John Snyder

Attachment B

COMMENTS OF THE CHESTER COUNTY ECONOMIC DEVELOPMENT COUNCIL ON THE PROPOSED CHAPTER 102 REGULATIONS

For fifty years, the Chester County Economic Development Council (CCEDC) has been the private, non-profit agency dedicated to the enhancement of Chester County's economic balance and the preservation of the County's quality of life. It has been instrumental in attracting new businesses and has succeeded in creating more than 50,000 jobs in the County. The eastern portion of the County is home to the high tech 202 Corridor as well as many successful business parks, shopping areas and corporate headquarters.

However, virtually the entire eastern third of the County is also home to exceptional value (EV) and high quality (HQ) watersheds. We are proud of the ability of the County and the companies who are located here to be able to balance the preservation and protection of these watersheds with the needs of a productive and vibrant community. We take our quality of life seriously.

It is in this vein that we have monitored the proposed Chapter 102 Storm Water Regulations. CCEDC has sponsored seminars and informational sessions to inform the members of the business community in the County regarding the contents of the proposed regulations. Many of our members have provided comments to the IRRC and the DEP during the course of the process. We have also been in contact with the professional organizations of those directly in the storm water design and implementation businesses to gain their insight and assessment of the proposals and to pass that information on to the County's business interests. Our main purpose has been to inform.

With the advent of the proposed final regulations, the CCEDC has decided to provide to the IRRC with its comments. We find a number of items in the proposed regulations to be counter productive and ill-conceived.

If one starts with the statutory scheme, one major flaw of the regulations becomes apparent. The applicable federal and Commonwealth Clean Water Acts mandate the prevention of degradation of waters. Special emphasis has been placed on protection of those streams yielding the highest quality, the EV and HQ streams. It is the duty of any proposed development to avoid the degradation of any such stream. The Environmental Hearing Board has held that "compliance with Chapter 102 regulations regarding erosion and sedimentation control does not automatically constitute compliance with the antidegradation requirements. Blue Mountain Preservation Association, 2006 EHB at 613." Crum Creek Neighbors v. Commonwealth of Pennsylvania, Department of Environmental Protection and Pulte Homes of PA, LP, 2009 EHB (# 2007-287-L). The statutory charge is to prevent degradation, even if adherence to the regulations would not achieve that goal.

We believe that the fixed criteria in the proposed Chapter 102 regulations are counter productive to assuring storm water designs that avoid degradation. The job of avoiding degradation begins with understanding the stream, its marine life and its flows. To avoid degradation storm water management has to be designed from the stream back and not from the development down. That means using actual conditions as a starting point. The problem with the proposed Chapter 102 regulations is that they once again establish fixed, paint-by-the-numbers requirements that do not address the individual requirements of the stream and its environment. It is the same "checking of the boxes on a form" design that was chastised by the EHB in the Crum Creek case.

The adherence to regulations that do not achieve the requirements of the statutes is an expensive proposition. Time and money is wasted analyzing properties on the basis of fictional but required presumptions, such as the requirement that 20% of an impervious site must be considered to have a pre-redevelopment condition of meadow. An assumption such as this disregards the fact that degradation can occur from changes in stream flows. Both over design of storm water facilities and the institution of BMPs that can increase evapotranspiration (like forested buffers) around low flow, ground water dependent streams and decrease ground water, can actually degrade the stream.

The experts in design tell our members that each stream has to be approached from the stream up, based on the actual existing conditions, to be able to design a non-degrading storm water management system for that property. The imposition of fixed fictitious formulae and mandatory BMPs (like the 150 foot buffer would be), result in the obligation to create both a permitting design set of calculations to meet the "checking of the boxes" requirements and another factually based design set of calculations to determine whether the permit is defendable as non-degrading. The supposed clarity of the fixed regulatory requirements is illusory since adherence to the regulations does not insure adherence to the statutes. In order to get a NPDES permit from the Department one may have to use a regulation mandated design that is not defendable on appeal.

Our members are tremendously concerned by the fixed 150 foot, non-flexible buffer. As stated above and as noted by the EHB in the Crum Creek case, some of that concern comes from the fact that the implementation of a 150 foot forested buffer may actually lower ground water levels or flow and degrade the stream. This is a particular concern in the case of low flow or intermittent streams dependent on ground water flow.

Another concern is the overly broad mandated width of the proposed buffers and its effect on commercial and industrial sites. Many existing corporate site stand to lose areas planned for expansion. For example the Aegon site on Route 202 in Frazer has developed three of its four corporate headquarters building. They are located with a center court yard which contains a lake, created as an aesthetic feature for its campus. It is located with 100 feet of the existing buildings and the proposed location of the fourth building. That last building will now be lost to the 150 foot buffer, notwithstanding that the lake is manmade, since, like all of the 202 Corridor, the Aegon campus is in a special protection watershed. Companies like Aegon will face the problem of moving, potentially out of state, when it needs the additional space.

When the causes of sprawl are examined, they all come down to utilizing more property than is necessary for land uses, whether commercial, industrial or residential. There is only one way that the implementation of the 150 foot buffer will not result in sprawl. That is if the buffer makes development in Pennsylvania so expensive or land intensive to discourage employers from moving into Pennsylvania or from staying in Pennsylvania when they out grow their existing facilities. In any other scenario, the same amount of development will simply take more ground in multiple locations to accommodate the need. That will mean more infrastructure and infrastructure cost to reach the extra sites. It will mean more expense to the developer. It will mean that each property will have a lower yield and therefore be less valuable to the current landowner. That in turn means that the property will have a lower assessed value and will, at the same taxing rate, yield less local governmental revenue. The bottom line is that Pennsylvania becomes an even more expensive opportunity for prospective new employers, with a loss of new job potential and the real probability of the loss of existing jobs. For these reasons alone, the Department must be made to actually establish the **scientific** need for and benefits of the buffer width that is proposed. The economic and social costs of allowing the Department to guess at a width and employ an overly wide non-flexible width are just too extensive.

What troubles our members and their consultants is the perception that we are simply talking about 150 feet along a stream, really twice that given the buffer on each side of the stream. Still it is only the length of a football field in width with the stream in the middle. But that is not the real impact. Two factors play heavily into increasing the actual loss of land to this buffer. First, we are not simply talking about named streams. In Chester County we are not just talking about the Crum and the Pickering and the French and the Valley. We are also talking about the tributaries, whether perennial or intermittent. In rolling terrain like eastern Chester County it is hard to find a commercial or industrial site that is not impacted by more than one "stream."

Second, these streams have to be related to property boundaries. One cannot just assume that areas outside the 150 foot buffers are available for development. There are yard and set back requirements under local zoning. Industrial and commercial setbacks routinely equal or exceed 50 feet. Between the setback and the buffer one must be able to design the use and its storm water management. For example, a double loaded parking bay has a design width of 65 feet. It needs storm water management between it and the buffer. Even if the storm water management facilities can be accommodated in as little as 25 feet, if there is a 50 foot yard requirement, the land owner would need 130 feet of width from the buffer to the property line to construct just a single parking area. To accommodate buildings the separation from the buffer to the property line would need to be even greater. What this means is that where a stream is within 280 feet of a property line it is likely that the entire 280 feet as well as the addition 150 feet on the non-property line side of the stream is lost to development. The buffer actually becomes 430 feet. In our County it is more likely than not that the buffer will neuter substantial additional land. From a cost standpoint, a commercial property worth $100,000/acre is devalued by almost $12,000 for each strip of land 50 deep by 100 feet long lost to un-needed buffer of un-useable area due to stream buffer location. On a normal sized commercial or industrial site that number will be in the hundreds of thousands of dollars.

This brings up two specific problems we have with the 150 foot inflexible buffer. First is its extreme width and second is the lack of flexibility to design other BMPs in conjunction with a buffer to provide for issues such as indicated in the previous paragraph. Looking first at the justification for the width, there appears to be none. The consultants for our members have shared with us and with the Department the only composite review of buffer widths. It is a study titled, A Review of Current Literature on Riparian and Wetland Buffers for Water Quality Protection, and was prepared within the past few years by R. Ruprecht, C. P. Kilgore and R Gunther, all of ENTRIX. A copy of the study is appended to these comments.

ENTRIX reviewed 137 published scientific papers on buffers and their purposes and benefits. It grouped the purposes into ten groups: temperature control; streambank stability and sediment control; minimization of direct human impact; removal of total suspended solids; maintaining surface water supply and quality; nitrogen removal; phosphorus removal; removal of pesticides; removal of bacteria; and, removal of metals. It reviewed the studies under each purpose group to determine the scientifically supported buffer widths needed for each purpose. The study concluded: "For streambank stability, temperature control, minimization of direct impacts, and pollution removal capacities, substantial benefits are achieved within the first 50 feet of vegetated buffer width. Marginal increases in benefits may accrue when the buffer widths are increased beyond 50 feet." The recommended range of buffer widths in the studies reviewed by ENTRIX only reached to 100 feet in the case of nutrient removal. Buffer widths of 150 feet were not recommended by the studies reviewed, except under extreme conditions ("extreme slopes, point source nutrient loading, areas with high contamination and other nontypical concentrations of contaminates"). In short ENTRIX found that the 137 published buffer studies did not support a buffer width of 150 feet and only with respect to nutrient removal supported a buffer width of 100 feet.

ENTRIX did not stop there. It then examined the results that would be expected if one were to combine a vegetated buffer with other storm water BMPs to determine what combination of buffer width and BMPs could be used to achieve the results of a maximum recommended riparian buffer alone. It concluded that the use of BMPs with buffers could reduce buffer widths to 50 feet. The study contains a table identifying the BMPs that could be used by buffer purpose. As our members' experts and consultants note, this means that the same results can be achieved through the use of good design, design that can be tailored to the specific watershed and the specific property conditions for the project as can be achieved by a 100 foot buffer or a 150 foot buffer (since there is no need for anything more than 100 feet). Land can be more effectively and more cost effectively used, sprawl can be reduced and the design can be created based upon the actual stream conditions and facts.

Our members do not argue that buffers should not exist. They object to the excessive width (given the lack of scientific support for 150 foot buffers) and they object to the lack of flexibility in the width which eliminates the ability to match the buffer to the actual conditions. As the engineers complain, the non-flexible buffers make them box checkers instead of designers and engineers. With respect to the proposed 150 foot buffer width we suspect that the proponents of such excessive buffers simply seek to reduce growth. That is simply wrong for Pennsylvania, which needs employers and jobs to locate here and to stay once they are here. With respect to the lack of flexibility we suspect that the Department favors the "box checking" approach. It is certainly easier to simply look for a 150 foot line on plans than it is to evaluate whether the proposed BMPs are a fitting application. However, as the EHB noted in the Crum Creek case, "box checking" does not assure statutory compliance. The applicant's obligation is to design storm water management that does not result in degradation of the stream. If it does that it should be entitled to receive a NPDES permit and to use its land in accordance therewith.

There is one other aspect of the regulations that relates to the requires non-flexible buffers that troubles us. The regulations propose that the buffers must become a permanently restricted area. The general provision found in Section 102.8(m)(2) is that a permittee with a BMP "shall record an instrument with the recorder of deeds which shall assure disclosure of the PCSM BMP and the related obligations in the ordinary course of a title search of the subject property." It is a notice provision. However, with respect to buffers a different requirement is proposed. Under proposed Section 102.14(g)(1) "Existing, converted and newly established riparian buffers including access easements must be protected in perpetuity through deed restriction, conservation easement, local ordinance, permit condition or any other mechanism that ensure the long term functioning and integrity of the riparian buffer." WHY THE DIFFERENCE?

Why make the buffer a permanent deed restriction? There is no assurance that the permit or the proposed land use or the natural location of the stream will be permanent. Thank goodness all land use and environmental permits have not required the assurance of such contractual permanence. There is no reason why the notice provision of Section 102.8(m)(2) should not be employed with regard to buffers.

The use of 102.8(m)(2) makes sense. Over the course of eternity it is possible, even likely, that one of a number of things could occur. The government could realize that 150 foot non-flexible buffer is not warranted. Science could advance, if it hasn't already, to the point that stream quality can be equally or better protected by the use of BMPs other than a 150 foot buffer. Pennsylvania may experience either unwanted and unnecessary sprawl or an exodus of employers and jobs and therefore desire to implement a flexible buffer/BMP program. Landowners may be successful is obtaining damages for the excess buffer requirements. Streams may move naturally. The important thing is that the future land owners know of the existence of the buffer, not that it be artificially made perpetual by a "deed". Such a permanence will only hamstring both the landowner and the Commonwealth in the future. We strongly request that concept of permanent deed restriction in 102.14(g)(1) be replaced by the concept of recorded notice in 102.8(m)(2).

Thank you in advance for your consideration of these comments.

Submitted by the Chester County
Economic Development Council

Appendix A

A REVIEW OF CURRENT LITERATURE ON RIPARIAN AND WETLAND BUFFERS FOR WATER QUALITY PROTECTION

R. Rupprecht, C. P. Kilgore, R. Gunther

ABSTRACT: Vegetated buffers adjacent to wetlands and stream channels up to 50 feet in width provide substantial benefits for protecting and enhancing water quality, based on a review of the published literature on wetlands and other regulated waters. State, regional, and local regulations vary greatly in their requirements for buffer widths. In four counties of southeastern Pennsylvania, (Bucks, Chester, Delaware, and Montgomery) regulatory requirements for stream and wetland buffers vary from 0 to 300 feet wide. Many of these regulations do not have published or stated goals and objectives supporting the choice of buffer widths or provide a scientific rationale for the width chosen. ENTRIX reviewed 137 published scientific papers, written over the preceding forty years, on riparian and wetland buffer widths, and on the subject of providing "ecosystem services;" the processes by which the environment produces resources, such as clean water. ENTRIX attempted to establish a scientific rationale for selecting buffer widths for streams and wetlands. ENTRIX also hoped to find a uniform buffer width, which could satisfy resource protection requirements for most buffer applications. The published studies were grouped by types of ecosystem services provided, buffer widths examined, and capacities for protection of water quality. For streambank stability, temperature control, minimization of direct impacts, and pollutant removal capacities, substantial benefits are achieved within the first 50 feet of vegetated buffer width. Marginal increases in benefits may accrue when buffer widths are increased beyond 50 feet. The application of some stormwater Best Management Practices (BMPs) when used in conjunction with riparian and wetland buffer strips, can result in a significant increase in water quality benefits from vegetated buffers less than 50 feet in width. Variable width buffers and the use of "buffer averaging" can result in significant benefits to water quality from vegetated buffers which are less than 50 feet in places.

A full copy of the study is appended as an attachment

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KEY TERMS FOR JAWRA CATEGORIZATION (6): Buffers, Rivers/Streams, Wetlands, Nonpoint Source Pollution, Best Management Practices (BMPs), Stormwater Management

INTRODUCTION

Pennsylvania does not have a statewide standard set of buffer requirements for riparian habitats or other wetlands, although a proposed rule would require a 50-foot standard buffer (PA DEP, 2005). Wetland and riparian buffer widths are instead decided on a county or township level. In four counties of southeastern Pennsylvania (Chester, Bucks, Montgomery, and Delaware) there are 278 municipalities creating a multitude of state, regional, and local jurisdictions, each with various, requirements for set-aside, protection or creation of riparian and wetland buffers. For example, East Pikeland Township requires 300 feet (S&LDO, 2004), while Bensalem Township requires 20 to 100 feet (NRP, 2005). Developers of small- to mid-sized residential communities and office/commercial campuses must therefore negotiate many different levels of political jurisdictions to remain in compliance with these regulations. Based on a review of regulations alone, it is unclear whether differences in buffer widths among municipalities were developed to represent real geographic variation in the contribution of buffers to ecological function. Jurisdictions do not necessarily appear to have previously established and/or defined their goals for maintaining water quality or other ecosystem services prior to setting requirements for buffer width.

Because the range of widths adopted by the many jurisdictions in southeastern Pennsylvania does not appear to have a scientific basis, ENTRIX questioned the scientific validity of these buffer widths as they relate to riparian and wetland resource protection. In this study, ENTRIX attempted to (1) review existing buffer regulations in southeastern Pennsylvania and their basis in ecosystem value protection, (2) review and summarize the scientific and technical literature addressing buffer widths and compositions and how changes in these variables affect ecosystem function, and (3) review and summarize literature addressing the use of Best Management Practices (BMPs) in conjunction with vegetated buffers to create a "treatment train" that would improve water quality and increase protection of ecosystem values. This article expresses the major finding and conclusions of this review.

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MATERIAL AND METHODS

ENTRIX reviewed existing environmental regulations in southeastern Pennsylvania and published scientific literature. ENTRIX began its analysis by reviewing local environmental ordinances for municipalities in Chester, Bucks, Montgomery, and Delaware Counties that specified wetland or riparian buffer requirements.

ENTRIX collected and reviewed 137 published studies and reports relating to riparian and wetland buffer widths and vegetative composition. These studies included primary literature as well as technical reports and review papers on the subject. Where possible, ENTRIX verified conclusions in review papers and technical reports by evaluating references cited in those papers.

Literature reviewed was ranked for relevance to riparian and wetland areas in southeastern Pennsylvania. Ecological services provided by riparian buffers were identified. The published studies were divided into categories for the types of ecosystem services provided, the buffer widths examined, and the capacities for protection of water quality and other ecosystem services. Ranges of buffer widths from relevant papers were recorded for each of the ecological services.

This review focused on studies that were applicable to residential development, suburban office and commercial development, and the conversion of rural land use. This study did not consider large-scale commercial development or associated BMPs. ENTRIX considered the following ecosystem services preformed by buffers:

- Temperature Control
- Streambank Stability and Sediment Control
- Minimization of Direct Human Impact
- Removal of Total Suspended Solids
- Maintaining Surface Water Supply and Quality
- Nitrogen Removal
- Phosphorus Removal
- Removal of Pesticides
- Removal of Bacteria
- Removal of Metals

Buffers provide additional ecosystem services, including providing habitat for water- or wetland-dependent wildlife, but an evaluation of buffer width on these ecological services is beyond the scope of this study; this study on focused the relationship between buffer widths and water quality.

Results of our literature search were compiled into a matrix listing the ranges of effective buffer widths for each of the ecosystem services. The matrix also reflected criteria relevance ranking and interpretation of effective buffer width ranges for each ecosystem service. Ranking criteria were developed based on (1) applicability to small-scale residential and commercial development, (2) similarity to southeastern Pennsylvania, (3) quality of research, (4) publication level, and (5) test parameters.

A second literature search was performed to evaluate the effectiveness of common stormwater BMPs combined with the construction and maintenance of wetland and riparian buffers.

RESULTS

Jurisdictions and Regulation of Environmental Factors in Southeastern Pennsylvania

Pennsylvania does not have a state minimum buffer width outside the Dam Safety and Encroachment Act of 1979, which requires that dams be set back 300 feet from "important" wetlands and water courses. The Riparian Buffer Ordinance Act Senate Bill #453 (Rafferty, 2007), if approved, would require a 35 to 100 foot wide buffer adjacent to each stream or nontidal wetland. This rule would apply to any activity where a building, grading, or encroachment permit is needed or when zoning board, subdivision/land development, or conditional use approvals are needed.

In the absence of state-level rules, buffer widths are determined on the county and township jurisdictional level. Local buffer requirements range greatly in southeastern Pennsylvania from no buffer requirements to 300 feet (e.g., S&LDO, 2004). Local environmental approvals that may require riparian and wetland buffers may include Sediment Erosion and Sediment Control Plans, County Grading Permits, and Nontidal/Tidal Wetland Permits.

Published Literature - Buffer Widths and Ecosystem Values

Temperature Control: Vegetated buffers bordering rivers, streams, and wetlands help maintain lower water temperatures in summer and reduce temperature decreases in the winter by providing shade and cover. The relationship between buffer width and water temperature control is determined by vegetation type, height, density, and cover. Broderson (1973 in Castelle et al., 1994) found that forested buffers 50 feet in width provided adequate shade for small to moderate streams and that buffer widths along slopes could decrease with increasing tree height with no significant loss of shade (Broderson, 1973 in Castelle et al., 1994). Buffers as narrow as 10 feet provide adequate temperature control if vegetation is tall enough to shade the wetland or water body (Brazier and Brown, 1973). Vegetated buffers 75- to 100-feet wide stabilized temperatures when vegetation was not tall enough to create direct shade or cover (Lynch et al., 1985).

Streambank Stability, Erosion Control: Vegetated buffers stabilize streambanks with plant root structures providing tensile strength and forming a physical barrier. Roots maintain soil structure and physically restrain otherwise erodible soils (Castelle et al., 1994). Vegetation reduces the channelization of water and slows surface water flow reducing erosion and soil transport. The relationship between buffer width, streambank stability, and erosion control is based on soil type and erodibility; vegetation type, density and cover; and bank slope. Ghaffarzadeh et al. (1992) examined sediment removal by grass vegetated filter strips ranging from 0 to 60 feet in width on 7 and 12% slopes. They found no difference in performance after 30 feet on either slope, at which point 85% of the sediment was removed; furthermore, they found no difference in sediment removal after the first 10 feet (Castelle et al., 1994). Young et al. (1980) found that an 80 foot vegetated buffer reduced the suspended sediment in feedlot runoff by 92%, (Castelle et al., 1994). In a study by Lynch et al. (1985), a 98-foot buffer between actively logged areas and wetlands and streams removed approximately 75 to 80% of the suspended sediment in stormwater.

Minimize Degradation from Direct Human & Livestock Impact: Buffers protect wetlands and waterbodies from direct human and livestock impact by limiting access and reducing noise, light, odors, and debris. Adjacent land use type accounted for much of the variation found in the level of human (Shisler et al., 1987; Castelle et al., 1994) and livestock (Wenger, 1999).

TABLE 1 Physical Ecosystem Service

Service	Recommended Range Under Normal Conditions [a]	Recommended Range Under Extreme Conditions [b]	Dependent Parameter	Minimum Width Using BMPs	BMP Type
Temperature Control	10 to 30 ft	25 to 100 ft	Requires trees of sufficient height to shade full width of stream. Width dependent on vegetative type, height, density and cover.	As low as 10 ft	Existing Natural Canopy of Forested Buffer Strip
Streambank Stability & Erosion Control	25 to 66 ft	benefits to 100 ft	Requires native vegetative cover and root mass for erosion prevention. Width dependent on vegetative type, height, density and cover.	As low as 25 ft	Forested Buffer Strip; Filter Strip; Land Preservation
Minimization of Direct Human & Livestock Impacts	50 ft	50 ft	Requires sufficient density of vegetation to limit access. Width dependent on adjacent land use and condition of watershed.	50 ft (human); 25 ft (livestock)	Fencing; dense vegetation
Contaminant Removal (Suspended Solids)	30 to 60 ft	50 to 150 ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 30 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration

Notes:

[a] Normal conditions refer to typical riparian areas in Southeastern Pennsylvania around residential and office/commercial campuses, and include low to moderate slopes, warmwater riverine habitat, and open lands.

[b] Extreme conditions refer to unusual and nontypical riparian areas, including extreme slopes, point source nutrient loading, areas with high contamination, and other nontypical concentrations of contaminates.

Nutrient Removal: While many studies confirm the value of forested and nonforested buffers in removing nutrients from runoff (e.g., Doyle et al., 1977; Lynch et al., 1985; Shisler et al., 1987; Hubbard and Lowrance, 1992; Palone and Todd, 1997; Jackson, 2006), the literature varies widely in its description of the relationship between buffer width and nutrient removal function. Dillaha et al., (1989) reported that 15-foot-wide vegetated areas removed an average of 70% of suspended solids, 61% of phosphorous, and 54% of nitrogen, while 30-foot-wide areas removed an average of 84% suspended solids, 79% of phosphorous, and 73% of nitrogen. Madison et al., (1992) found similar results using simulated 1 and 10-year storm events, and did not record increased nutrient removal as buffer widths increased beyond 30 feet. Riparian buffers between 5 and 15 feet wide removed significant proportions of total nitrogen, although wider buffers more consistently removed nitrogen entering the riparian zone (Mayer et al., 2005). Nitrogen reductions of 25% to over 90% of total loadings occur in the first 35 to 90 feet of forested buffers (Palone and Todd, 1998).

Nieswand et al. (1990) determined that slope and width were the main factors influencing the effectiveness of buffers in trapping sediment and associated pollutants. They developed a simple formula for determining width based on a modified Manning's equation. The equation uses a constant "50 feet" based on common buffer recommendations, with the assumption that a 50-foot buffer at 1% slope provides adequate protection to streams. (Nieswand et al. 1990).

Pesticide Removal: Hatfield et al., (1995) found that 40- to 60-foot wide grassy buffers removed 10 to 40% of the atrazine, cyanazine and metolachlor from runoff. Arora et al. (1996 in Wenger, 1999) found that 66-foot-wide riparian buffers at 3% slope retained from 8 to 100% of the herbicides (atrazine, metolachlor and cyanazine) that entered during storm events. Payne et al. (1988) found that a 65-foot-wide forested buffer reduced permethrin spray cloud dispersal reaching surface waters to concentrations protective of fish.

Bacteria Removal: Riparian buffers can trap waste transported in surface runoff in the same way that they trap sediments and associated nutrients (Wenger, 1999), where pathogenic microorganisms can be exposed to oxygen and sunlight and either destroyed, or their concentrations reduced. Buffers as narrow as 12.5 feet can reduce fecal coliform levels in runoff (Doyle et al., 1977; Coyne et al., 1995).

Total Suspended Solids (TSS) Removal: Vegetated buffers remove suspended solids from runoff, with the rate of removal affected by buffer width, vegetative composition, adjacent land use, and slope. Grassed areas 15- and 30-feet wide removed 70% and 84% ofTSS (Dillaha et al., 1989). However, Ghaffarzadeh et al. (1992) found that vegetated filter strips removed 85% of sediments within the first 30 feet of width, on slopes between 7 and 12%, with no additional removal up to a total of 60 feet, on either slope. Similar results were observed by Peterjohn and Correll (1984) in a riparian buffer in the Middle-Atlantic coastal plain. Lynch et al. (1985) found that a 98-foot-wide buffer strip removed 75 to 80% of suspended sediment from runoff from an up-slope logging operation.

Metals Removal: Grassy swales and other vegetated areas can be effective in removing lead and other pollutant metals from runoff. Herson-Jones et al.(1995) citing data from a 1992 study by the Metropolitan Seattle Water Pollution Control District which found removal rates exceeding 40% for lead (Pb), 60% for copper (Cu), Zinc (Zn), and iron (Fe), concluded that urban buffers have a moderate to high ability to remove or retain hydrocarbons and metals from surface runoff. Studies in Rhode Island (Groffman et al., 1991 in Wenger, 1999) also found high metal retention rates.

TABLE 2 Chemical Ecosystem Service

Service	Recommended Range Under Normal Conditions	Recommended Range Under Extreme Conditions	Dependent Parameter	Minimum Width Using BMPs	BMP Type
Nutrient Removal (Nitrogen)	15 to 50 ft	50 to 100 ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 15 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration
Nutrient Removal (Phosphorus)	30 to 100 ft	100 + ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 30 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration
Contaminant Removal (Pesticides)	40 to 66 ft	benefits to 200 ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 40 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration
Contaminant Removal (Bacteria)	15 to 30 ft	30 + ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 15 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration
Contaminant Removal (Metals)	50 ft minimum	benefits to 200 ft	Requires 2 zone or 3 zone buffer; forested, managed forest, grasses. Width dependent on slope, flow length, permeability, vegetative cover and type, concentration.	As low as 50 ft	Wet Ponds, Wetlands, Bioretention, Infiltration, Filtration

Published Literature- BMPs

In addition to or in concert with buffers, the operation of wet and dry retention areas and other BMPs to collect and treat stormwater can be protective of riparian and wetland ecosystem values. Stormwater management BMPs trap and remove nutrients and other contaminants in runoff. Horner and Mar (1982), reported that a 200-foot wide grassy swale removed 80% of suspended solids and total recoverable lead (Pb), and a study by Young et al. (1980) found that a 200-foot-wide grassy area reduced fecal coliform by 87%, total coliform by 84%, and biological oxygen demand (BOD) by 62%.

The Center for Watershed Protection (2007) analyzed data in the National Pollutant Removal Performance Database, Version 3, for sediment, nutrient and other pollutant removal efficiencies for various types of BMPs, including dry ponds, wet ponds, wetlands, filtering practices, bioretention and open channels. BMPs removed between 29 and 86% of most metals, between 24 and 67% of nitrogen, 20 to 65% of phosphorus, and between 48 and 89% of TSS. Removal efficiencies for all bacteria ranged between 37 and 88%. The International Stormwater Best Management Practices Database (ISBMP 2008) analyzed data on metals removal by stormwater BMPs, the BMP classes included detention pond (EDD), wet pond, wetland basin, biofilter (bioretention), media (sand) filter, hydrodynamic devices and porous pavement. BMPs ranged between 40 and 54% removal for most metals. Removal efficiency for all nitrogen ranged between 22 and 30%, while removal efficiencies for all phosphorus ranged between 28 and 39%. Removal efficiency for total suspended solids ranged between 63 and 71%.

BMPs can be combined with vegetated buffers to provide pre-treatment for stormwater runoff. "Storm Water Treatment Trains" consist of using several BMPs to control stormwater quantity and quality in an integrated planning and design approach whose components work together to limit the adverse impacts of urban development on downstream waters and riparian areas. When considered comprehensively, a treatment train consists of all the nonstructural and structural controls that work to attain water quality and quantity goals. The Charlotte Mecklenburg (North Carolina [NC]) Office of Stormwater Services developed a pilot program in which 24 different BMP treatment trains were selected as being the most common for application in the Mecklenburg County (NC Piedmont) area. Detailed water quality modeling was performed on those 24 BMP combinations to determine the combined pollutant removal capability. Treatment trains consisted of two or three BMPs in series; and included bioretention, treatment wetlands, grassed swales, sand filters, buffer strips, extended dry detention, wet ponds, infiltration trenches, and enhanced grassed swales. Pollutant removal efficiencies for TSS and total phosphorus (TP) were determined for each of the 24 combinations. The stormwater treatment trains tested removed an average of 87% of TSS, with most combinations removing 90% and above, and 78% of TP, with many combinations in excess of 80% (CharMeck SWS, 2008).

DISCUSSION

The majority of published studies and technical reports support the conclusion that vegetated buffers adjacent to wetlands and stream channels provide substantial benefits for protecting and enhancing water quality. For streambank stability, temperature control, minimizing degradation from direct impacts, and pollutant removal capacities, substantial benefits are achieved within the first 50 feet of vegetated buffer width. Marginal increases in benefits may accrue when buffer widths are increased beyond 50 feet.

Vegetated buffers are most protective of riparian and wetland resources when their creation and maintenance is coupled with other stormwater BMPs, such as the creation of wet and dry retention areas. "Storm Water Treatment Trains" consisting of several BMPs to control stormwater quantity and quality provides an integrated planning and design approach whose components work together to limit the adverse impacts of residential and commercial development on downstream waters and riparian areas (CharMeck SWS, 2008).

The use of BMP treatment trains to improve and enhance water quality, prior to the site runoff reaching the riparian and wetland buffer, potentially limits the need for buffers to trap or filter contaminants; therefore, buffer width can be reduced below 50 feet when paired with well designed BMPs, when buffer goals include removal of sediment, nutrients and other contaminants. "Buffer Averaging" consists of the use of a variable width buffer, in which some sections are greater than the required width, and some sections are less than the required width, but the average square footage for the total area is satisfied, and widths are chosen based on appropriate site conditions and site design for residential (Figure 1) and commercial (Figure 2) developments. Using this approach, buffers and BMPs can be configured to accommodate various development layouts while still protecting wetland and riparian ecosystem values.

Riparian and wetland buffer requirements found in the regional and local ordinances of southeastern Pennsylvania do not appear to be based on the conclusions of these scientific studies. However, science-based buffer recommendations have been recommended in other eastern U.S. regions. For example, 25- to 50-foot-wide averaged buffers have been recommended for Rhode Island (Roman and Good, 1985; Palmstrom, 1991), and buffers less than 50-feet wide used in conjunction with BMPs have been deemed effective in Mecklenburg County, NC (CharMeck SWS, 2008). Well-planned developments incorporating "averaged" vegetated buffers of 50 feet or less, combined with shared BMP treatment trains, may be more protective of riparian and wetland ecosystem values than the much larger buffers required by some regional and local regulations.

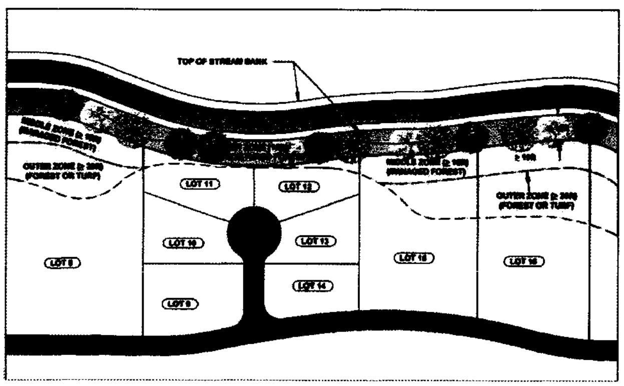

FIGURE 1. Example of Buffer Averaging in a Residential Area

Source: Knox County Tennessee Stormwater Management Manual

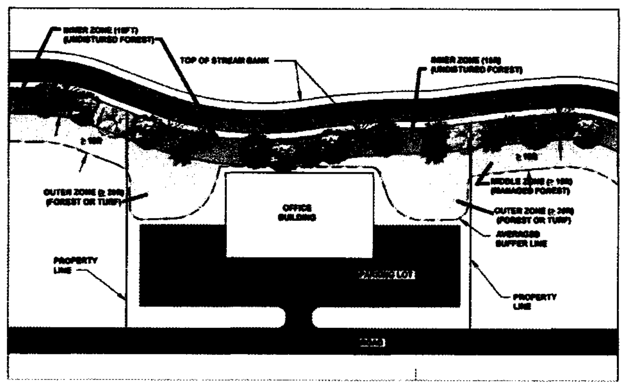

FIGURE 2. Example of Buffer Averaging in a Nonresidential Area

Source: Knox County Tennessee Stormwater Management Manual

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