8.0 WATER QUALITY ANALYSIS

The County, like other coastal communities, is highly dependant on its surface waters to support its local economy and enhance the quality of life for its residents and visitors. The protection of surface waters is essential to sustaining these objectives. Therefore, the County is being proactive in developing a comprehensive program that meets the current and anticipated needs for storm water services and protects public and private properties, rivers, estuaries, and other surface waters from unnecessary damage due to storm water releases and nonpoint source pollution.

8.1 GENERAL DESIGN CRITERIA

The design criteria required for all new development to control and reduce water quality degradation within Georgetown County will be addressed at three levels. Pursuant to the Storm Water Management Program Ordinance, the following levels of analysis and protection shall be adhered to for new nonresidential development and multi-lot residential development:

Method 1: For parcels of 10 acres or less (small size development)
Method 2: For parcels greater than 10 acres and less than 40 acres (mid-size development)
Method 3: For parcels equal to or greater than 40 acres (large size development)

Redevelopment or expansion of existing development within the Critical Urbanized Area (CUA) that meets the thresholds defined in the Storm Water Management Ordinance shall follow the same requirements as outlined in this chapter. Additional water quality analysis is not required if redevelopment does not meet or exceed the thresholds, as determined in the Ordinance, and design requirements are adhered to, as stated in the Ordinance.

<u>Method 1 – Water Quality Control for Small Size Development</u>

Developments shall install and maintain structural BMPs approved by Georgetown County, and control the Water Quality Volume (WQV) within the site prior to discharge, according to Table 7-1, Chapter 7 of the Manual. BMPs approved for design and accepted for operation upon construction will be deemed to satisfy targeted pollutant removal efficiencies.

<u>Method 2 – Water Quality Control for Mid-Size Development</u>

Developments shall install and maintain structural BMPs approved by Georgetown County to achieve targeted pollutant removal efficiencies. The targeted pollutant for design analysis and BMP selection only shall be phosphorus. Engineering calculations shall be submitted to evaluate whether or not a proposed BMP plan for a development project will meet the recommended anti-degradation water quality goal. Analysis and evaluation of predicted performance will utilize the expected phosphorus removal efficiencies identified in this chapter. BMPs approved for design and accepted for operation upon construction under this methodology will be deemed to satisfy targeted pollutant removal efficiencies.

This methodology is established to address all potential pollutants (i.e. suspended solids, nitrogen, etc.), and does not attempt to imply that only phosphorus is being removed or that phosphorus is the only pollutant of concern. Phosphorus removal (as well as other pollutant removal) occurs as a result of its attachment to solids. Therefore by focusing on phosphorus, the BMP will indirectly target other pollutants, such as sediment. This methodology has also been chosen to streamline the analysis effort and to be consistent with other storm water programs with similar water quality concerns.

Method 3 – Water Quality Control for Large Size Development

Developments shall install and maintain structural BMPs approved by Georgetown County to achieve zero degradation as compared to predevelopment pollutant loads. The permit applicant shall submit a water quality modeling plan to the County for approval prior to submitting a storm water plan. The modeling plan submittal shall include an explanation of the analysis approach, identification of pollutants or indicators and relationships thereof, description of model methodology, expected range of accuracy in result prediction, and sources of all data to be used for modeling.

8.2 POLLUTANT TYPES AND SOURCES

A pollutant is a man-made or naturally occurring constituent that creates an undesirable effect when introduced to a specific environment. Elements such as nutrients, sediment, organic matter, organic compounds, and metals are naturally occurring constituents do not create adverse affects when introduced to an aquatic system in balanced proportions. In fact, many of these constituents are essential for the propagation of aquatic life. However, the introduction of excessive, unbalanced quantities can create an undesirable effect and result in their acting as pollutants. Constituents that provide no beneficial use in an aquatic system are also termed pollutants. Water quality control is the balancing of required constituent masses with the elimination of pollutants to provide a desirable aquatic system. Typical pollutants found in storm water include but are not limited to the following:

- Sediment (suspended and dissolved) from erosion, exposed ground, and construction activity.
- Nutrients (nitrogen, phosphorus) from fertilizers and other chemicals in the urban environment, including atmospheric deposition.
- Oxygen demanding matter (BOD) as a result of decomposition of organic matter in storm water.
- Heavy metals (iron, lead, manganese, etc.) from vehicular waste and other transportation related activities.
- Bacteria and other pathogens from domestic pets, birds, and leaking sanitary sewers.
- Oil and grease from illegal dumping, or poorly maintained vehicles.
- Household hazardous waste (insecticide, pesticide, solvents, paints, etc.)
- Polycyclic Aromatic Hydrocarbons (PAH), as a result of outboard exhaust and petroleum and tire residues on paving.

Human activities, or the results of human activities, are the principal source of pollutants that affect water quality. These sources are classified as either point or nonpoint. Point sources are easily identified as they are usually pipes from sewage treatment plants, storm water systems, or industries. These types of point sources are monitored under effluent standards program of the NPDES. Nonpoint sources are far more difficult to assess quantitatively and to control. Nonpoint pollution sources represent a significant source of pollutants. These sources include soil erosion and land disturbances, animal waste, agri-chemicals, waste from automotive use and maintenance, onsite wastewater systems, resource extraction, atmospheric deposition, and more.

Storm water, and nonpoint source pollution in particular, has the potential to significantly impact surface water quality. Storm water generated from impervious surfaces or saturated soil conditions collects and transports pollutants from the terrestrial landscape to the surface water. When considering surface water impacts, it is helpful to understand the phenomenon called first flush. Studies have shown that the portion of storm water runoff captured during the first fifteen minutes of a storm event contains high concentrations of pollutants. This is commonly referred to as the first flush. Thus, the pollutant accumulation in intense small runoff events can be more detrimental to water quality than larger flooding events. As a result, upstream management practices that control small volumes of initial runoff can be very effective in enhancing nonpoint source pollutant removal.

8.3 WATER QUALITY IMPACT

Impacts associated with the discharge of storm water into surface water depend upon the type of pollutants present. In general, organic compounds lead to a decrease in dissolved oxygen and potentially to loss of aquatic life while suspended solids lead to sedimentation in the water body and poor water quality. Nutrients, such as phosphorous and nitrogen, lead to the eutrophication of surface water, algal blooms, and eventually poor water clarity. Aquatic organisms amass metals such as lead, cadmium, zinc, and other toxic chemicals by the process of bioaccumulation. In fish this process results in concentrations of toxic substances that are far greater than the concentrations present in the water the fish inhabit. This, in turn, may further result in food chain biomagnification causing increased concentrations of substances as one food chain level is consumed by the next. Trace metals and organic contaminants can result in acute or chronic toxic effects if concentrations become extreme. Pathogens result in surface waters that are hazardous for human recreation, consumption, and fish harvesting.

8.4 POLLUTANT LOADING ANALYSIS

The County, in order to quantify the impact of storm water pollution for mid-size and large size developments, requires a computation of the expected removal efficiency of the targeted pollutants. Small size developments are exempt from the engineering analysis to verify removal efficiency. Pollutant exports are the quantity of a pollutant, typically expressed as mass of pollutant per year, expected to be generated by a specific land use and transported by runoff off the site. All sites, natural or disturbed, produce some composition and quantity of pollutants.

For purposes of pollutant export control, the County requires that the excess pollutant quantities be controlled to the maximum extent practicable on all new development and redevelopment, except as defined in the Storm Water Management Program Ordinance. The best way to control pollutant export is by preventing the generation of pollutants in the first place, however, complete prevention of pollutant generation is unrealistic and impractical. Therefore, pollution export must be controlled to the greatest extent possible through the use of Best Management Practices (BMPs). Some BMPs prevent the interaction of stormwater with the pollutant thus preventing it from leaving the site while most perform some type of control or treatment of the pollutant through an engineered structure. These BMPs are termed structural BMPs and are discussed further in Chapter 7.

8.4.1 Pollutant Removal Analysis

The BMP fact sheets in Chapter 7 provide estimated removal efficiencies of BMPs for certain pollutants. These efficiencies were derived from a range of literature citations and documented laboratory field experiments and represent an anticipated level of removal under normal conditions. BMP efficiency is highly variable and dependant on many environmental and physical factors.

Method 1 - Water Quality Control for Small Size Development

There is no pollutant removal analysis required for Method 1.

Method 2 – Water Quality Control for Mid-Size Development

For the purpose of BMP selection, evaluation, and approval, the following table lists the assumed total phosphorous removal for approved BMP facilities:

TABLE 8-1
ASSUMED BMP PHOSPHORUS REMOVAL EFFICIENY

BMP	EFFICIENY (%)
Wet (Retention) Pond	55
Extended Detention Pond	30
Constructed Wetland System	30
Bioretention Area	55
Infiltration Trench	60
Filter Strip	20
Vegetated Swale	25
Sand Filter	25
Permeable Pavement System	40
Exfiltration Trench	60

A worksheet in the following section provides a step-by-step process for assessing the pollutant removal efficiency of the planned BMPs, and comparing that with the pollutant removal required by the County. Using the worksheet, the required removal efficiency (based on imperviousness of the developed portion of the site) is compared to the assumed removal efficiency provided by a pretreatment and primary BMP. The developed area would include roof tops, buildings, sidewalks, patios, paths, streets, and parking areas but would exclude managed open space areas such as lawns, gardens, parks, recreation facilities, wetlands, and ponds. If the primary BMP is not sufficient, then suggested alternatives include adding pretreatment BMPs, using BMPs with higher removal efficiency, and the combined removal efficiency of the pretreatment BMPs and primary BMPs can be calculated.

Method 3 – Water Quality Control for Large Size Development

The larger the development, the greater the risk of detrimental impact to receiving waters due to improper functioning of BMPs. Georgetown County requires specific detailed modeling to assess the pre and post development pollutant loading from the proposed development in order to minimize that risk. Model results for large size developments will show through the use of BMPs in multiple locations and/or in series (i.e. treatment train) such that the post development pollutant discharge is equal to or less than the predevelopment pollutant discharge. The permit applicant shall submit a water quality modeling plan to the County for approval prior to submittal of the storm water plan. The modeling plan submittal shall identify the analysis approach, pollutants identified for analysis, model methodology, expected range of accuracy in pollutant removal prediction, and source of data to be used for modeling.

8.4.2 Method 2 – Worksheet

Step 1 - Calculation of Percentage of Impervious Cover for Developed Area

Total Project Site Area (acres)
Includes developed area and area left undisturbed during construction __________ A_{site}

Impervious Cover within Disturbed Area (acres)
Includes developed areas that will be covered with an impermeable surfaces such as roof tops, buildings, sidewalks, patios, paths, streets, parking areas, etc. Compacted gravel surfaces for this calculation are considered impermeable. __________ A_{imp}

Pervious Cover within Disturbed Area (acres)
Includes developed areas that will be stabilized and covered with a natural infiltrative surface such as lawns, gardens, parks, recreation facilities, wetlands, ponds, etc. __________ A_{per}

Open Space Preservation (acres)
Includes areas left undisturbed during construction and intended to remain preserved in this manner. __________ A_{open}

Percentage of Impervious Cover for Developed Area (%)
$A_{imp} / (A_{imp} + A_{per}) \times 100$ __________ I

Step 2 – Determination of Phosphorus Removal Percentage

Required Removal Percentage (%)

Select removal percentage base on percentage of impervious cover (I) from list below: __________ R

I	%	I	%
0-10	0	51-60	52
11-20	27	61-70	54
21-30	42	71-80	58
31-40	46	81-90	63
41-50	50	91-100	68

Removal Percentage Correction for Open Space Preservation (acres)

$100 – (100 - R) / [(A_{imp} + A_{per}) / A_{site}]$ Use zero for $R_{reqr} < 0$ __________ R_{req}

Step 3 – BMP Removal Efficiency Calculation

Pretreatment BMP Removal Efficiency Percentage (%)

Select an assumed BMP removal percentage from Table 8-1. Use zero if no pretreatment BMP is used. __________ E_{ptm}

Primary BMP Removal Efficiency Percentage (%)

Select an assumed BMP removal percentage from Table 8-1. __________ E_{pri}

Percentage of Developed Area Treated (%)

Indicate the percentage of area to be served by this BMP system. __________ A_{ser}

Calculated BMP Removal Efficiency (%)

$[(E_{ptm} / 100) + (E_{pri} \times (100 - E_{ptm})) / 100^2] \times A_{ser}$

__________ E_{cal}

Use integers for percentages

If $E_{cal} < R_{req}$ then proposed BMP configuration is not meeting required phosphorus removal standards for the site. To meet standards consider the following suggestions and verify through recalculation.

- Increase open space preservation planned for the project site
- Decrease impervious areas planned for the project site
- Use more effective BMPs for pretreatment or primary treatment
- Use a pretreatment BMP if one is not already proposed

8.4.3 Method 2 – Example

A developer is building an apartment complex on 12 acres of land that will result in parking lots, sidewalks, and buildings compromising 6.7 acres of disturbed area. The balance of the disturbed area will be managed lawns and landscaping. The developer is required to preserve the 35-foot buffer around the site which has a perimeter of 2,100 feet. The developer is planning on using a single storm water wetland to handle the entire post construction runoff from the developed area. Work through the worksheet to determine if a storm water wetland is sufficient in meeting quality control

Step 1 - Calculation of Percentage of Impervious Cover for Developed Area

Total Project Site Area (acres) Includes developed area and area left undisturbed during construction	**12**	A_{site}
Impervious Cover within Disturbed Area (acres) Includes developed areas that will be covered with an impermeable surfaces such as roof tops, buildings, sidewalks, patios, paths, streets, parking areas, etc. Compacted gravel surfaces for this calculation are considered impermeable.	**6.7**	A_{imp}
Pervious Cover within Disturbed Area (acres) Includes developed areas that will be stabilized and covered with a natural infiltrative surface such as lawns, gardens, parks, recreation facilities, wetlands, ponds, etc.	**3.6**	A_{per}
Open Space Preservation (acres) Includes areas left undisturbed during construction and intended to remain preserved in this manner.	**1.7**	A_{open}
Percentage of Impervious Cover for Developed Area (%) $A_{imp} / (A_{imp} + A_{per}) \times 100$	**65**	I

For Step 1, the total impervious cover for the disturbed area is calculated. The problem statement provided the total project site acreage (12 acres) and acreage (6.7 acres) to be covered by impermeable surfaces. It can also be derived from the problem statement that the open space preservation will be 1.7 acres by multiplying the buffer width by the site perimeter. Subtracting the open space acreage from the total project site acreage yields the disturbed or developed acreage (10.3 acres). Approximately, 6.7 acres of the total disturbed acreage (10.3 acres) comprises impervious cover; the other 3.6 acres (10.3-6.7) is left as pervious cover.

Step 2 – Determination of Phosphorus Removal Percentage

Required Removal Percentage (%)

Select removal percentage base on percentage of impervious cover (*I*) from list below: **54** *R*

I	%	*I*	%
0-10	0	51-60	52
11-20	27	61-70	54
21-30	42	71-80	58
31-40	46	81-90	63
41-50	50	91-100	68

Removal Percentage Correction for Open Space Preservation (acres)

$100 - (100 - R) / [(A_{imp} + A_{per}) / A_{site}]$ Use zero for $R_{req} < 0$ **46.4** R_{req}

Using the 65 percent impervious cover for the disturbed area from Step 1, 54 percent is the corresponding BMP removal efficiency for phosphorus. This BMP removal efficiency is reduced as a credit for preserving open space by virtue of the buffer requirements. The new targeted BMP removal efficiency is corrected to be 46.4 percent

Step 3 – BMP Removal Efficiency Calculation

Pretreatment BMP Removal Efficiency Percentage (%)

Select an assumed BMP removal percentage from Table 8-1. Use zero if no pretreatment BMP is used. **0** E_{ptm}

Primary BMP Removal Efficiency Percentage (%)

Select an assumed BMP removal percentage from Table 8-1. **30** E_{pri}

Percentage of Developed Area Treated (%)

Indicate the percentage of area to be served by this BMP system. **100** A_{ser}

Calculated BMP Removal Efficiency (%)

$[(E_{ptm} / 100) + (E_{pri} \times (100 - E_{ptm})) / 100^2] \times A_{ser}$ **30** E_{cal}

Use integers for percentages

If $E_{cal} < R_{req}$ then proposed BMP configuration is not meeting required phosphorus removal standards for the site. To meet standards consider the following suggestions and verify through recalculation.

- Increase open space preservation planned for the project site
- Decrease impervious areas planned for the project site
- Use more effective BMPs for pretreatment or primary treatment
- Use a pretreatment BMP if one is not already proposed

In Step 3, the developer's plan for storm water quality control is evaluated against the expected removal derived in Step 2. The developer is planning on using a single storm water wetland to handle the control all runoff from the disturbed area. Since no pretreatment device is being employed, the pre-treatment removal efficiency is zero. From Table 8-1 for a constructed wetland system, a BMP efficiency of 30 percent is assumed. As previously mentioned, the entire disturbed acreage (100 percent) is being conveyed for treatment to the BMP. The calculated BMP removal efficiency for this configuration is 30 percent, which does not meet the targeted removal efficiency of 46.4 percent.

There are a number of options this developer could utilize to meet the targeted BMP removal efficiency. Some suggestions include using a more efficient BMP that still would be able to handle the water quality volumes from an approximately 10 acre disturbed site. Other alternatives would include adding a pre-treatment BMP with at least 25 percent removal efficiency to the storm water wetland; reducing the impervious cover by decreasing excessive parking stalls or roadways widths or using permeable pavement systems in order to reduce the targeted BMP removal efficiency; or increasing the buffer widths to receive more credit towards the targeted BMP removal efficiency.