APPENDIX I

WATER QUALITY FACTORS FOR FEE CREDIT CALCULATIONS

I.1. Purpose

There are a wide variety of water quality best management practices (BMPs) available for engineers to select from for post construction storm water quality management. The selection of an individual BMP or a BMP treatment train for a particular site will depend on several factors including specific site and receiving water conditions. Post construction water quality BMP selection is discussed in Section 9 of the Greenville County Storm Water Management Design Manual. The purpose of Appendix I is to provide a list of approved water quality BMPs and their associated Water Quality Factors for use in calculating Storm Water Fee Credits. Storm Water Fee Credits are discussed in the Greenville County Storm Water Fee Credit Policy Manual and Application Form.

I.2. Approved Water Quality BMPs

A literature review was conducted to obtain information and performance data on the most commonly accepted post-construction storm water quality BMPs. Several sources were consulted including the International BMP Database, The U.S. Environmental Protection Agency's Storm Water Menu of BMPs, data from the Center for Watershed Protection as well as BMP and Storm Water Management Manuals states of North Carolina, Georgia, and New Jersey, and Manuals for counties of Mecklenburg County, North Carolina and Knox County, Tennessee.

Table I-1 contains the approved list of post-construction storm water quality BMPs for use in Greenville County, South Carolina. The specific proprietary devices included in Table I-1 are storm water treatment technologies certified by the New Jersey Corporation for Advanced Technology (NJCAT) Technology Verification Program or verified by the United States Environmental Protection Agency's (USEPA's) Environmental Technology Verification (ETV) Program. It is noted that use of these devices is approved only when designed to perform under the operating conditions specified in the certification/ verification documents. The NJCAT and ETV Programs provide documentation of independent third party confirmation of pollutant removal efficiencies and other performance data. Innovative technologies as well as other proprietary devices will be considered for use in Greenville County if the performance is verified by independent third-party sources and data. In some cases, the efficiency of a pre-fabricated control structure may be verified by requiring the owner to monitor the pollutant removal efficiency of the structure. If satisfactory results are obtained, the system may be used and no other monitoring studies shall be required. If the control is not sufficient, other controls shall be designed to trap the required pollutants. Performance data for the approved BMPs is discussed in detail in Section I.3, Water Quality Factors.

I.3. Water Quality Factors

Approved post-construction water quality facilities and BMPs shall be designed to effectively reduce pollutants associated with post-construction storm water runoff. Up to a 25% credit will be available for property owners that install water quality facilities or BMPs on their properties. All storm water quality BMP structural controls must be designed in accordance with the Greenville County Storm Water Management Design Manual. The amount of credit a particular BMP can earn is dependent upon the amount of storm water runoff from impervious areas of the property that is routed through the BMP facility and the relative effectiveness of the particular BMP in removing pollutants of concern. A Water Quality Factor was developed for each approved BMP in order to represent the relative effectiveness of that BMP in removing the various pollutants of concern. Development of the

Water Quality Factors is described in the following paragraphs.

Literature Review

A literature review was conducted to obtain information and performance data on the most commonly accepted post-construction storm water quality BMPs in use in the United States. Several sources were consulted including:

- International Storm Water Best Management Practices (BMP) Database;
- The U.S. Environmental Protection Agency's Storm Water Menu of BMPs;
- Article 64 – Comparative Pollutant Removal Capability of Storm Water Treatment Practices, Center for Watershed Protection;
- North Carolina Department of Environment and Natural Resources (NCDENR) Storm Water BMP Manual;
- Georgia Storm Water Management Manual;
- Charlotte-Mecklenburg BMP Design Manual
- Knox County Tennessee Storm Water Management Manual; and,
- New Jersey Storm Water Best Management Practices Manual.

All literature sources used in the development of the Water Quality Factors are listed in Section I.5, References.

Pollutants of Concern

A review of the literature data revealed that there are a wide variety of pollutants removed by post-construction water quality BMPs. However, a total of 9 pollutants were identified as the most common tested for in BMP performance studies. These 9 pollutants also represent several of the pollutants of concern in Greenville County. These are:

1. Total Suspended Solids (TSS)
2. Total Phosphorus (TP)
3. Total Nitrogen (TN)
4. Nitrate Nitrogen (Nitrate-N)
5. Total Copper (TCu)
6. Total Lead (TPb)
7. Total Zinc (TZn)
8. Bacteria (Fecal coliform)
9. Petroleum Hydrocarbons

Pollutant Removal Assessment

Individual BMP performance is dependent on many factors including site specific characteristics, influent concentrations, flow rates, and flow volumes. These variable factors make it difficult to directly compare results from separate experiments or tests. The most comprehensive and up to date data source found in the literature for BMP pollutant removal performance data is considered to be the International Storm Water Best Management Practices (BMP) Database. This database contains and summarizes data from over 300 BMP studies and provides performance analysis results as well as other tools and guidance. These performance data from this database were used if available. Performance data from other data sources were used if unavailable from the International BMP Database. The pollutant removal efficiency values used in the computation of Water Quality Factors

are shown in Table I-2.

Pollutant Removal Scores and Water Quality Factors

The pollutant removal scoring system developed to assess the pollutant removal capability of each approved BMP uses the pollutant removal efficiencies provided in Table I-2. The pollutant removal efficiency for each pollutant for each BMP was given a rating between 0 and 5, with 5 being the highest. The relative score given to a particular BMP for a particular pollutant was based on the expected removal potential for the given pollutant. For example, TSS removal of 80% or higher is desirable and given a score of five, however 80% removal of Total N is difficult, so 60% Total N removal is given a score of five. Table I-3 identifies pollutant removal efficiency ranges for each pollutant of concern and the associated score for that range.

Table I-4 lists the score given to each BMP for its removal performance for each pollutant. The total score for each BMP is provided in Table I-5. Because the highest score each pollutant could potentially receive is five, and the number of pollutants considered is 9, the highest possible score a BMP could receive is a 45. The Water Quality Factor for each approved BMP was determined by dividing the total score received by the maximum possible score then rounding that value to the nearest multiple of five as shown on Table I-5. Water Quality Factors for each Greenville County approved BMP is shown in decimal and percentage format in Table I-5.

I.4 Determination of Storm Water Service Fee Credit

Up to a 25% credit will be available for property owners that install water quality facilities and BMPs on their properties. All storm water quality BMP structural controls must be designed to effectively reduce pollutants associated with post-construction storm water runoff and in accordance with the Greenville County Storm Water Management Design Manual. To be eligible for this credit, the property owner shall submit a certification from a licensed engineer verifying that the flow from the percentage of the property indicated is routed through the water quality facility or BMP. The Water Quality Factor shall be used along with the percent impervious drainage area of the property draining to the BMP to determine the Water Quality Credit for new water quality BMPs as follows:

New Storm Water Quality Control BMP Credit = Percentage of the impervious area of the property that is routed through the BMP x Water Quality Factor % (from Table I-5) x 25%

I.5 References

Atlanta Regional Commission, 2001. "Georgia Storm Water Management Manual", Volume 2, Technical Handbook, First Edition, August 2001.

British Columbia Environmental Protection Division. "Municipal Urban Runoff, BMP Compendium", <http://www.env.gov.bc.ca/wat/wq/nps/BMP_Compendium/Municipal/Urban_Runoff/Treatment/Detention.htm#basins >

Center for Watershed Protection. Article 64 – Comparative Pollutant Removal Capability of Storm Water Treatment Practices, Technical Note #95 from Center for Watershed Protection Techniques. 2(4):515-520. http://www.cwp.org/ResourceLibrary/pwp.htm/

Charlotte-Mecklenburg BMP Design Manual, April 30, 2008.
Geosyntec, Inc. and Wright Water Engineers, Inc. 2008. "International Storm Water Best Management Practices (BMP) Database", Overview of Performance by BMP Category and Common Pollutant Type, June 2008. < http://www.bmpdatabase.org/BMPPerformance.htm >

Knox County, Tennessee. "Storm Water Management Manual", Volume 2, Technical Guidance.

New Jersey Storm Water Best Management Practices Manual, February 2004.

North Carolina Department of Environment and Natural Resources, 2007. Storm Water BMP Manual, Chapter 4, revised 09-28-07.

U.S. Environmental Protection Agency. Storm Water Menu of BMPs, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm/

Table I-1. Approved Post-Construction Storm Water Quality BMPs Greenville County, South Carolina		
BMP	**Examples**	**Specific Products/ Manufacturers***
NON-STRUCTURAL BMPS		
Open vegetated conveyance systems		
Natural stream buffers		
Disconnected rooftop to pervious area		
Grass or alternative paving surfaces		
Natural Infiltration		
STRUCTURAL BMPS – GENERAL APPLICATION		
Dry Detention Basin	Dry detention pond Dry underground vault/ pipe	
Wet Detention Pond	Wet detention pond Wet underground vault/ pipe	
Storm Water Wetlands	Wetland basin Wetland channel	
Biofilter	Enhanced Grassed Swale	
Media Filter	Bioretention Area Infiltration Trench Sand Filter	
MTD Type 1, 2, and 3		**See MTD Specification**
STRUCTURAL CONTROLS – LIMITED APPLICATION		
Vegetated Filter Strip		
Vegetated Channels and Swales		

Table I-2. Pollutant Removal Efficiencies for Approved BMPs Greenville County, South Carolina									
BMP	**TSS**	**TP**	**TN**	**Nitrate-N**	**TCu**	**TPb**	**TZn**	**Bacteria**	**TPH**
NON-STRUCTURAL BMPS									
Open vegetated conveyance systems	45	25	20					Low	
Natural stream buffers	60	35	30					Low	
Disconnected rooftop to pervious area	0	0	9					Med	
Grass or alternative paving surfaces	0	0	9					Med	
Natural Infiltration	63	30	42	-100	30	67	59	Med	84
STRUCTURAL BMPS – GENERAL APPLICATION									
Dry Detention Basin	57	19	31	17	40	37	46	Med	60
Wet Detention Pond	61	43	13	36	29	63	52	High	81
Storm Water Wetlands	52	48	46	41	25	30	35	High	85
Biofilter	54	29	17	38	67	66	77	Low	62
Media Filter	63	30	42	-100	30	67	59	Med	84
Media Filter (Manufactured Devices)	63	30	-42	-100	30	67	59	Med	84
Hydrodynamic Device (Manufactured Devices)	5	-8	-61	-30	8	42	33	None	High
STRUCTURAL CONTROLS – LIMITED APPLICATION									
Vegetated Filter Strip	54	-25		-27		-16	47	Low	
Vegetated Channels and Swales	45	25	20					Low	

Table I-3. Pollutant Removal Ranges and Scores for Pollutants of Concern Greenville County, South Carolina									
Pollutant Removal Range %	TSS	TP	TN	Nitrate-N	TCu	TPb	TZn	Bacteria	TPH
	Pollutant Removal Score								
90-100	5	5	5	5	5	5	5	5	5
80-89	5	5	5	5	5	5	5	5	5
70-79	4	5	5	5	5	5	5	5	4
60-69	4	4	4	5	4	4	4	5	4
50-59	3	4	4	4	4	4	4	4	3
40-49	3	4	4	4	4	4	4	4	3
30-39	2	3	3	4	3	3	3	3	2
20-29	2	3	3	3	3	3	3	3	2
10-19	1	2	2	3	2	2	2	2	1
5-9	1	1	1	2	1	1	1	1	1
0-4	1	1	1	1	1	1	1	1	1
<0	0	0	0	0	0	0	0	0	0

Table I-4. Pollutant Removal Scores for Approved BMPs Greenville County, South Carolina									
BMP	**TSS**	**TP**	**TN**	**Nitrate-N**	**TCu**	**TPb**	**TZn**	**Bacteria**	**TPH**
NON-STRUCTURAL BMPS									
Open vegetated conveyance systems	3	3	3					1	
Natural stream buffers	4	3	3					1	
Disconnected rooftop to pervious area	1	1	1					3	
Grass or alternative paving surfaces	1	1	1					3	
Natural Infiltration	4	3	4	0	3	4	4	3	5
STRUCTURAL BMPS – GENERAL APPLICATION									
Dry Detention Basin	3	2	3	3	4	4	4	3	4
Wet Detention Pond	4	4	2	4	3	4	4	5	5
Storm Water Wetlands	3	4	4	4	3	3	4	5	5
Biofilter	3	3	3	1	5	5	5	1	4
Media Filter	4	3	4	0	3	4	4	3	5
Media Filter (Manufactured Devices)	4	3	4	0	3	4	4	3	5
Hydrodynamic Device (Manufactured Devices)	1	0	0	0	2	4	3	0	5
STRUCTURAL CONTROLS – LIMITED APPLICATION									
Vegetated Filter Strip	3	3	2					1	
Vegetated Channels and Swales	3	3	3					1	

Table I-5. Water Quality Factors for Approved BMPs Greenville County, South Carolina				
BMP	**Total Score**	**Computed Water Quality Factor***	**Adopted Water Quality Factor**	**Adopted Water Quality Factor (%)**
NON-STRUCTURAL BMPS				
Open vegetated conveyance systems	10	0.22	0.20	20
Natural stream buffers	11	0.24	0.25	25
Disconnected rooftop to pervious area	6	0.13	0.15	15
Grass or alternative paving surfaces	6	0.13	0.15	15
Natural Infiltration	30	0.67	0.65	65
STRUCTURAL BMPS – GENERAL APPLICATION				
Dry Detention Basin	30	0.67	0.65	65
Wet Detention Pond	35	0.78	0.80	80
Storm Water Wetlands	35	0.78	0.80	80
Biofilter	30	0.67	0.65	65
Media Filter	30	0.67	0.65	65
Media Filter (Manufactured Devices)	30	0.67	0.65	65
Hydrodynamic Device (Manufactured Devices)	15	0.33	0.35	35
STRUCTURAL CONTROLS – LIMITED APPLICATION				
Vegetated Filter Strip	9	0.20	0.20	20
Vegetated Channels and Swales	10	0.22	0.20	20

***** Computed Water Quality Factor = Total Score/ Maximum Score. Maximum Score = 45.