or Ortho-P can occur if there is an imbalance in remaining nutrients required for biological activity in the latter zones of treatment.
        - There are ways to minimize or prevent this secondary release, however, additional equipment (aeration), controls, and understanding are required.
- In general, suspended-growth biological systems are capable of both TN and TP removal. Many fixed-film biological systems may be limited in their ability to achieve nitrate removal or BPR.
    - Some fixed-film reactors, such as Nitrification Towers, have a limited ability to regulate DO concentrations in its unit process effluent (low ammonia, high (converted) nitrate). High DO reduces the efficiency of anoxic zones downstream (or upstream, with IR loading of nitrates returned to mix with reactor influent).
    - Some fixed-film reactors, such as Moving Bed Biofilm Reactors, achieve limited BPR since it is difficult to create and maintain anaerobic conditions within the associated biofilm.
    - Note that there are hybrid systems (combined suspended-growth and fixed-film) that overcome general fixed-film NR limitations and are often employed where site constraints are an issue (requiring a smaller footprint technology or solution).
- Combined sewer systems tributary to NR systems can limit the ability of the POTW to remove nutrients.
    - During wet weather, the peaking factors through the POTW can increase significantly, significantly above typical 2.5x peak daily flow peaking factor and 3.0x peak hourly flow peaking factor.
    - **During wet weather or higher groundwater levels, the wastewater temperature can be lower**. Most biological treatment rates are slower with lower wastewater temperatures.
    - **During wet weather, solids washout can occur**. Nitrifiers, in particular, are slow-growing microorganisms and the NR system may require long periods of recovery (Denitrification is preceded by Nitrification).
    - During wet weather, the wastewater concentrations of key influent parameters can become dilute, which can affect the NR driving forces – limiting the effective removal of TN or TP.
- **Industrial waste discharges to the POTW can inhibit** or, in extreme circumstances, prevent Nitrification, Denitrification, and/or BPR.
    - Pretreatment and/or load equalization may be required as part of manufacturing a POTW influent wastewater more inline with typical ratios of constituents that drive NR.

- **Industrial waste discharges can contain "non-biodegradable" fractions of nitrogen** that will not be converted or removed – at least within the typical hydraulic or solids retention times at POTW NR facilities.
    - Note that this is typically not a significant issue unless effluent goals approach enhanced NR, often termed as limit-of-technology (LOT) levels (defined as TN 3-4 mg/L, TP 0.1-0.3 mg/L).
- Industrial or "non-domestic" wastewater can change typical ratios of influent wastewater parameters key to predicting the effectiveness and operating cost of NR. BOD is the "food" for BNR. Lower influent BOD:TKN or lower BOD:TP ratios, for example, suggest that **NR performance could be "BOD-limited"**. Supplemental carbon (food) chemical storage & feed would be required to achieve lower TN (or TN & TP) effluent levels.
- An issue for NR goals near the LOT, incremental reduction in TN and/or TP at low-low levels can actually result in a net increase in the release of greenhouse gases (GHGs). Elevated chemical feed rates and feed ratios to achieve low-low TP levels should consider the chemical production methods and transportation. NR levels that trigger filtration or ultrafiltration significantly increase the electrical power costs of a POTW.
- Effective and reliable NR requires equipment redundancy and equipment systems (and often more instrumentation, sophisticated controls) that are flexible to meet changing (daily or seasonal) loading conditions.
    - More in-plant laboratory analysis or online analyzers is often needed for advanced or enhanced NR.
- NR retrofits that introduce significant headloss (certain technologies) within an existing hydraulic profile (average or average and peak) require larger diameter inter-unit piping and/or intermediate lift stations.
- Regulatory enforcement can be an issue with voluntary NR programs, where the local or far-field impact of nutrients may not be well documented.
- On an annual basis, generally, wet years (higher monthly or seasonal or annual rainfall) result in higher nutrient loadings from point sources. Even with lower (influent and) effluent concentrations, the elevated flow rates result in higher loadings (pounds) discharged to the environment.

The above focuses on POTW removal of TN and/or TP from the influent wastewater. **The ultimate effectiveness of NR in a watershed should consider other factors such as sludge disposal**.

- Land application of biosolids must replace a demand for nutrients (fertilizer), otherwise a net increase in non-point nutrient runoff can occur.
- There are other potential factors or unintended impacts on nutrient release. For example, certain corrosion inhibitor chemicals used in potable water treatment and distribution can contain more phosphorus. More phosphorus in the water leads to more phosphorus in the wastewater, which requires more effective NR to achieve similar effluent quality.

And, finally, design standards and regulatory guidelines and requirements often times do not adequately address NR design and operation when NR programs are promulgated. For example, operator certification and shift coverage tables may need to be updated to consider varying degrees or NR upgrade and process complexity. Stand-by power provisions may need to also be amended to consider NR upgrade components and effluent quality requirements. The 10-States Standards – Recommended Standards for Wastewater Facilities (2004 edition, as amended) provide general wastewater pumping and treatment guidelines and requirements for design and operation. 10-States Standards document provides guidance regarding facilities related to NR:

- Screening, grit removal, flow equalization
- Settling
- Disinfection
- Supplemental systems including chemical feed and filtration
- Sludge processing

Biological treatment chapters are limited to: Trickling Filters, Activated Sludge (conventional), Wastewater Treatment Ponds, and "Other". These standards may not apply or actually be deleterious to NR performance depending upon the sizing criteria or operating mode. For example, oversized blower systems can lead to DO poisoning of NR. Also, secondary clarifier sizing criteria may need to be more conservative for NR compared to certain conventional treatment arrangements.

Many standards such as 10-States Standards and state-by-state regulations governing wastewater treatment (and biosolids) do not include sufficient information regarding BNR technologies, and do not cover innovative approaches such as nutrient recovery from sidestreams or sludge. Most if not all lack advanced or enhanced NR information or standards. And, recognizing that advanced or enhanced NR is often times involves a combination of site-specific approaches and solutions, and can rely upon emerging or developing treatment technologies (some proprietary), the approach to BNR regulations may be prescriptive (similar to the current 10-States Standards format) but ANR & ENR may need to be more performance based, relying upon the design engineer's explanation and certification. Ohio and OEPA can develop its guidelines based on guidelines developed in Chesapeake Bay watershed states, for example – however, these are often developed for grant program NR-eligibility determination (eligible size or sizing criteria by unit process) versus specific design guidance.

**The above constraints can, in many instances, be overcome, and there are often benefits of implementing NR, beyond a higher quality effluent.** For example, NR can provide additional process stability.

- An anaerobic zone acts as a selector, reducing filamentous organisms (which do not dominate in such an environment) and improving mixed liquor settleability in the secondary clarifiers. This is an example of potential, quantifiable savings associated with NR. If a plant has poorly-performing secondary clarifiers and NR improves settleability of the biomass, then less coagulant or polymer feed may be needed for the same or better effluent suspended solids quality.

- Denitrification results in an alkalinity credit (Nitrification reduces alkalinity), providing a buffering capacity to the wastewater, adding protection against pH suppression.
- If BOD is removed as part of Denitrification, less aeration in the Oxic zone is required (aeration for any remaining BOD removal required by permit, aeration for any Nitrification requirement). When properly designed and operated, removing BOD in the presence of nitrates (versus in an oxic zone with air) reduces the overall aeration demand and, specifically, the air demand at the front end of a bioreactor (guarding against periodic septic conditions if DO is suppressed during higher loading periods).
- Internal recycle or other NR plant modifications can have a net cost less than the net savings associated with (mostly) aeration (annualized), especially where IR pumping is internal to the bioreactor (low-head application).

In order to overcome the common constraints associated with NR, the following **recommendations** are offered:

- A funding mechanism for initial actions (low-hanging fruit) be identified, and OEPA and program stakeholders begin to give thought to how further actions might be funded if or when state or federal regulations or near-field water quality requires.
- Annual average wasteload caps are appropriate, weekly and monthly limits are not needed. There is plenty of precedence to monitor, control, and/or regulate both nitrogen and phosphorus on an annual basis. This will address several constraints including seasonal load variations and cold weather.
- An operator training network for NR should be established by OEPA, and can be an expansion of services by other programs and organizations.
- Because the vast majority of NR projects will be retrofits versus “green field” new plants, site-specific solutions will need to be developed (optimizing the use of existing liquid and solids treatment facilities), and this starts with a process audit and NR alternatives evaluation. Beyond funding this initiative and study, there should be a means to share knowledge of NR solutions and activities in the state, by watershed or region.

# SUBGROUP 8 SUMMARY

# CONSTRAINTS ON THE FEASIBILITY OF MEETING A LEVEL OF NUTRIENT REMOVAL (NR)

## Subgroup #8 – Summary

## Constraints on the Feasibility of Meeting a Level of Nutrient Removal (NR)

### Summary

NR often times requires changes in the treatment facilities and operations at a POTW. NR challenges can be significant and diverse. A constraint on the feasibility of meeting a level of nutrient removal is cost. The most successful NR programs include a funding mechanism that reasonably matches the costs to the benefits for the affected ratepayers. Certain existing wastewater treatment technologies are more conducive to NR retrofit than others. Effective and efficient NR requires knowledgeable operators trained in NR for their facilities, influent wastewater characteristics, and sludge disposal requirements. NR requires a holistic approach. NR design and operation must consider solids handling and plant recycle systems. Note that incremental reduction in TN and/or TP at low-low levels can actually result in a net increase in the release of greenhouse gases (GHGs). 10-States Standards and state-by-state regulations governing wastewater treatment (and biosolids) do not include sufficient information regarding BNR technologies, and do not cover innovative approaches such as nutrient recovery from sidestreams or sludge. The constraints can be overcome in many instances, and there are often benefits of implementing NR, beyond a higher quality effluent. For example, Biological NR can provide additional process stability and realize O&M savings.

# SUBGROUP 9-3A
# WHITE PAPER ON THE NEED FOR SUPPLEMENTAL POINT/URBAN SOURCE WASTEWATER OR STORMWATER NUTRIENT CONTROLS IN THE OHIO RIVER BASIN

# White Paper on the Need for Supplemental Point/Urban Source Wastewater or Stormwater Nutrient Controls in the Ohio River Basin

## What is the issue?

There is considerable evidence of nutrient-caused impairment for Western Lake Erie and some water bodies in the Lake Erie drainage basin (LEDB). Phosphorus is the suspected nutrient pollutant associated with most of these impacts. The recently-formed Nutrient Reduction Strategy workgroup has, to date, focused on immediate and long-term strategies that could reduce nutrient loadings to water bodies in the Lake Erie drainage basin. The issue is whether similar strategies should be considered and discussed for sources in the Ohio River drainage basin (ORDB), including direct dischargers to the Ohio River.

## What do we know about nutrient loads and possible effects in the ORDB?

The first task is to collate and synthesize existing information on: 1) contemporary nutrient loads in the ORDB; 2) evaluate source apportionment, to the extent possible; and 3) assess the evidence for water quality impairment and/or biological effects that have been associated with nutrient loading. In addition, since the ultimate receiving stream for all water bodies in the ORDB is the Ohio River and Ohio EPA partners with ORSANCO and other states to properly manage water quality, assessing information on this large river is prudent.

The following summarizes information on items 1-3 above based on the source of information:

1. *Ohio EPA draft 2012 integrated report*

Appendix 1 summarizes the compilation of nutrient-related aquatic life use impairments on a 12-Digit Hydrologic Unit Code (HUC12) basis for the ORDB, based on information available to the agency in 2012. Water body impairment is based on observed deviations from numeric biological criteria (i.e., exceedances of chemical-specific criteria may provide information on possible biological response, but biological performance alone is the final arbiter of aquatic life use attainment or non-attainment). A total of 414 ORDB HUC12 segments (45% of the total HUC12s assessed) are considered impaired by nutrient-related causes. In terms of the causes or sources of impairment, both non-point and point-sources have been identified. Of the total 414 segments that are considered impaired, however, not all of these require a Total Maximum Daily Load (TMDL) per CWA Section 303(d). The following table breaks down the sources of impairment for those water bodies that: 1) are impaired due to nutrient-related causes; and 2) require a TMDL that has yet to be completed and/or implemented:

**Table 1. Matrix of HUC12 water bodies in Ohio River drainage basin that are water quality-impaired (aquatic life use) and require the development of TMDL – segregated by non-point and point-source sources. NOTE: some segments are impaired by both non-point and point-sources.**

| | |
|---|---|
| No. assessed ORDB HUC12 segments | 919 |
| No. segments impaired by nutrient-related causes | 414 |
| No. segments impaired by nutrients that require TMDL development | 215 |
| No. segments nutrient-impaired that require TMDL where source of impairment is ag/non-point | 118 |
| No. segments nutrient-impaired that require TMDL where source of impairment is point-source | 147 |

The above table seems to indicate that reductions in nutrient loadings are needed in the ORDB – from both point-source and non-point source categories – for attainment of applicable water quality standards.

2. *USGS Sparrow Model outputs*

USGS's SPARROW model (Spatially Referenced Regressions on Watershed Attributes) provides spatially-explicit relationships between measured levels and loads of nutrients to sources. The model was accessed to compare the relative levels of loads of two nutrients (total nitrogen and total phosphorus) between the Lake Erie basin and ORDB. See http://water.usgs.gov/nawqa/sparrow/mrb/3.html

This was a **general, preliminary** analysis that will require additional evaluation. There are eight individual metrics that can be chosen (e.g., total accumulated nitrogen yield, total delivered nitrogen load). Appendix 2 indicates model outputs for total accumulated yield and total accumulated load. Note that the highest nutrient loadings are in dark brown, whereas the lowest nutrient loadings are in dark green. In general, these four model outputs suggest that the ORDB has a lower relative total loading of nitrogen and phosphorus compared to the Lake Erie basin. Stated another way, there are more light and dark green colored hydrological segments in the ORDB. Further evaluation of the SPARROW model inputs and parameters should be conducted to understand the accuracy and reliability of model outputs/predictions.

3. *ORSANCO monitoring data*

At most lock and dam locations, ORSANCO collects water samples for the analysis of several nutrient species (total phosphorus, ammonia-nitrogen, nitrate/nitrite, and total Kjedahl nitrogen). Appendix 3 indicates plots of these measurements at various lock and dam locations during the years 1999 – 2009. Overall and in general, there is little evidence that measured levels of any of the nutrients are consistently increasing or decreasing from a temporal standpoint. At some locations there appears to be some suggestion of an increasing trend (e.g., TKN levels at Huntington, WV), while at some locations there is a suggestion of a decreasing trend (e.g., TKN levels at Louisville, KY). Further analysis of these data would be required before any definitive conclusions can be made on temporal trends in nutrient levels.

Recommendations and data gaps

There seems to be valid reasons why cost-effective measures to reduce nutrient loadings from point-source and urban sources, in the ORDB, should be strongly considered. For example, there is clear evidence that many water body segments in the ORDB have been, and are, impaired by nutrients either directly or indirectly. The data provided in Table 1, however, show that reductions from both major source sectors (non-point and point-source) are needed.

Before specific recommendations on immediate (short-term) and long-term measures to reduce nutrient loadings are defined, there should be a careful consideration of any data gaps. The following are possible areas where additional information would be helpful to assist in making load reduction strategies based on a prioritization scheme:

- How well are municipal and industrial source waste streams characterized in terms of nutrient concentration and loads?

- What is the relative contribution of nutrient-related effects/impairment caused by stormwater? What information is available on surges in nutrient loads caused by storm events? Are there BMPs that are technically effective and cost-effective for this source?

- What are some established regulatory programs that can begin to be implemented? A formal water quality trading program now exists for the Ohio River (signed agreements between Ohio EPA, ORSANCO, and EPRI). EPRI and AEP will soon begin a pilot trade to reduce nitrogen loads in the upper Ohio River. These programs should be better publicized and encouraged.

# SUBGROUP 10

# PROGRAM OPERATIONAL FACTS – CHANGES TO WLA / TMDL

DRAFT

## Issue 10: Program Operational Facts – Changes to WLA / TMDL

**Background and Issue**

The Workgroup anticipates that new WQS for nutrients – similar to the current Ohio EPA working draft – will be implemented. When these are in place, including Trophic Index Criterion (TIC) analysis, it will be possible for the first time to determine on a weight of scientific evidence basis the water quality status of Ohio streams with respect to nutrient impacts. The TIC analysis will replace prior means of impairment determination based upon interpretation of the current narrative water quality criteria. Where the TIC indicates a stream segment impaired or threatened by nutrient enrichment, a Waste Load Allocation (WLA) would be calculated for the identified nutrient cause of impairment.

There are many nutrient WLAs in current TMDLs for Ohio watersheds which were developed following determination of nutrient-caused WQ impairment in prior 303(d) listing of non-attaining water bodies. Some of these impairment determinations may not be confirmed by a future TIC analysis. In such a circumstance, the WLA would have been developed in a TMDL for a nutrient pollutant subsequently shown not to be a cause of impairment.

The recently published Draft Nutrient Reduction Strategy Framework for Ohio Waters notes certain "program operational facts" which relate to this issue. The Framework states that "*WLAs in TMDLs can be removed only by re-doing TMDL (attaining WQS does not alleviate WLA in approved TMDL)*". If this is in fact a correct interpretation of federal law and regulation, it sets up potential for a situation where WLA(s) may exist for a nutrient TMDL which should not have been developed in the first place. A further guiding principle in the Framework states that "*we should be able to articulate what will be gained for the expenditures we request*". Clearly, the potential circumstance described would be one in which a point source would be required to expend resources to provide nutrient removal from a discharge to a stream segment that is not impaired by nutrients. Rulemaking should provide a means to avoid or correct such a circumstance.

**Recommendation**

It is recommended that some procedure should be implemented to deal with the potential circumstance of prior TMDLs for non-existing nutrient impairment.

- One possibility would be to provide a rule in OAC that would suspend a nutrient WLA from a TMDL that had been approved prior to implementation of the new nutrient WQS if a subsequent TIC analysis indicates no nutrient-caused impairment.
- Alternatively, if automatic suspension of an approved TMDL WLA is not acceptable to US EPA, then perhaps there could be provision for replacement or recalculation of the WLA in such circumstances within a prescribed (relatively short) time period.

## SUBGROUP 11

## POINT SOURCE/URBAN RUNOFF NUTRIENT WORKGROUP

## *POTWS TO PURSUE FEASIBLE LOW COST OPTIONS (LOW HANGING FRUIT) ON A FACILITY BY FACILITY BASIS*

## SubGroup 11: POTWs to pursue feasible low cost options (low hanging fruit) on a facility by facility basis

Point sources of nutrients into the aquatic ecosystem need to pursue feasible low cost options or "low hanging fruit" for reducing nutrient loads that can be accomplished in a relatively easy and low cost manner for a specific facility. It also must be understood that what is a feasible low cost option at one facility may not be a feasible low cost option at another facility. Each facility would need to individually define easy and low cost.
For some treatment facilities, making a "simple" process change may be feasible – but the sophistication and capabilities of the staff would determine what can reasonably be expected. Some plants may have someone in-house who may be able to do some research of relevant texts/ MOPs/ etc and be able to translate that into changes in their plant operation. Other facilities do not have staff capable of doing this on their own.

Potential "low hanging fruit"

1. Development of a state-wide nutrient mass balance looking at both point and non-point sources of nutrients so that cost-benefit assessments can be done and potential POTW expenditures is justified or rejected. An Urban Perspective (NACWA, 2011) was interesting: *'In a recent analysis of widespread hypoxia in the Gulf of Mexico, which drains 40% off the land mass in the US, NOAA concluded that because nutrient inputs were so highly dominated by agricultural sources, even if the highest level, tertiary, was installed at every municipal treatment plant in the basin, it would reduce nitrogen loads by only a few percent to the Gulf of Mexico with little to no effect on hypoxia*.' See page 15: http://www.nacwa.org/images/stories/public/2012-03-06wp.pdf

2. Utilization of chemical nutrient (phosphorus) removal in lieu of biological nutrient removal when it makes sense, if/when P limits are added to NPDES permits.
3. 
4. Utilization of existing tanks or retrofit of existing tanks to create anaerobic & anoxic zones to attempt to realize benefits of BNR.
5. Nutrient trading as an alternative to BNR or chemical treatment technology at POTWs.
6. Suggest Ohio EPA retain a BNR/Nutrient removal expert staff person (or team) to work with POTWs to offer operational strategies for nutrient removal implementation.
7. POTWs with Nitrification limits, which can achieve Nitrification in less tank volume than constructed. (candidate for partitioning anoxic zones within existing aerated tankage)
8. POTWs operating, at least during dry weather conditions, at significantly less than basis-of-design average flow and/or loadings (BOD, TKN). (site-by-site evaluation often identifies ways to optimize performance and yield more nutrient removal)
9. POTWs with aeration control (output to actual loadings) and air flow distribution (multiple droplegs, multiple control points through the aerated portion of the reactor). (Simultaneous Nitrification-Denitrification candidate)
10. POTWs with a concentrated sidestream (anaerobic digester supernatant, centrate, filtrate), concentrated in TP and/or TN (often Ammonia).
11. Some POTWs that have higher BOD/TKN and BOD/TP ratios in the influent (more potential nutrient removal before becoming BOD limited or needing supplemental carbon chemical feed), which could mean - so long as adequate tankage - more potential nutrient removal at lesser

O&M costs (use BOD for Nitrate removal, using aerated tankage for nitrification (vs BOD removal and Ammonia conversion to Nitrate).

12. Develop a nutrient removal clearing house in the State of Ohio.
13. Develop Wastewater Treatment Plant Operators training that to assist facilities better understand potential nutrient removal options.
14. Facilities need to appoint/develop a nutrient removal expert at each facility
15. Load management at Significant Industrial Users - often times, there is active management and enforcement of BOD, TSS, and other "conventional" parameters at SIUs (by owner, by POTW through its Industrial Pretreatment Program and Ind Sewer Use Permits). Discussions with SIUs can sometimes yield simple ways to manage the load to the POTW that can improve N or P removal (more or less BOD to result in a better combined ratio at the POTW, bleeding the load to the POTW vs "all" on the 3rd shift when domestic is lower). Equalization can be a quick fix to better balance BOD, TKN/Ammonia, TP, etc., to the POTW (combined with domestic wastewater). Water audit or nutrient management may be alternate terms to this discussion and investigation by SIU and POTW representatives.
16. Primary Activation - Volatile Fatty Acids (VFAs) are the food for phosphorus-accumulating organisms (PAOs) in Bio-P operations. They are naturally formed in most sanitary sewer systems. More can be released at the POTW, driving more "free" Bio-P. A low-cost method for those with primary clarifiers is "primary activation" (maintaining thicker sludge blankets and recycling a portion of this raw sludge through the PCs to elutriate more VFAs for downstream Bio-P.

**SUBGROUP 13/14**

**POINT SOURCE/URBAN RUNOFF NUTRIENT WORKGROUP**

# *WAYS TO TRANSFER BIOLOGICAL NUTRIENT REMOVAL (BNR) TECHNOLOGIES (AND GENERAL KNOW-HOW) TO SMALLER WASTEWATER TREATMENT FACILITIES IN OHIO*

Ohio EPA Point Source Urban Runoff Workgroup

Sub-group 13

Ways to transfer biological nutrient removal (BNR) technologies (and general know-how) to smaller wastewater treatment facilities in Ohio

Background and Objectives:

"Nutrient pollution is a major water quality problem in Ohio and throughout the nation" (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). While phosphorus, as opposed to nitrogen, is usually the more critical nutrient of concern in fresh water systems in Ohio, control of both is essential for the restoration and maintenance of intended uses for the state's waters. In Ohio, both point and non-point sources contribute to nutrient enrichment. Point source nutrient loads come primarily from municipal wastewater treatment facilities (i.e. POTWs); non-point source nutrient loads come primarily from agricultural activities. Both must be sufficiently controlled if water quality improvements are to be realized.

Ohio EPA desires to find cost-effective means to reduce the delivery of nutrients present in point source effluents and non-point source runoff (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). For many years now and in an effort to control point source effluents, Ohio EPA has included nutrient discharge limits in NPDES permits for some POTWs. Ohio EPA intends to add nutrient limits into many other NPDES permits for POTWs once more comprehensive regulatory mechanisms are in place to allow for such additions. In the interim, Ohio EPA is seeking, among other things, actions that can be taken immediately to reduce phosphorus (and nitrogen) loadings from POTWs.

Recommendations:

This workgroup's first and most important recommendation is that Ohio EPA should immediately conduct a nutrient mass-balance assessment for all of Ohio identifying percent-contribution of phosphorus and nitrogen by both point and non-point sources into waters of the state. Once this assessment has been completed and peer-reviewed and publicized, and assuming additional point source nutrient reductions are warranted and justified, and assuming adequate rules and plans are in place to realize necessary non-point source reductions so that mitigative efforts are equitable across all discharge sources, then this workgroup supports the following:

One way to attempt to immediately reduce nutrient loadings from POTWs is to promote the transfer of BNR technologies and 'know-how' to smaller facilities in Ohio. To promote this option, we offer the following recommendations:

1. Development of state-funded (or assisted) technology transfer workshop(s) and/or other training opportunities by Ohio EPA

2. Development of technology transfer email list-serve where operators and engineers can submit and respond to BNR-related inquiries, possibly coordinated through OWEA or other similar state trade group
3. Deployment of an Ohio EPA BNR expert, or team, to small POTWs state-wide to survey facilities and offer operational strategies/opportunities for BNR implementation; or endorsement by Ohio EPA of BNR experts in the private sector to offer the same services
    a. Focusing on utilization of existing tanks and/or low-cost tank retrofitting options to create proper anaerobic and anoxic zones to attempt to realize benefits of BNR; and
    b. Focusing on proper sampling and testing protocol so that results can be properly documented
4. Inclusion of compliance schedules in NPDES permits for dischargers to nutrient-impacted waters requiring feasibility assessments exploring plant conversion opportunities to BNR treatment, including financial impact scenarios; Ohio EPA might offer funding to support such assessments, or provide qualified staff to assist with studies (see #3)
5. Compilation of a list of wastewater treatment processes that are compatible with BNR, as well as a list of processes that are more difficult and/or more expensive to convert to BNR, such as single-compartment oxidation ditches; distribution of list to Ohio POTWs
6. To incentivize voluntary (pre-compliance) adoption of BNR technologies, Ohio EPA might offer NPDES permit “relief” or violation waivers for a specified period of time (i.e. 60-90 days) for POTWs attempting to incorporate BNR processes
    a. POTWs may need to submit written action plan, including sampling and analytical objectives, for Ohio EPA approval
7. Development and/or promotion of nutrient trading programs by Ohio EPA as an alternative to BNR installations, especially at small POTWs; Ohio EPA might offer incentives to non-regulated participants by approving favorable trading ratios for pre-compliance investments
8.

# SUBGROUP 14

## POINT SOURCE/URBAN RUNOFF NUTRIENT WORKGROUP

## *WAYS TO PROMOTE OPERATIONAL EXPERIMENTATION FOR NUTRIENT (PHOSPHORUS AND NITROGEN) REDUCTION AT OHIO WASTEWATER TREATMENT FACILITIES*

Ohio EPA Point Source Urban Runoff Workgroup

Sub-group 14 - DRAFT

Ways to promote operational experimentation for nutrient (phosphorus and nitrogen) reduction at Ohio wastewater treatment facilities

Background and Objectives:

"Nutrient pollution is a major water quality problem in Ohio and throughout the nation" (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). While phosphorus, as opposed to nitrogen, is usually the more critical nutrient of concern in fresh water systems in Ohio, control of both is essential for the restoration and maintenance of intended uses for the state's waters. In Ohio, both point and non-point sources contribute to nutrient enrichment. Point source nutrient loads come primarily from municipal wastewater treatment facilities (i.e. POTWs); non-point source nutrient loads come primarily from agricultural activities. Both must be sufficiently controlled if water quality improvements are to be realized.

Ohio EPA desires to find cost-effective means to reduce the delivery of nutrients present in point source effluents and non-point source runoff (Ohio's Nutrient Reduction Strategy; Ohio EPA, 2011). For many years now and in an effort to control point source effluents, Ohio EPA has included nutrient discharge limits in NPDES permits for some POTWs. Ohio EPA intends to add nutrient limits into many other NPDES permits for POTWs once more comprehensive regulatory mechanisms are in place to allow for such additions. In the interim, Ohio EPA is seeking, among other things, actions that can be taken immediately to reduce phosphorus (and nitrogen) loadings from POTWs.

Recommendations:

This workgroup's first and most important recommendation is that Ohio EPA should immediately conduct a nutrient mass-balance assessment for all of Ohio identifying percent-contribution of phosphorus and nitrogen by both point and non-point sources into waters of the state. Once this assessment has been completed and peer-reviewed and publicized, and assuming additional point source nutrient reductions are warranted and justified, and assuming adequate rules and plans are in place to realize necessary non-point source reductions so that mitigative efforts are equitable across all discharge sources, then this workgroup supports the following:

One way to attempt to immediately reduce nutrient loadings from POTWs is to promote operational experimentation for nutrient reduction at Ohio wastewater treatment facilities. Operational experimentation for nutrient reduction includes both biological nutrient removal (BNR) strategies as well as chemical treatment options. To promote this idea, we offer the following recommendations:

1. Development of state-funded (or assisted) nutrient removal workshop(s) and/or other training opportunities by Ohio EPA
    a. For example, development of BNR 101, BNR 201, etc. courses detailing "what BNR is, why do it, how to do it, plant requirements / 'prerequisites' to do it, what and how to sample to see if it is working properly, etc."

    b. Detail operational strategies/opportunities for nutrient removal treatment:
        i. Focusing on utilization of existing tanks and/or low-cost tank retrofitting options to create proper anaerobic and anoxic zones to attempt to realize benefits of BNR; and/or
        ii. Focusing on opportunities for most effective and most efficient chemical treatment options; and
        iii. Focusing on proper sampling and testing protocol so that results can be properly documented
2. Development of a nutrient reduction /BNR email list-serve where operators and engineers can submit and respond to BNR-related inquiries, possibly coordinated through OWEA or other similar state trade group
3. Ohio EPA should incentivize operational experimentation at POTWs that reduce nutrient loads now, in advance of permit-driven compliance; incentives might include:
    a. Grant support to POTWs wishing to experiment with BNR or other nutrient reduction processes to cover costs of increased sampling and analysis, so as to properly characterize wastewater streams and properly assess treatment options, and/or
    b. Grant support to POTWs wishing to experiment with BNR or other nutrient reduction processes to cover cost of treatment evaluation studies – including financial assessments of various options (capital costs, O&M costs, etc.), and/or
    c. Delaying or eliminating a "hard" permit limit in exchange for voluntary / early adoption of nutrient removal treatment, and/or
4. To incentivize voluntary (pre-compliance) adoption of nutrient removal technologies, Ohio EPA might offer NPDES permit "relief" or violation waivers for a specified period of time (i.e. 60-90 days) for POTWs attempting to incorporate nutrient removal / BNR processes
    a. Violation waivers could consist of the removal of both concentration and loading limits, or simply the removal of loading limits, for the defined experimental period for parameters likely affected by operational adjustments aimed at nutrient removal (ie. Ammonia, TSS, etc)
    b. POTWs may need to submit written action plan report, including sampling and analytical objectives, for Ohio EPA approval prior to experimentation (a standardized Ohio EPA-created report form would be helpful), and
    c. POTWs may need to submit a post-project summary report to Ohio EPA detailing successes, failures, challenges, opportunities for long-term implementation, etc., as well as compiled analytical data from project (a standardized Ohio EPA-created report form would be helpful)
5. Compilation and distribution of a list of wastewater treatment options and opportunities that are conducive to nutrient reduction processes, as well as a list of processes that are more difficult and/or more expensive to use to achieve nutrient reductions; list could include such thing as:
    a. Suggest that smaller POTWs experiment with BNR treatment during "down time", when residential flows are depressed, to see if proper treatment zones can be developed and corresponding effluent nutrient concentrations reduced during short periods of time
    b. Suggest that smaller POTWs experiment with chemical nutrient removal treatment during "down time", and attempt to do all chemical addition in one tank (if available) to limit operational variables, regulate chemical dosing, ensure chemical dispersal and saturation, control costs, and limit instrumentation needs

c. Suggest that EQ volumes are critical for enabling operational experimentation, and thus maximizing EQ is paramount for POTWs interested in (biological) nutrient reduction opportunities
d. Suggest that POTWs, if/when retrofitting existing tankage, incorporate multiple compartments or trains into tanks, so system can be operated in conventional manner or in experimental (BNR) mode, in whole or separately
e. Suggest that the conversion of large single-compartment tanks (i.e. oxidation ditches) to BNR treatment might be cost-prohibitive / operationally-challenging

6.

# Subgroup 16a
# Green Infrastructure One Pager
# Ohio EPA Urban/Point Source Nutrient Work Group

# GREEN INFRASTRUCTURE ONE PAGER
# OHIO EPA
# URBAN/POINT SOURCE NUTRIENT WORK GROUP
# 5/15/2012

---

## Polluted Stormwater Runoff

Precipitation runs across impervious surfaces, collecting a variety of pollutants as it travels before discharging into our waterways[i]. This stormwater is either drained into separate stormwater pipes or into combined sewer and stormwater pipes. Both types of systems fail to adequately protect water quality. Research shows that stormwater contains a variety of pollutants including: bacteria, metals, ***nutrients***, oil and grease, oxygen-depleting substances, pesticides, sediment, toxic chemicals, trash and debris[ii]. Combined Sewer Overflows are known to contain pathogenic bacteria, viruses, parasites, oxygen depleting substances ($BOD_5$), suspended solids, ***phosphorus, nitrogen***, cadmium, cooper, lead, zinc and trash and other debris[iii]. ***Each year over 10 billion gallons of raw and partially treated sewage flows into Lake Erie[iv].***

## Overview of Green Infrastructure[v]

Green infrastructure is a flexible, decentralized stormwater management approach that utilizes natural processes to both reduce the volume of stormwater runoff and treat stormwater. Green infrastructure can be used by implementing practices that preserve, restore or create vegetated areas and natural corridors such as, riparian buffers, green roofs, trees, rain gardens, bioswales and permeable pavement among others. These areas or practices are able to capture and infiltrate rain where it falls, thereby reducing stormwater runoff and treating pollutants. The effectiveness of stormwater best management practices (BMP's) varies by each individual BMP and by site location. ***However, data from a meta-analysis of BMP research indicates that many stormwater BMP's are able to reduce the percent of precipitation runoff by 40%-90% removing 25%-75% of total phosphorus, and removing 20%-60% of nitrogen[vi].***

## Economic Benefits of Green Infrastructure

An economic analysis of the green infrastructure (GI) program in Milwaukee, Wisconsin revealed that the current economic benefit from the existing GI is $2.2-$2.3 million a year. Extrapolating the programs' potential for the next 50 years showed that Milwaukee could receive $5.7-$8.8 billion in economic benefits from GI. The value of avoided infrastructure costs for a single year is $0.2-$1.0 million, over 50 years it is $8.0-$97.9 million. The value of avoided water treatment costs for a single year is $34,000-$40,900, over 50 years it grows to $5.6 billion. The value of improved water quality over a single year is $175-$211, over 50 years this grows to $2.8-$8.5 billion. [vii]

## Recommendations

- Eliminate State Barriers to Funding & Incentivizing Green Infrastructure Projects
- Change financing structure to incentivize GI
- Develop & Adopt Bright Green Project Ranking Criteria
- Education & Outreach
- Data Collection on Effectiveness of GI in Ohio

## FOOTNOTES

[i] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[ii] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[iii] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[iv] Environment America. (2007). "Sewage Overflow." Available at: http://cdn.publicinterestnetwork.org/assets/E7Gu4-F8VzEy8QpeEHsVWQ/Ohio.Sewage- Overflow-Report.May2007.pdf

[v] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/ ; American Rivers. "Putting Green to Work: Economic Recovery Investments for Clean and Reliable Water. Available at: http://www.americanrivers.org/library/reports-publications/putting-green-to-work-report.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[vi] Center for Watershed Protection. (2008). "Technical Memorandum: The Runoff Reduction Method." Available at: http://www.cwp.org/smrc

[vii] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/

# Subgroup 16b
# Green Infrastructure Issue Paper
# Ohio EPA
# Urban/Point Source Nutrient Work Group

# GREEN INFRASTRUCTURE ISSUE PAPER
# OHIO EPA
# URBAN/POINT SOURCE NUTRIENT WORK GROUP
# 5/15/2012

## EXECUTIVE SUMMARY

### Polluted Stormwater Runoff

Impervious surfaces (roads, driveways, rooftops, parking lots, etc.), prevent precipitation from entering the water cycle naturally by preventing precipitation from infiltrating into the ground and evaporating. As a result, precipitation runs across these impervious surfaces, collecting a variety of pollutants as it travels before discharging into our waterways[1]. This stormwater is either drained into separate stormwater pipes or into combined sewer and stormwater pipes. Both types of systems fail to adequately protect water quality.

***Each year over 10 billion gallons of raw and partially treated sewage flows into Lake Erie[2].***

Research shows that stormwater contains a variety of pollutants including: bacteria, metals, ***nutrients***, oil and grease, oxygen-depleting substances, pesticides, sediment, toxic chemicals, trash and debris[3]. Combined Sewer Overflows are known to contain pathogenic bacteria, viruses, parasites, oxygen depleting substances ($BOD_5$), suspended solids, ***phosphorus, nitrogen***, cadmium, cooper, lead, zinc and trash and other debris[4].

### Overview of Green Infrastructure[5]

Green infrastructure is a flexible, decentralized stormwater management approach that utilizes natural processes to both reduce the volume of stormwater runoff and treat stormwater. Green infrastructure can be used by implementing practices that preserve, restore or create vegetated areas and natural corridors such as conservation easements, riparian buffers, green roofs, trees, rain gardens, bioswales and permeable pavement among others. These areas or practices are able to capture and infiltrate rain where it falls, thereby reducing stormwater runoff and treating pollutants.

Green infrastructure reduces the rate, volume and pollutant load of stormwater, helps reduce the number of CSO events, helps recharge drinking water supplies, creates wildlife habitat, and improves water quality. Green infrastructure can regenerate and grow on its own, rather than degrade over time and when considering construction and operation and maintenance costs, green infrastructure can be less expensive than traditional infrastructure.

Green infrastructure works to reduce nutrients in waterways through two mechanisms, (1) reducing the amount of stormwater runoff entering stormwater and/or combined sewer/stormwater systems and (2) removing pollutants from stormwater through natural treatment mechanisms. Green infrastructure practices remove pollutants through a variety of mechanisms, including, filtering, biological uptake, adsorption, and settling. The effectiveness of stormwater best management practices (BMP's) varies by each individual BMP and by site location. ***However, data from a meta-analysis of BMP research indicates that many stormwater BMP's are able to reduce the percent of precipitation runoff by 40%-90% removing 25%-75% of total phosphorus, and removing 20%-60% of nitrogen[6].***

### Economic Benefits of Green Infrastructure

An economic analysis of the green infrastructure (GI) program in Milwaukee, Wisconsin revealed that the current economic benefit from the existing GI is $2.2-$2.3 million a year. Extrapolating the programs'

potential for the next 50 years showed that Milwaukee could receive $5.7-$8.8 billion in economic benefits from GI. The value of avoided infrastructure costs for a single year is $0.2-$1.0 million, over 50 years it is $8.0-$97.9 million. The value of avoided water treatment costs for a single year is $34,000-$40,900, over 50 years it grows to $5.6 billion. The value of improved water quality over a single year is $175-$211, over 50 years this grows to $2.8-$8.5 billion. [7]

A 2005 study of Washington DC showed that if green roofs were constructed on only 20% of buildings over 10,000 sq feet, the green roofs would create an additional 23 million gallons of storage, reduce outflows to storm sewer or combined sewer system by an average of nearly 300 million gallons per year and reduce the annual number of CSO events by 15%[8]. Additionally, implementing GI has the potential to create jobs and boost revenue. A study by American Rivers showed that covering even 1% of large building in America's medium to large sized cities with vegetated roofs could create over 190,000 jobs and provide billions in revenue to suppliers and manufacturers[9].

## Recommendations

***Eliminate State Barriers to Funding & Incentivizing Green Infrastructure Projects***
OEPA should consider conducting a comprehensive review of current policies and funding structures that may be preventing or inhibiting the utilization of green infrastructure projects by POTW's and municipalities (townships, cities, counties).

***Change financing structure to incentivize GI***
OEPA may consider evaluating and changing the current financing structures and mechanisms. Doing so could make more financing is available for GI as well as provide incentives for POTW's and municipalities (townships, cities, counties) to utilize these funding sources for the implementation of green infrastructure.

***Develop & Adopt Bright Green Project Ranking Criteria***
OEPA may consider developing a green infrastructure project evaluation process and criteria. In funding green infrastructure projects, funding should be spent in the most effective manner (i.e. funding projects that are most effective at reducing runoff and removing pollutants). It would thus, be valuable to develop criteria for prioritizing project proposals, with "bright green" projects receiving higher priority.

***Education & Outreach***
(1) Through education and outreach OEPA could actively solicit green infrastructure projects from both traditional and nontraditional partners. (2) The State could conduct education and outreach with municipalities on the issues of zoning, building codes and other land-use ordinances. This education and outreach could provide information on ordinances that restrict the implementation of GI, those that allow and incentivize the use of GI, and the variety of benefits provided by GI from improving water quality to the economic benefits. (3) The State could conduct a public awareness campaign to increase Ohioans' knowledge and understanding of what GI is and the numerous benefits it provides. The state could work with the numerous local watershed groups it supports to accomplish these activities.

***Data Collection on Effectiveness of GI in Ohio***
Currently, OEPA does not have data on the effectiveness of various stormwater BMP's at reducing precipitation runoff and removing nutrients. Data on both of these measures does exist and is included in the body of this paper. However, if OEPA believes it is valuable in having state specific data, it would be helpful to establish a data collection/monitoring program whereby OEPA could work with GI funding applicants. In doing so, OEPA could collected baseline data on runoff and nutrient loading before these new GI projects are implemented and then collect data once the project has been fully implemented.

# POLLUTED STORMWATER RUNOFF

Overview:
In the urban setting, land development contributes to the pollution of our waters. Impervious surfaces (roads, driveways, rooftops, parking lots, etc.), prevent precipitation from entering the water cycle naturally by preventing precipitation from infiltrating into the ground and evaporating. As a result, precipitation runs across these impervious surfaces, collecting a variety of pollutants as it travels before discharging into our waterways[10]. In undeveloped land, trees, vegetation and open space are able to capture precipitation and allow it to infiltrate where it falls. "Under natural conditions, the amount of rain converted to runoff is less than 10% of the rainfall volume, while roughly 50% is infiltrated and another 40% goes back into the air.[11]"

Effective stormwater management is of critical importance in reducing pollutant loading and protecting waterways. Research shows that the amount of impervious surface has a direct impact on water quality and thus, the wildlife it supports; when the level of impervious cover reaches 10% water quality in receiving waterways becomes degraded, when it reaches 25-60% nearby streams no longer perform hydrologic functions or meet habitat, water quality, or biological diversity standards, when impervious cover is greater than 60% a stream is no longer considered functioning[12].

Our existing stormwater and wastewater infrastructure is unable to adequately manage stormwater in a manner that is protective of water quality[13]. Furthermore, our water infrastructure is outdated and overextended as indicated by the D minus grade the American Society of Civil Engineers gave our drinking and wastewater infrastructure, the lowest grade of any public infrastructure[14].

Pollution:
Stormwater runoff contains a wide variety of pollutants that it collects as to flows across impervious surfaces. This stormwater is either drained into separate stormwater pipes or into combined sewer and stormwater pipes. Both types of systems fail to adequately protect water quality. This contaminated stormwater is responsible for beach closings, swimming and fishing advisories, habitat degradation and public health threats[15].

Polluted stormwater may be directly discharged into local waterways (via separate stormwater system). Research shows that stormwater contains a variety of pollutants including: bacteria, metals, ***nutrients***, oil and grease, oxygen-depleting substances, pesticides, sediment, toxic chemicals, trash and debris[16].

Stormwater also causes combined sewer overflow (CSO), which results in the discharge of sewage and numerous other pollutants. Combined sewer and stormwater systems are designed to discharge stormwater and untreated sewage directly into nearby water bodies to prevent sewage from backing up into homes and businesses. The result is polluted stormwater and untreated human, commercial and industrial waste entering our waterways[17].

CSO's pose significant environmental and public health concerns as discharges are known to contain pathogenic bacteria, viruses, parasites, oxygen depleting substances ($BOD_5$), suspended solids, ***phosphorus, nitrogen***, cadmium, cooper, lead, zinc and trash and other debris[18].

***Each year over 10 billion gallons of raw and partially treated sewage flows into Lake Erie[19].***

Green infrastructure is effective at managing stormwater runoff as it both reduces the volume of stormwater and removes a variety of pollutants. Reducing the volume of stormwater entering either stormwater systems or combined systems goes a long way in reducing the amount of pollutants entering

our waterways and is considered the most effective stormwater pollution control. This results in fewer discharges from separate systems and helps reduce the number of combined sewer overflows. Additionally, green infrastructure utilizes natural processes, which allow pollutants to be filtered or biologically or chemically degraded[20].

**For more information on polluted stormwater runoff see Appendix.*

## WHAT IS GREEN INFRASTRUCTURE (GI)

Green infrastructure is a flexible, decentralized stormwater management approach that utilizes natural processes to both reduce the volume of stormwater runoff and treat stormwater. Green infrastructure enables the environment to manage water naturally, utilizing natural processes to capture and retain stormwater and trap and absorb pollutants. Green infrastructure can be used by implementing practices that preserve, restore or create vegetated areas and natural corridors such as conservation easements, riparian buffers, green roofs, trees, rain gardens, bioswales and permeable pavement among others. These areas or practices are able to capture and infiltrate rain where it falls, thereby reducing stormwater runoff and treating pollutants. Green infrastructure is thus able to both decrease pollutants entering our waterways and decrease the strain on our wastewater infrastructure[21].

A 2005 modeling study of Washington DC found that if green roofs were constructed on 20% of buildings over 10,000 square feet, the green roofs would create an additional 23 million gallons of storage and reduce outflows to storm sewer or combined sewer systems by an average of nearly 300 million gallons per year and reduce the annual number of CSO events by 15%[22].

**For more information on types of GI see Appendix.*

## OVERVIEW OF GI BENEFITS[23]

Green Infrastructure provides a variety of environmental, economic and social benefits. Green infrastructure reduces the rate, volume and pollutant load of stormwater, helps reduce the number of CSO events, helps recharge drinking water supplies, creates wildlife habitat, and improves water quality. Green infrastructure is also flexible and decentralized, which allows it to be implemented at various scales and allows for water control on a site-specific basis. Green Infrastructure also costs less than traditional gray infrastructure and creates domestic jobs. Furthermore, green infrastructure can regenerate and grow on its own, rather than degrade over time and when considering construction and operation and maintenance costs, green infrastructure can be less expensive than traditional infrastructure.

**For more information on the benefits of GI see Appendix.*

## NUTRIENT REMOVAL PERFORMANCE OF GI[24]

In addition to decreasing pollutants by reducing the sheer volume of stormwater, green infrastructure practices are effective at removing pollutants directly from stormwater. Green infrastructure practices remove pollutants through a variety of mechanisms, including, filtering, biological uptake, adsorption, and settling. The below tables present information from the Center For Watershed Protection's technical memorandum, which provides a meta-analysis of data on a variety of stormwater BMP's effectiveness of both reducing total precipitation runoff, as well as reducing nutrient pollutant loading in stormwater runoff.

**For more information on nutrient removal performance see Appendix.*

**TABLE 1: RUNOFF REDUCTION FOR VARIOUS BMPS**

| GI Practice | Runoff Reduction (%) |
|---|---|
| Green Roof | 45-60% |
| Rooftop Disconnection | 25-50% |
| Raintanks and Cisterns | 40% |
| Permeable Pavement | 45-75% |
| Grass Channel | 10-20% |
| Bioretention | 40-80% |
| Dray Swale | 40-60% |
| Wet Swale | 0% |
| Infiltration | 50-90% |
| ED Pond | 0-15% |
| Soil Amendments | 50-75% |
| Sheetflow to Open Space | 50-75% |
| Filtering Practice | 0% |
| Constructed Wetland | 0% |
| Wed Pond | 0% |

*Source: Center for Watershed Protection. (2008). "Technical Memorandum: The Runoff Reduction Method." Available at: http://www.cwp.org/smrc

**TABLE 2: NUTRIENT REMOVAL FOR VARIOUS BMP'S**

| GI Practice | Total Phosphorus Removal % | Total Nitrogen Removal % |
|---|---|---|
| Green Roof | 0% | 0% |
| Disconnection | 0% | 0% |
| Raintanks and Cisterns | 0% | 0% |
| Permeable Pavement | 25% | 25% |
| Grass Channel | 15% | 20% |
| Bioretention | 25-50% | 40-60% |
| Dry Swale | 20-40% | 25-35% |
| Wet Swale | 20-40% | 25-35% |
| Infiltration | 25% | 15% |
| ED Pond | 15% | 10% |
| Soil Amendments | 0% | 0% |
| Sheetflow to Open Space | 0% | 0% |
| Filtering Practice | 60-65% | 30-45% |
| Constructed Wetland | 50-75% | 25-55% |
| Wet Pond | 50-75% | 30-40% |

*Source: Center for Watershed Protection. (2008). "Technical Memorandum: The Runoff Reduction Method." Available at: http://www.cwp.org/smrc
**Note: Data is based on studies that reported EMC-based nutrient removal efficiencies.
**Note: The range of values represents the median and 75th percentile pollutant removal rates.

## COST COMPARISON TO TRADITIONAL (GRAY) INFRASTRUCTURE

There is a need to invest nearly $300 billion over the next 20 years for water and wastewater infrastructure in the US, of which 63.6 billion is needed for CSO correction[25]. Green infrastructure is often more cost-effective and able to reduce CSOs and stormwater runoff at a lower cost than conventional infrastructure alternatives alone[26].

Examples:

**Kentucky-**Sanitation District 1 developed an integrated, watershed-based plan that includes green infrastructure. Officials expect this plan to save up to $800 million and to reduce bacteria and nutrient pollution relative to the gray-only plan initially developed[27].

**Philadelphia, PA-** The green infrastructure components are expected to annually reduce the CSO burden by 12.2 million gallons. Officials there estimate that an all gray approach to reducing CSOs would have cost billions more than its state-approved green infrastructure plan[28].

## FUNDING APPROACHES

Federal Funding[29]

There are a variety of avenues for public officials and government leaders to provide funding for green infrastructure projects.

- State Revolving Funds (SRF), which is typically used to help finance drinking and wastewater infrastructure.
- Department of Housing and Urban Development's Community Development Block Grant Program can be used for green development.
- Community Action for a Renewed Environment (CARE) program—funds local projects.
- Section 319 funds – to support efforts by state and local organizations to control non-point pollution sources, including green infrastructure projects.
- Targeted Watershed Grants Program –funds innovative local approaches to community-based water quality improvement.

Stormwater Utility Fees[30]

Perhaps the most common and effective tool for funding green infrastructure projects is the development of a stormwater utility district, which can raise funding to use for both traditional and green infrastructure.

A stormwater utility district may be defined as "a special assessment district that imposes a user fee to fund stormwater management." These utility districts can be formed within a town or by bringing several towns together to form a district. A stormwater utility district allows municipalities or counties to charge properties that contribute to the stormwater problem but do not have water or sewer service, such as parking lots, vacant lots, and others.

There are three basic fee structures that stormwater utilities use to calculate service fees. Impervious area is the most important factor influencing stormwater runoff and is therefore a major element in each method.

The first fee structure is called the Equivalent Residential Unit (ERU) and is used by more than 80% of all stormwater utilities. Using this method, the stormwater utility district bills the property an amount proportional to the impervious area on his or her parcel, regardless of the parcel's total area. There are some distinct advantages to this method.

The second fee structure is called Intensity of Development (ID). This stormwater cost allocation system is based on the percentage of impervious area relative to an entire property owners' parcel size. All parcels, including undeveloped parcels, are charged a fee according to this system. For developed parcels, fees are based on their intensity of development, or percentage of impervious area within the parcel. Undeveloped parcels are subject to a lower fee. Rates are calculated and billed on a sliding scale.

The third fee structure is entitled Equivalent Hydraulic Area (EHA). In this fee structure system, similar to the intensity of development system, property owners' parcels are billed on the basis of the stormwater runoff generated by his or her impervious and pervious areas. However, in the EHA system, impervious areas are charged a much higher rate than the pervious areas.

**For more information on stormwater utilities see Appendix.*

Incentives

Incentives may also be used as a part of stormwater utility district fee structures. The Philadelphia Water Department (PWD) recently transitioned its monthly stormwater management service charge from being based on the size of the water meter (reflecting volume of water used) to an impervious area-based charge for all nonresidential properties within city limits. As a part of their new fee structure, the PWD provides an opportunity for properties owners to claim credits and reduce their fees if they retrofit their parcels to manage runoff on-site[31]. In order to make incentive programs work, they need to be geared toward key motivating factors for developers and property owners. The key motivating factors for developers include revenue increases, cost reductions, streamlined permitting and inspection processes, and reduced risk[32]. Key factors that motivate action for property owners and the general public, on the other hand, are cash rebates, discounts, tax credits, and small community grants[33].

Other Funding/Fees

In addition to seeking to tap into these federal sources of funding, cities or counties may institute charges or fees to offset green infrastructure and stormwater management costs. These fees may include: (1) development fees, (2) drinking water/waste water fees, (3) impact/facility fees, and (4) permit and inspection fees[34]. One very creative fee system was established in San Mateo County, California, where local officials instituted a vehicle registration fee to address stormwater pollution issues associated with vehicles and transportation infrastructure[35].

## ECONOMIC BENEFITS OF GI

Covering even 1% of large buildings in America's medium to large sized cities with vegetated roofs could create over 190,000 jobs and provide billions in revenue to suppliers and manufacturers that produce or distribute green-roof related materials[36].

Table 2, below, provides a summary of existing green infrastructure projects and their benefits in the Milwaukee Wisconsin area partially or fully funded by the Milwaukee Metropolitan Sewerage District (MMSD).

**For more information on the economic benefits of GI see Appendix.*

**Table 3. Summary of MMSD's Existing Green Infrastructure Projects**

| Project Type | Quantity | Units | Recharge Obtained (gallons/year) | TSS Removed (lbs./year) |
|---|---|---|---|---|
| Wetlands | 0.03 – 0.04 | Acres | 22,500 – 30,000 | 32 – 43 |
| Porous Pavement | 4 – 4.8 | Acres | 2.8 – 3.4 million | 3,794 – 4,553 |
| Rain Barrels | 17,000 – 20,400 | 55-gallon barrels | 20.1 – 24.1 million | 14,478 – 17,374 |
| Cisterns | 13 – 16 | 6,350-gallon cisterns | 1.8 – 2.2 million | 1,278 – 1,573 |
| Green Alley/Street | 1.4 – 1.7 | Acres | 1.0 – 1.2 million | 1,327 – 1,612 |
| Bioswale | 202,605 – 243,125 | Square Feet | 2.6 – 3.1 million | 2,823 – 3,388 |
| Rain Gardens | 25,163 – 30,195 | Square Feet | 0.4 – 0.5 million | 477 – 570 |
| Green Roof | 309,695 – 371,635 | Square Feet | 4.0 – 4.8 million | 4,316 – 5,179 |
| Totals | N/A | N/A | 32.7 – 39.3 million | 28,500 – 34,300 |

*Source: Sands, Karen. 2011. Manager of Sustainability, MMSD. Personal Communication. August 31; MMSD. 2011. H20Capture Tool. Retrieved on August 31, 2011 from http://www.h2ocapture.com/Calculate.aspx

**Notes: Given the limited scope of projects and programs in our discussion, the lower bound quantities likely under represent the total amount of green infrastructure in the area. Assuming the data under-represent existing projects, we have generated a range of values; the upper limit is calculated by multiplying the lower value by 1.2.

Table 3, below, outlines the current and projected economic benefits from green infrastructure projects in the Milwaukee area.

**Table 4. Summary of Benefits from Existing and Potential Green Infrastructure Projects in the Milwaukee Area**

| | Existing ($/year) | Potential (50-year Net Present Value) |
|---|---|---|
| Value of Avoided Infrastructure Costs | $0.2 - $1.0 million | $8.0 - $97.9 million |
| Value of Avoided Water Treatment Costs | $34,000 - $40,900 | $5.6 billion |
| Value of Improved Water Quality | $175 - $211 | $2.8 - $8.5 billion |
| Reduced Flooding | Not Quantified | Not Quantified |
| Total Value of Energy Savings | $17,100 - $20,500 | $37.6 - $47.0 million |
| Total Value of Improved Air Quality from Trees and Green Roofs | $1,200 - $2,200 | $9.8 - $12.3 million |
| Total Value of Improved Air Quality from Emissions Reduction | $8,500 - $10,200 | $17.8 - $22.7 million |
| Total Value of Carbon Absorption | $300 - $1,800 | $7.7 - $103.4 million |
| Total Value of Reduced Carbon Emissions | $2,900 - $18,000 | $6.2 - $86.0 million |
| Heat Island Effect | Not Quantified | Not Quantified |
| Community Livability | Not Quantified | Not Quantified |
| Value Derived from Wetland Habitat | $2.2 million | $58.3 million |
| Public Education Benefits | Not Quantified | Not Quantified |
| **Total** | $2.2 - $2.3 million | $5.7 - $8.8 billion |

*Source: ECONorthwest with data from previous tables.
**Notes: To sum the benefits, we did not combine the three quantified water-related benefits in the first three rows of the table. Rather, we used the full range of potential benefits across the three benefit categories.

## RECOMMENDATIONS

Eliminate State Barriers to Funding & Incentivizing Green Infrastructure Projects
OEPA should consider conducting a comprehensive review of current policies and funding structures that may be preventing or inhibiting the utilization of green infrastructure projects by POTW's and municipalities (townships, cities, counties).

Change financing structure to incentivize GI
OEPA may consider evaluating and changing the current financing structures and mechanisms. Doing so could make more financing is available for GI as well as provide incentives for POTW's and

municipalities (townships, cities, counties) to utilize these funding sources for the implementation of green infrastructure.

Develop & Adopt Bright Green Project Ranking Criteria

OEPA may consider developing a green infrastructure project evaluation process and criteria. In funding green infrastructure projects, funding should be spent in the most effective manner (i.e. funding projects that are most effective at reducing runoff and removing pollutants). It would thus, be valuable to develop criteria for prioritizing project proposals, with "bright green" projects receiving higher priority.

Education & Outreach

(1) Through education and outreach OEPA could actively solicit green infrastructure projects from both traditional and nontraditional partners. (2) The State could conduct education and outreach with municipalities on the issues of zoning, building codes and other land-use ordinances. This education and outreach could provide information on ordinances that restrict the implementation of GI, those that allow and incentivize the use of GI, and the variety of benefits provided by GI from improving water quality to the economic benefits. (3) The State could conduct a public awareness campaign to increase Ohioans' knowledge and understanding of what GI is and the numerous benefits it provides. The state could work with the numerous local watershed groups it supports to accomplish these activities.

Data Collection on Effectiveness of GI in Ohio

Currently, OEPA does not have data on the effectiveness of various stormwater BMP's at reducing precipitation runoff and removing nutrients. Data on both of these measures does exist and is included in the body of this paper. However, if OEPA believes it is valuable in having state specific data, it would be helpful to establish a data collection/monitoring program whereby OEPA could work with GI funding applicants. In doing so, OEPA could collected baseline data on runoff and nutrient loading before these new GI projects are implemented and then collect data once the project has been fully implemented.

## APPENDIX

### POLLUTED STORMWATER RUNOFF

Each year rain and snowfall in urban settings across the US leads to billions of gallons of stormwater and CSOs. Approximately 850 billion gallons of untreated sewage and stormwater is discharged into waterways nationally each year[37]. Developed land has increased significantly; from 1982-2007 developed land increased by 56%. Furthermore, if this trend continues the US will see an increase in 68 million acres of developed land by 2025[38].

In areas with combined sewer and stormwater systems, storm events both large and small (as little as 0.2 inches in DC can trigger a CSO), have the ability to overwhelm the system with more stormwater than the system is able to hold[39]. Estimates indicate that CSO discharges are comprised of 15-20% sewage and 80-85% of stormwater[40]. In separate stormwater systems, while only stormwater is collected, transmitted and later discharged, the stormwater receives little to no treatment. However, the stormwater is still heavily polluted as it collects a variety of contaminates as it flows across the urban environment[41].

### TYPES OF GREEN INFRASTRUCTURE

Green Roofs[42]

A rooftop that is partially or completely covered with vegetation over a waterproof membrane. It may also contain additional layers such as a root barrier and drainage or irrigation systems. Green roofs capture, absorb, store, and later evapotranspire precipitation. Green roofs thus, reduce both the rate and quantity of stormwater runoff. Green roofs both reduce the quantity of stormwater directly entering waterways as well as sewer systems and thus, help decrease the risk of a CSO event. Additionally, green roofs, reduce the urban heat island effect, reduce energy costs for heating and cooling, increase the longevity of roofing materials, provide habitat for birds and wildlife and increase rent or property value of units with views or access.

Tree Planting[43]

Trees provide many services that have ecological, economic and social impacts. Trees intercept rainfall, assist with infiltration and the ability of soil to store water, and by transpiration through leaves minimize soil moisture which helps reduce runoff. Additionally, trees reduces the urban heat island effect, provide habitat for birds and wildlife, reduce energy costs for heating and cooling and improves air quality.

Bioretention & Infiltration Practices[44]

There are a variety of bioretention and infiltration practices including rain gardens, bioswales and wetlands. Bioretention utilizes soils and both woody and herbaceous plants to remove pollutants from stormwater runoff. Runoff is temporarily stored and released over a period of four days to the receiving water.

Rain Gardens are created at the bottom of a slope in order to collect water from a roof downspout or adjacent impervious surface. Bioswales are usually installed within or next to paved areas like parking lots or along roads and sidewalks. They allow water to pool for a period of time and then drain, and allow for overflow into a sewer system. Bioswales effectively trap silt and other pollutants.

Rain Gardens[45]

A rain garden consists of native perennial plants, which slow down stormwater runoff from impervious surfaces and allow it to infiltrate back into the soil. Rain Gardens filter silt, pollutants and debris, reduce the rate and quantity of stormwater entering the sewer system, recharges ground water, can help reduce localized flooding and provides habitat for birds and wildlife.

Permeable Pavement[46]

Permeable pavements come in several forms: permeable asphalt, permeable concrete, and permeable pavers. Permeable pavement has pores that allow water to infiltrate through the surface and be absorbed and infiltrated by the underlying soil, on site. Can be used in combination with subsurface drainage systems in areas with soils that do not drain freely. Permeable pavement both reduces surface runoff volumes and rates.

Naturalized Detention[47]

Naturalize detention is designed to look and function as a native wetland. It temporarily stores stormwater onside and slowly releases it at a controlled rate. These areas utilize native plants growing both above and below the normal water level. Naturalized dentition areas reduce both the rate and quantity of runoff, filter silt, pollutants and debris, reduces erosion of pond edges, provides habitat for birds and wildlife and provides an attractive amenity.

Bioswales and Vegetated Swales[48]

A bioswale or vegetated swale is a broad, shallow trench or channel with dense native plant vegetation covering both the side slopes and the bottom. Bioswales and vegetated swales are designed to reduce the flow and velocity of surface runoff, allow stormwater to infiltrate back into the ground and trap particulate pollutants. Swales reduce both the rate and quantity of stormwater, filter silt, pollutants and debris, recharges ground water, reduces storm sewer piping and structures, can reduce detention requirements, provides opportunity for wildlife habitat. Swales can be used in place of curbs, gutters and additional storm sewer systems.

## NON- WATER QUALITY BENEFITS PROVIDED BY GREEN INFRASTRUCTURE[49]

Improved Air Quality:
Trees and plants literally filter the air, capturing pollution (including dust, ozone, and carbon monoxide) in their leaves and on their surfaces. In 1994, trees in New York City removed an estimated 1,821 metric tons of air pollution at an estimated value to society of $9.5 million.

Lower Air Temperature:
Trees and plants cool the air through evapotranspiration, the return of moisture to the air through evaporation from soil and transpiration by plants. The shade provided by trees also reduces air temperatures and buildings' energy use. The cooling savings from trees range from 7% to 47%.

Reduced Urban Heat Island Effect:
An urban heat island is a metropolitan area that is significantly warmer than the surrounding suburban and rural areas due to its large amount of impervious surfaces. Green roofs and lighter colored surfaces in urban areas reflect more sunlight and absorb less heat, significantly reducing the heat island effect.

Reduced Energy Use:
Additional insulation provided by the growing media of a green roof can reduce a building's energy consumption by providing superior insulation compared with conventional roofing materials. When properly placed, trees provide shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings. In warm water, this can reduce the energy needed for air-conditioning. Trees reduce wind speeds, which can have a significant impact on the energy needed for heating, especially in areas with cold winters.

Conservation of Water:
Green infrastructure crates organic matter on the soil surface, and tree and plant roots increase soil permeability, resulting in reduced surface runoff, reduced soil erosion, less sedimentation of streams, and increased groundwater recharge.

## NUTRIENT REMOVAL PERFORMANCE OF GI[50]

North Carolina's Department of Environment and Natural Resources, Stormwater BMP Manual provides information on various stormwater BMP's effectiveness in nutrient removal, as well as information on construction and maintenance costs, community acceptance and creation of wildlife habitat. A categorization of North Carolina's BMP's by removal mechanism is provided in Table 1. The nutrient removal performance data of these various BMP's is provided in Table 2. Table 3 provides information relative to each BMP"s costs, and community and environmental issues.

**TABLE 1: BMPS CATEGORIZED BY REMOVAL MECHANISM**

| Removal Mechanism | BMPs |
|---|---|
| Detention/Retention | Dry Extended Detention Basin<br>Wet Detention Basin<br>Stormwater Wetlands |
| Filtration | Sand Filters<br>Bioretention |
| Infiltration | Infiltration Devices<br>Porous Pavement |
| Natural Conveyance | Filter Strip<br>Grassed Swale<br>Restored Riparian Buffer |

*Source: North Carolina Department of Environment and Natural Resources, Division of Water Quality, Stormwater BMP Manual, Chapter 3, pg. 21. Available at: http://portal.ncdenr.org/web/wq/ws/su/bmp-manual

**TABLE 1: BMPS POLLUTION REMOVAL PERFORMANCE**

| | TP Removal Efficiency | TN Removal Efficiency | TSS Removal Efficiency | Fecal Removal Ability |
|---|---|---|---|---|
| Bioretention without IWS | 45% | 35% | 85% | High |
| Bioretention with IWS (Costal Counties) | 60% | 60% | 85% | High |
| Bioretention with IWS (Non-Coastal Counties) | 45% | 40% | 85% | High |
| Stormwater Wetlands | 40% | 40% | 85% | Med. |
| Wet detention basin | 40% | 25% | 85% | Med. |
| Sand Filter | 45% | 35% | 85% | High |
| Filter Strip | 35% | 20% | 25-40% | Med. |
| Grassed Swale | 20% | 20% | 35% | Low |
| Restored Riparian Buffer | 35% | 30% | 60% | Med. |
| Infiltration Devices | 35% | 30% | 85% | High |
| Dry Extended Detention basin | 10% | 10% | 50% | Med. |
| Permeable pavement System | 0% | 0% | 0% | Low |
| Rooftop Runoff Management | 0% | 0% | 0% | Low |

*Source: North Carolina Department of Environment and Natural Resources, Division of Water Quality, Stormwater BMP Manual, Chapter 4, pg. 4. Available at: http://portal.ncdenr.org/web/wq/ws/su/bmp-manual

**TP = Total Phosphorus; TN = Total Nitrogen; TSS = Total Suspended Solids

**TABLE 3: BMP COSTS, COMMUNITY ACCEPTANCE, WILDLIFE HABITAT**

| | Construction Cost | Maintenance Level | Community Acceptance | Wildlife Habitat |
|---|---|---|---|---|
| Bioretention | Med-High | Med-High | Med-High | Med |
| Stormwater Wetlands | Med | Med | Med | High |
| Wet Detention Basin | Med | Med | Med | Med |
| Sand Filter | High | High | Med | Low |
| Filter Strip | Low | Low | High | Med |
| Grassed Swale | Low | Low | High | Low |
| Restored Riparian Buffer | Med | Low | High | Med-High |
| Infiltration Devices | Med-High | Med | Med-High | Low |
| Dry Extended Detention Basin | Low | Low-Med | Med | Low |
| Permeable Pavement system | Med-High | High | Med | N/A |
| Rooftop Runoff Management | Med | Med | High | Low |

*Source: North Carolina Department of Environment and Natural Resources, Division of Water Quality, Stormwater BMP Manual, Chapter 4, pg. 4. Available at: http://portal.ncdenr.org/web/wq/ws/su/bmp-manual
**Note: Evaluation based on comparison with other BMP's, not traditional gray infrastructure.

## FUNDING APPROACHES – STORMWATER UTILITIES

The major steps involved in starting a stormwater utility include developing a feasibility study, create a billing system, rolling out a public information program, adopting an ordinance, creating a credit or exemption portion of the program, and implementing the utility[51]. It takes at least one champion, often the mayor or another senior local official, to create a stormwater utility, especially in the face of local political opposition.

In order to make a stormwater utility successful, it is important to explain the benefit of the new assessment to the press and the public. Opposition from local news outlets sometimes can turn public opinion against the utility, often by using inaccurate terms such as "rain tax." When clearly informed of the financial and environmental benefits of a stormwater utility –such as improved flood control, fishing, recreation, and enhancement of future drinking water supplies through increased recharge— the community will be more likely to support its implementation[52].

ERU Fee[53]

First, because there is a direct relationship or nexus between impervious area and stormwater impact, it is relatively easy to explain to the public as "you pave, you pay." Additionally, it is a relatively simple and less time consuming method because the number of billable ERUs can be determined by limiting the parcel area review to impervious surface only. The major disadvantage to this method is that stormwater runoff from the pervious area of a property owner's parcel is not reviewed. As a result, this method sometimes is considered to be less equitable than the other two methods, which will be discussed below.

ID Fee[54]

The main advantage of this method is that it accounts for stormwater from impervious and pervious sections of the parcel and is, therefore, considered to be more equitable than the ERU method mentioned above. The main disadvantages of this method are that the "intensity of development" categories are broad, the method is more difficult to explain to the public than the ERU method, and that it might discourage urban infill and inadvertently encourage sprawl.

EHA Fee[55]

The main advantage of this method is that it accounts for pervious portions of the parcel (like the ID method), but is fairer than the ID method because parcels are billed on the basis of individual measurements of pervious and impervious surfaces rather than a scale. The most prominent disadvantages are that this approach requires more time to take individual measurements and that it is more complicated to explain to customers than ERU method.

## ECONOMIC BENEFITS OF GI[56]

Table 1, below, outlines the economic benefits provided by wetlands and the variety of services that they provide.

**Table 1. Value of Services Provided by Wetland Habitat ($/Acre/Year)**

| Single Service Wetland Type | Mean Value | Range of Values |
|---|---|---|
| Flood | $645 | $146-$2,865 |
| Water Quality | $684 | $207-$2,260 |
| Water Quantity | $208 | $10-$4,216 |
| Recreational Fishing | $585 | $156-$2,201 |
| Commercial Fishing | $1,276 | $177-$9,214 |
| Bird Watching | $1,988 | $866-$4,562 |
| Amenity | $5 | $2-$23 |
| Habitat | $502 | $156-$1,609 |
| Storm | $389 | $389-$8,433 |

*Source: Woodward, R., and Y. Wui. 2001. "The Economic Value of Wetland Services: A Meta-Analysis". *Ecological Economics.* 37: 257-270.

## FOOTNOTES

[1] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[2] Environment America. (2007). "Sewage Overflow." Available at: http://cdn.publicinterestnetwork.org/assets/E7Gu4-F8VzEy8QpeEHsVWQ/Ohio.Sewage- Overflow-Report.May2007.pdf

[3] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[4] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[5] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/ ; American Rivers. "Putting Green to Work: Economic Recovery Investments for Clean and Reliable Water. Available at: http://www.americanrivers.org/library/reports-publications/putting-green-to-work-report.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[6] Center for Watershed Protection. (2008). "Technical Memorandum: The Runoff Reduction Method." Available at: http://www.cwp.org/smrc

[7] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/

[8] US EPA. (2008). "Green Roofs." Available at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=114

[9] American Rivers. "Putting Green to Work: Economic Recovery Investments for Clean and Reliable Water. Available at: http://www.americanrivers.org/library/reports-publications/putting-green-to-work-report.html

[10] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[11] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." p. 7. Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[12] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[13] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[14] American Society of Civil Engineers. (2009). "Report Card for America's Infrastructure." Available at: http://www.infrastructurereportcard.org/sites/default/files/RC2009_full_report.pdf

[15] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[16] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[17] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[18] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[19] Environment America. (2007). "Sewage Overflow." Available at: http://cdn.publicinterestnetwork.org/assets/E7Gu4-F8VzEy8QpeEHsVWQ/Ohio.Sewage- Overflow-Report.May2007.pdf

[20] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[21] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/ ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[22] US EPA. (2008). "Green Roofs." Available at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=114

[23] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/ ; American Rivers. "Putting Green to Work: Economic Recovery Investments for Clean and Reliable Water. Available at: http://www.americanrivers.org/library/reports-publications/putting-green-to-work-report.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[24] Center for Watershed Protection. (2008). "Technical Memorandum: The Runoff Reduction Method." Available at: http://www.cwp.org/smrc ; Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[25] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[26] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[27] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[28] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[29] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[30] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[31] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[32] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[33] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[34] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[35] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[36] American Rivers. "Putting Green to Work: Economic Recovery Investments for Clean and Reliable Water. Available at: http://www.americanrivers.org/library/reports-publications/putting-green-to-work-report.html

[37] Environment America. (2007). "Sewage Overflow." Available at: http://cdn.publicinterestnetwork.org/assets/E7Gu4-F8VzEy8QpeEHsVWQ/Ohio.Sewage- Overflow-Report.May2007.pdf

[38] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[39] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[40] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[41] Natural Resources Defense Council. (2006). "Rooftops to Rivers: Green strategies for controlling stormwater and combined sewer overflows." Available at: http://www.nrdc.org/water/pollution/rooftops/contents.asp

[42] Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/ ; US EPA. (2008). "Green Roofs." Available at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=114

[43] Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[44] US EPA. (1999). "Storm Water Technology Fact Sheet: Bioretention." Available at: http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_biortn.pdf ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[45] Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html

[46] Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html ; Center for Neighborhood Technology. (2010). "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental and Social Benefits." Available at: http://www.cnt.org/news/2011/01/21/new-guide-helps-municipalities-monetize-the-value-of-green-infrastructure-2/

[47] Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html

[48] US EPA. (1999). "Stormwater Technology Fact Sheet: Vegetated Swales." Available at: http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_vegswale.pdf ; Chicago Department of Transportation. (2011). "The Chicago Green Alley Handbook: An Action Guide to Create a Greener, Environmentally Sustainable Chicago." Available at: http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html

[49] Natural Resources Defense Council. (2011). "Rooftops to Rivers II: Green strategies for controlling stormwater and combined sewer overflow." Available at: http://www.nrdc.org/water/pollution/rooftopsii/

[50] North Carolina Department of Environment and Natural Resources, Division of Water Quality, Stormwater BMP Manual, Chapter 4, pg. 4. Available at: http://portal.ncdenr.org/web/wq/ws/su/bmp-manual

[51] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[52] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[53] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[54] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[55] US EPA. (2009). "Funding Stormwater Programs." Available at: http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

[56] ECONorthwest. (2012). "Economic Benefits of Green Infrastructure: Great Lakes Region." Available at: http://www.econw.com/our-work/publications/economic-benefits-of-green-infrastructure-in-the-great-lakes-region/

# SUBGROUP 20
# OHIO EPA
# POINT SOURCE PHOSPHORUS LOADS

**Point Source Phosphorus Loads**

We have appreciated the opportunity to participate in the Point Source/Urban Nutrient Workgroup. While the lawn care category does not represent a point source, the industry has been involved in multiple urban nutrient workgroups pertaining to phosphorus loads in Ohio waters. The Ohio Lake Erie Phosphorus Task Force final report concluded most products used for lawn care have relatively low phosphorus levels and runoff potential varies based on management practices. Although local runoff potential can have impacts, overall lawn fertilizer contributions to algal blooms are not significant. Minimized runoff potential is attainable by reducing phosphorus content, improved application devices, and better package labeling.

Waste water solids removed in the treatment process (biosolids) have nutrient value and are often offered as fertilizer materials which could have limited turf applications. The lawn care industry supports practices and policies that encourage the sale and use of phosphorus-free turf maintenance fertilizers while retaining the availability of phosphorus containing turf fertilizers for use when establishing new turf or when correcting a soil deficiency, as pursuant to The Ohio State University Extension Service recommendations. This applies to all forms of phosphorus regardless of the source.

**Gina Zirkle**
Scientist, Environmental Stewardship
The Scotts Miracle-Gro Company
14111 Scottslawn Rd.
Marysville, Oh 43041
office: 937-578-5009
cell: 937-309-5998
fax: 937-578-5771

# Attachment C - Recommendations and Comments Submitted by Interested Parties

OPARR
Your Resource for Pesticide and Fertilizer Information
Ohio Professional Applicators for Responsible Regulation

Ohio Environmental Protection Agency (OEPA)
Lazarus Government Center
50 W. Town St., Suite 700
Columbus, Ohio 43215

July 26, 2012

On behalf of the Ohio Professional Applicators for Responsible Regulation "OPARR", and our member association, the Ohio Lawn Care Association, thank you for the opportunity to provide interested party comments and recommendations to the "Ohio EPA Point Source and Urban Runoff Nutrient Work Group Draft; Final Report and Recommendations".

By way of introduction, OPARR is an alliance of associations, businesses, and individuals from lawn care, pest management, golf course, tree service, grounds management, landscaping, parks and recreation, and related industries. OPARR members are manufacturers, distributors, and applicators of pest management, fertilizer, weed control, and related environmental products who are dedicated to the responsible use of these materials in communities throughout Ohio. The materials used by OPARR members have resulting in healthier and more pleasant and productive lives and the protection and conservation of our environmental resources. OPARR is committed to working in cooperation with federal, state, and local government officials, and other environmentally-concerned organizations to ensure effective use of agricultural, turfgrass and tree care products in an environmentally sound manner. Among our association members is the Ohio Lawn Care Association (OLCA). Thus, we hope you will accept these comments on behalf of both OPARR and OLCA.

OPARR and OLCA have appreciated the opportunity to participate in the Point Source/Urban Nutrient Workgroup. Specifically, Jeff Bisker, President of Your Lawn, Inc., and current legislative committee chairman of OLCA, has appreciated the invitation to participate in the meetings and a "seat at the table". Jeff and others in our association have been involved in multiple urban nutrient workgroups pertaining to phosphorus loads in Ohio waters. Per our previous communications, we would like to see the final "Report and Recommendations" include the following paragraphs.

While the lawn care category does not represent a "point source" the industry participated in the work group. As discussed in the meetings, it is noteworthy that the Ohio Lake Erie Phosphorus Task Force final report concluded that most products used for lawn care have relatively low phosphorus levels and runoff potential varies based on management practices. Although local runoff potential can have occasional impacts, overall lawn fertilizer contributions to algal blooms are not significant.

Minimized runoff potential is attainable by reducing phosphorus content, improved application devices, and better package labeling.

Ohio Professional Applicators for Responsible Regulation
Belinda Jones, Executive Director • bjones@capitol-consulting.net • 614.224.3855
c/o Capitol Consulting Group • 37 W. Broad St., Suite 820, Columbus, OH 43215

Waste water solids removed in the treatment process (biosolids) have nutrient value and are often offered as fertilizer materials which could have limited turf applications. The lawn care industry supports practices that encourage the sale and use of phosphorus-free turf maintenance fertilizers while retaining the availability of phosphorus containing turf fertilizers for use when establishing new turf or when correcting a soil deficiency, as pursuant to The Ohio State University Extension Service recommendations. This applies to all forms of phosphorus regardless of the source.

We hope that you will allow OLCA and OPARR to serve as a resource for you as Ohio continues down the important path of improving our water quality.

Respectfully,

Belinda Jones
Executive Director, OPARR

Ohio Professional Applicators for Responsible Regulation
Belinda Jones, Executive Director • bjones@capitol-consulting.net • 614.224.3855
c/o Capitol Consulting Group • 37 W. Broad St., Suite 820, Columbus, OH 43215