KNOX COUNTY, TENNESSEE
Site Planning Roundtable
WQv Credits for the Use of *Better Site Design* Practices

1.0 INTRODUCTION

This white paper presents a discussion of *Better Site Design* practices and how such practices can be utilized within the Knox County Stormwater Management program to reduce the required stormwater treatment volume.

1.1 SPR Recommendations

The use of *Better Site Design* practices in new developments can address several of the Site Planning Roundtable recommendations that were developed in 2003. Further, the ability to decrease the required stormwater treatment volume (WQv) by reductions of imperviousness and/or through optional volume credits provide incentives for a great majority of the recommendations. These recommendations are presented in Table 1.

Table 1: SPR Recommendations that are Addressed by the Use of *Better Site Design* Practices

SPR Recomm. Number	Recommendation
1	Change current residential street design standards to reduce road width based on average daily trips (ADT) and number of dwelling units served.
2	The bulb radius of cu-de-sacs should be reduced to 30 ft. if the street length is 150 ft. or less. MPC should encourage the use of alternative street layouts (eye brow and hammerheads) in place of cul-de-sacs if street length is 250 ft. or less.
3	Require vegetated open channels for stormwater conveyance in large lot subdivisions.
4	Develop standards for water quality open channel design to be used as a stormwater best management practice.
6	Encourage and allow shared parking. Examine options to allow for shared parking when new development adjoins existing development.
7	Set standards for stormwater treatment and landscaping requirements for parking areas and provide incentives to developers for additional treatment and reuse of stormwater.
8	Promote maximum preservation of connected open space within a development and provide additional opportunities for stormwater treatment.
11	Direct rooftop runoff to pervious areas and avoid routing directly to the roadway or stormwater conveyance system.
12	Establish an Open Space planning mechanism for Knox County to be used as the basis for open space incentives, and to encourage developers to go beyond minimum requirements, provide opportunities for watershed based stormwater detention and identify land area to be protected and managed as open space.
13	Establish a minimum undisturbed buffer along streams, along with incentives to increase the undisturbed buffer or to utilize low impact construction/design

	practices for sewer installation in stream buffer areas.
14	Develop a performance standard to measure the stormwater quantity/rate and quality from a subdivision after development, against the discharge from the pre-development land use. Give incentives for site or best management practice (BMP) designs that exceed performance standards. Develop alternatives to required BMPs that can meet or exceed performance standards.

2.0 BACKGROUND INFORMATION

2.1 Definitions

For purposes of this white paper, the following definitions are included:

***Better Site Design*:** a combination of non-structural design approaches intended to reduce the impacts of stormwater runoff from development through the conservation of natural areas, reduction of impervious areas, and integration of stormwater treatment controls. *Better Site Design* practices are often referred to as "non-structural practices or controls".

Channel Protection Volume (CPv): The sizing criteria that will be utilized to provide channel protection for channels and streambanks located downstream from a new development. The CPv standard will require that new developments attenuate the post-development runoff rate to the pre-development rate for the 1-year, 24-hour storm event. Note that the appropriate design storm event is still under investigation by the consultant.

Credit: a reduction in the water quality treatment volume (WQv) for the use of certain non-structural practices, in accordance with design criteria provided by Knox County.

Extreme Flooding Criteria (Q_{100}): The sizing criteria that will be utilized to provide extreme flood protection downstream from a new development. The Q_{100} criteria will require that new developments evaluate the effects of the 100-year storm on the stormwater management system, adjacent property, and downstream facilities and property via a pre-post peak rate comparison. The impacts of the extreme storm event must be managed through detention controls and/or floodplain management practices, in accordance with Knox County regulations.

Overbank Flooding Criteria (Q_{25}): The sizing criteria that will be utilized to provide overbank flood protection downstream from a new development. The Q_{25} criteria will require that new developments provide peak discharge control of the 2-year, 5-year, 10-year, 25-year return frequency, 24-hour duration storm events, such that the post-development peak rate does not exceed the predevelopment rate.

Water Quality Volume: the volume of stormwater runoff from a developed site that must be treated to a standard of 80% removal of Total Suspended Solids (TSS).

2.2 Current Local Standards

Although non-structural practices are generally welcomed and encouraged, currently there are no provisions within City or County regulations or development guidelines that provide treatment volume or other incentives for the use of *Better Site Design* practices. Guidelines and planning documents that have been produced by the Metropolitan Planning Commission often contain a discussion of such practices, but not in the context of water quality treatment.

2.3 Review of WQv

Before discussion of water quality treatment volume credits, it may be helpful to briefly review the WQv approach, which is summarized in steps 1 through 4 below. This white paper discusses steps 3 and 4 in detail. Steps 1 and 2 were discussed in detail in the white paper entitled Using a Water Quality Volume (WQv) Approach for Site Design, which was provided as read ahead material to the Knox County Site Planning Roundtable meeting that occurred on July 27, 2005.

1. The runoff water quality treatment volume (WQv) is calculated based on the amount of impervious surfaces (e.g., rooftop, pavement, and other structures impermeable to rainfall) located on the site.
2. The runoff must be treated to the 80% TSS removal goal.
3. Consider the use of non-structural BMPs. Such measures can be used to gain credits against (i.e., reductions in) the water quality treatment volume. Non-structural BMPs are specific and defined "green" design approaches in the site layout.
4. One or more structural BMPs (such as bioretention areas) can then be designed to treat the remaining WQv (after credits).

The amount of stormwater runoff that must be treated from a developed site (i.e., the WQv) is calculated using the following equation:

$$WQv = \frac{P * Rv * A}{12}$$

where:

WQv = water quality volume (ac-ft);
P = rainfall depth for the 85% storm event (approx. 1-inch);
Rv = runoff coefficient; and
A = site area (acres).

The runoff coefficient (*Rv*) is calculated as follows:

$$Rv = 0.015 + 0.009I$$

where:

I = percent impervious area of site.

Note that WQv increases as impervious area increases. In other words, the more you pave, the more you treat. Therefore, to reduce the amount of stormwater runoff that must be treated, the developer should find ways to reduce site imperviousness.

The percent TSS removal that is achieved on a site can be calculated during the site design using the following equation and is simply an area-weighted TSS reduction, based on the area draining to each BMP, as shown in the equation below. Knox County proposes to set a water quality treatment goal of 80% removal of TSS.

$$\%TSS = \frac{\sum_n^1 (TSS_1 A_1 + TSS_2 A_2 + ... + TSS_n A_n)}{\sum_n^1 (A_1 + A_2 + ... + A_n)}$$

where:

TSS_n = TSS removal % for each structural BMP located on-site;
A_n = the area draining to each BMP (in acres).

3.0 OVERVIEW OF *BETTER SITE DESIGN* PRACTICES

3.1 Goals and Advantages

The first step in addressing stormwater management begins with the site planning and design process. Development projects can be designed to reduce their stormwater impact on local streams when careful efforts are made to conserve natural areas, reduce impervious cover and better integrate stormwater treatment practices. By implementing a combination of these non-structural approaches collectively known as stormwater *Better Site Design* practices, it is possible to reduce the amount of runoff and pollutants that are generated from a site and provide for some non-structural on-site treatment and control of runoff. However, as stated in previous white papers and SPR meetings, site developers will have the flexibility of choosing whether or not to implement non-structural BMPs.

The goals of *Better Site Design* include:

- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing stormwater collection and conveyance;
- Preventing stormwater impacts rather than mitigating them after they occur;
- Utilizing simple, non-structural methods for stormwater management that are lower cost and lower maintenance than structural controls;
- Creating a multifunctional landscape;
- Minimizing the use of structural treatment controls to the extent possible;
- Using hydrology as a framework for site design.

Better Site Design for stormwater management includes a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management. The aim is to reduce the environmental impact "footprint" of

the site while retaining and enhancing the owner/developer's purpose and vision for the site. Many of the *Better Site Design* concepts can reduce the cost of infrastructure while maintaining or even increasing the value of the property. Using *Better Site Design* can reduce the required runoff peak discharge and/or volumes that need to be conveyed and controlled on a site. As a result, the size and cost of necessary drainage infrastructure and structural stormwater controls can be reduced as well. Reducing the runoff from a site also reduces pollutant loading from a site. For these reasons, *Better Site Design* concepts can be viewed as both a water quantity and water quality management tool and should be a primary consideration when planning the design of a site.

Through the WQv method, *Better Site Design* practices can reduce the required treatment volume in two ways.

1. Any reduction in impervious area will lead to a decrease in WQv because of the direct relationship between the treatment volume and impervious area (I). This may also lead to a calculable reduction in the sizing requirements of detention structures because the post-development peak discharges and volumes may be reduced as well.
2. Several of the site design practices described in this white paper can provide a site design treatment volume "credit" which can be applied to the WQv.

The use of stormwater *Better Site Design* can also have a number of other ancillary benefits that were supported and or recommended through the Site Planning Roundtable recommendations that were developed in 2003. These benefits include:

- Reduced construction costs;
- Increased property values;
- More open and/or natural spaces;
- More pedestrian-friendly neighborhoods;
- Protection of sensitive forests, wetlands and habitats;
- More aesthetically pleasing and naturally attractive landscape;
- Easier compliance with wetland and other resource protection regulations.

3.2 Summary of *Better Site Design* Practices

General stormwater *Better Site Design* practices and techniques are grouped into four categories and are listed below. These practices will be encouraged in Knox County through the Knox County Stormwater Management Manual (currently under development), within the bounds of applicable subdivision, zoning, flood management and stormwater management regulations. The list below notes any SPR recommendations that support, either directly or indirectly, encouragement of the practice in Knox County.

Conservation of Natural Features and Resources

- Preserve Undisturbed Natural Areas *(Recommendation 12)*
- Preserve Riparian Buffers *(Recommendation 13)*
- Avoid Floodplains *(Recommendation 18)*
- Avoid Steep Slopes *(Recommendation 18)*
- Minimize Siting on Porous or Erodible Soils *(Recommendation 13)*

Lower Impact Site Design Techniques

- Fit Design to the Terrain *(Recommendation 8 and 18)*
- Locate Development in Less Sensitive Areas *(Recommendation 18)*
- Reduce Limits of Clearing and Grading *(Recommendation 8, 13, and 18)*
- Utilize Open Space Development *(Recommendations 8 and 12)*
- Integrate Stormwater Management areas

Reduction of Impervious Cover

- Reduce Roadway Lengths and Widths *(Recommendations 1 and 8)*
- Reduce Building Footprints *(Recommendation 8)*
- Reduce the Parking Footprint *(Recommendations 5 and 6)*
- Reduce Setbacks and Frontages *(Recommendation 8)*
- Use Fewer or Alternative Cul-de-Sacs *(Recommendation 2)*
- Create Parking Lot Stormwater "Islands" *(Recommendation 7)*

Utilization of Natural Features for Stormwater Management

- Use Buffers and Undisturbed Areas *(Recommendations 12 and 13)*
- Use Natural Drainageways Instead of Storm Sewers *(Recommendations 3 and 4)*
- Use Vegetated Swale Instead of Curb and Gutter *(Recommendations 3 and 4)*
- Drain Rooftop Runoff to Pervious Areas *(Recommendation 11)*

Information on these design practices and the *Better Site Design* process in general will be provided in the Knox County Stormwater Management Manual (under development).

4.0 OBTAINING WQv CREDITS

To provide additional incentives for the implementation of *Better Site Design* practices, Knox County proposes to recognize the water quality benefits of certain site design practices by allowing for a reduction in, or a waiver of, the WQv. If a developer incorporates one or more of the credited practices in the design of the site, the requirement for capture and treatment of the water quality volume will be reduced and possibly eliminated. Several site design credits also function as treatment BMPs and are assigned TSS reduction values. Regardless of whether a non-structural BMP is utilized, each site must comply with the 80% TSS removal goal.

Knox County staff recommend that the following *Better Site Design* practices be offered as options to obtain stormwater treatment volume credits against the water quality treatment volume, WQv.

- Credit #1: The Natural Area Conservation Credit
- Credit #2: Managed Conservation Area Credit
- Credit #3: The Stream and Vegetated Buffer Credit
- Credit #4: The Vegetated Channel Credit
- Credit #5: The Impervious Area Disconnection Credit
- Credit #6: The Environmentally Sensitive Large Lot Neighborhood Credit

Each credit option is discussed in detail below. Each discussion includes a description of the credit, the credit "rules" for calculation of WQv and %TSS, and a list of the site-specific

conditions and design criteria that will determine the applicability of each credit on a site-by-site basis. The information presented below is based upon design criteria developed for the *Georgia Stormwater Management Manual*, suitably modified to local, Knox County hydrologic and hydraulic conditions.

4.1 Credit #1: The Natural Area Conservation Credit

Description

A credit may be granted when undisturbed, natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements. The area can be used as an undisturbed buffer for sheet flow discharge for site design Credit #2, or for sheet flow of disconnected impervious areas under Credit #4. An added benefit of the use of the natural area conservation credit will be that the post-development peak discharges will be smaller for all design events, and hence water quantity control volumes (CP_v, Q_{p25}, and Q_f) will be reduced due to lower post-development curve numbers or rational formula "C" values.

Rule

Subtract conserved natural areas from the total site area (A) when computing the water quality volume (WQv). The percent impervious (I) is held constant. Areas qualifying for this credit receive a 100% TSS reduction value in pollutant reduction computations.

Design/Implementation Criteria

- The natural conservation area cannot be disturbed during project construction. If it is already disturbed prior to development or redevelopment, it can be restored as a natural area to gain a credit, provided that a suitable planting and management plan is submitted with the Stormwater Management Plan prepared for Knox County approval.
- The limits of disturbance on the site surrounding the natural conservation area shall be clearly shown on all construction drawings. The area must be staked in the field prior to issuance of a grading permit.
- The conservation area shall be protected in perpetuity by a permanent conservation easement that is recorded with the deed. If the area is not publicly owned, the easement must be held by either of the following non-governmental entities:
    1. A land trust or similar conservation-oriented, non-profit organization with legal authority to accept such easements. The organization shall be bona fide and in perpetual existence and the conveyance instruments shall contain an appropriate provision for re-transfer in the event the organization becomes unable to carry-out it functions; or
    2. A homeowners association (HOA), provided that the following criteria are met:
        a. Membership in the HOA is mandatory and automatic for all homeowners of the subdivision and their successors.
        b. The HOA shall have lien authority to ensure the collection of dues from all members.
        c. The HOA assumes the responsibility for protecting, monitoring and maintaining the area as a conservation easement, in perpetuity.

- The conservation easement must clearly specify how the natural area vegetation shall be managed and how the boundaries of the area will be marked. (Note: managed turf areas, such as playgrounds and regularly maintained open areas, are not an acceptable form of vegetation management).
- The natural conservation area shall have a minimum contiguous area requirement of 10,000 square feet.

4.2 Credit #2: The Managed Conservation Area Credit

Description

A credit may be granted when areas of managed open space, typically reserved for passive recreation or agricultural practices, are conserved on a site. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements. The area can be used for sheet flow of disconnected impervious areas under Credit #4. An added benefit of the use of the natural area conservation credit will be that the post-development peak discharges will be smaller for all design events, and hence water quantity control volumes (CP_v, Q_{p25}, and Q_f) will be reduced due to lower post-development curve numbers or rational formula "C" values.

Rule

Subtract conserved natural areas from the total site area (A) when computing the water quality volume (WQv). The percent impervious (I) is held constant. No TSS reduction is received through this credit.

Design/Implementation Criteria

- The conservation area must have a passive recreational or agricultural land use.
- The conservation area must be protected in perpetuity by a permanent conservation easement that is recorded with the deed. If the area is not publicly owned, the easement must be held by either of the following non-governmental entities:
  1. A land trust or similar conservation-oriented, non-profit organization with legal authority to accept such easements. The organization shall be bona fide and in perpetual existence and the conveyance instruments shall contain an appropriate provision for re-transfer in the event the organization becomes unable to carry-out it functions; or
  2. A homeowners association (HOA), provided that the following criteria are met:
     a. Membership in the HOA is mandatory and automatic for all homeowners of the subdivision and their successors.
     b. The HOA shall have lien authority to ensure the collection of dues from all members.
     c. The HOA assumes the responsibility for protecting, monitoring and maintaining the area as a conservation easement, in perpetuity.
- The conservation easement must clearly specify how vegetation shall be managed and how the boundaries of the area will be marked.
- A legally-binding Management Plan must accompany the conservation easement. The Management Plan must show the vegetation management practices and other BMPs that will be utilized for maintenance of the area. Practices that have the potential to cause discharges of pollutants and sediment off-site are prohibited. If the area is to be actively farmed, the Management Plan must be approved and monitored by the NRCS.

- The managed conservation area shall have a minimum contiguous area requirement of 10,000 square feet.

4.3 Credit #3: The Stream and Vegetated Buffers Credit

Description

This credit may be granted when stormwater runoff is effectively treated by a stream buffer or other vegetated buffer. Effective treatment constitutes treating runoff as overland sheet flow through an appropriately vegetated and forested buffer. Under the proposed credit, a designer would be able to subtract areas draining via overland flow to the buffer from total site area when computing water quality volume requirements. The area draining to the buffer and the buffer itself qualify for credit. In addition, the volume of runoff draining to the buffer can be subtracted from the CPv. The design of the buffer treatment system must use appropriate methods for conveying flows above the annual recurrence (1-yr storm) event.

Rule

Subtract areas draining via overland flow to the buffer from total site area when computing the water quality volume (WQv). The percent impervious (I) is held constant. For buffers with a grassed and managed outer zone (Zone 2), the buffer and areas draining to the buffer qualify for the credit and receive an 80% TSS reduction credit. For buffers that are at least 50' in width and are comprised entirely of undisturbed forest vegetation, the buffer itself can qualify for credit #1 as a natural conservation area, while the areas draining to the buffer qualify for the buffer credit and receive an 80% TSS reduction value.

Design/Implementation Criteria

- The area of the buffer that is utilized for stormwater treatment must have a minimum buffer width of 50 feet. If buffer averaging is utilized, buffer areas that have a width less than 50 feet are not eligible to receive this credit.
- At a minimum, buffers must be designed and managed (in perpetuity) in accordance with the requirements and policies for water quality buffers in Knox County (e.g., two-zones, forested and grassed, etc.). Increases in buffer width and/or widths of forest vegetation are strongly encouraged.
- Undisturbed and unmanaged buffers that are at least 50' wide can qualify for credit #1 as a natural conservation area.
- Stormwater runoff must enter the buffer as overland sheet flow.
- The maximum contributing length of sheet flow shall be 225 feet, with a maximum of 150 feet for pervious surfaces, and 75 feet for impervious surfaces.
- The average contributing slope shall be 3% maximum unless a flow spreader is used.
- This credit is not applicable if the impervious area disconnection credit (Credit 4) is already being applied to the same area.

4.4 Credit #4: The Vegetated Channel Credit

Description

This credit may be granted when vegetated (grass) channels are used for water quality treatment. Site designers will be able to subtract the areas draining to a grass channel and the channel area itself from total site area when computing water quality volume requirements. A vegetated channel may be able to fully meet the water quality volume requirements for certain kinds of low density residential development (see Credit #5). An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Rule

Subtract the areas draining to a vegetated (grass) channel from total site area when computing the water quality volume (WQv). The percent impervious shall be held constant. Areas qualifying for this credit receive an 80% TSS reduction value in pollutant reduction computations.

Design/Implementation Criteria

- The vegetated channels must be located within a conservation easement.
- The credit shall only be applied to residential land uses that have a maximum of three (3) dwelling units per acre.
- The maximum flow velocity in the channel for the WQv design storm shall be less than or equal to 1.0 feet per second.
- The minimum residence time for the water quality storm shall be 5 minutes.
- The bottom width shall be a maximum of 6 feet. If a larger channel is needed, use of a compound cross-section (i.e., a benched channel) is required.
- The side slopes shall be 3:1 (horizontal:vertical) or flatter.
- This credit will not be granted if engineered grass channels are being used as a limited application structural stormwater control in order to meet the 80% TSS removal goal for WQv treatment.

4.5 Credit #5: The Impervious Area Disconnection Credit

Description

This credit may be granted when impervious areas are disconnected from the stormwater control system via overland flow filtration/infiltration (i.e., pervious) zones. These pervious areas are incorporated into the site design to receive runoff from rooftops or other small impervious areas (e.g., driveways, small parking lots, etc). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or “rain garden” areas. If impervious areas are adequately disconnected in accordance with the criteria listed below, they can be deducted from the total site area when computing the water quality volume requirements. An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Rule

If impervious areas are adequately disconnected, they can be deducted from the total site area when computing the water quality volume (WQv). The percent impervious area

shall be held constant. Areas qualifying for this credit receive an 80% TSS reduction value in pollutant reduction computations.

Design/Implementation Criteria

- Relatively permeable soils or placed topsoil (hydrologic soil groups A and B) should be present.
- Runoff shall not come from an area that is known to have a higher than normal likelihood for pollutant discharges (also called a "hotspot").
- The maximum contributing impervious flow path length shall be 75 feet.
- Downspouts shall be at least 10 feet away from the nearest accessible impervious surface (including off site impervious areas) to discourage "re-connections" or flow concentration along a paved edge.
- The disconnection shall drain continuously through a vegetated channel, swale, or filter strip to the property line or structural stormwater control.
- The length of the "disconnection" shall be equal to or greater than the contributing length.
- The entire vegetative disconnection shall be on a slope less than or equal to 3 percent.
- The impervious surface area to any one discharge location shall not exceed 5,000 square feet.
- For those areas draining directly to a buffer, either the impervious area disconnection credit or the stream buffer credit can be used, but not both.

4.6 Credit #6: The Environmentally Sensitive Large Lot Neighborhood Credit

Description

This credit is targeted toward large lot residential developments that implement a number of *Better Site Design* practices to reduce stormwater discharges from the development as a whole. This credit may be granted when a group of environmental site design techniques are applied to low and very low density residential development (e.g., 1 dwelling unit per 2 acres [du/ac] or lower). The credit can eliminate the need for structural stormwater controls to treat water quality volume requirements. This credit is targeted towards large lot subdivisions and will likely have limited application.

Rule

The requirement for structural controls to treat the water quality volume treatment requirements shall be waived.

Design/Implementation Criteria

- The total impervious cover footprint (including streets) of the residential development shall be less than 15% of the total area.
- Restrictive covenants, conservation easements or other legal instrument must be used to limit imperviousness for each lot or to set open space aside as perpetually undevelopable. The legal instrument must be conveyed with each property within the development.
- Lot areas shall be at least 2 acres, unless clustering is implemented. Open space developments should have a minimum of 25% of the site protected as natural conservation areas and shall be at least a half-acre average individual lot size.
- Grass channels shall be used to convey runoff versus curb and gutter.

- Impervious areas shall be disconnected, in accordance with the criteria set forth in Credit #4, to the maximum extent practicable.