Date: November 21, 2008

To: Nancy Stoner, Natural Resources Defense Council

From: Tom Schueler, Chesapeake Stormwater Network

Re: Expert Report: Implementation Issues Related to the Draft Montgomery County MS4 NPDES Stormwater Permit

I have analyzed the strengths and weaknesses of the proposed permit cited above, and offer a series of comments that focus on the most effective methods to implement and track pollutant reductions within the framework of the new permit. The permit challenge, in my view, is how to make the maximum improvement in County water quality in the shortest timeframe by guiding increased investments toward the most cost effective combination of stormwater practices and programs that really work. With this in mind, this report outlines recommendations in ten specific areas of the permit that can substantially meet this permit challenge without dramatically increasing County expenditures at a time of budget uncertainty. The scope of the report is as follows:

Section 1: Track Pollutant Loads to Show Progress toward Waste Load Allocations and Water Quality Standards
Section 2: Apply a Broad Range of Stormwater Control Measures
Section 3: Integrate Multiple Permit Requirements at the Watershed Level
Section 4: Assess and Retrofit County Lands and Stormwater Treatment Infrastructure
Section 5: Survey to Craft Most Cost Effective Trash Prevention/Reduction Techniques
Section 6: Undertake Process to Remove Local Barriers to ESD
Section 7: Classify and Manage County Streams
Section 8: Target Illicit Discharge Detection and Elimination Efforts
Section 9: Takeover Inspection of Industrial Stormwater Hotspots
Section 10: Alternative Monitoring for Compliance Assessment
Section 11: References and Sources

Section 1
Track Pollutant Loads to Show Progress towards Meeting Water Quality Standards

Overall Recommendation: *Develop a transparent and scientifically-based pollutant load tracking system to gauge collective progress made in reducing stormwater pollutant loads from existing development, future development and redevelopment sectors that is externally reviewed.*

Justification. The proposed permit requires that the County implement pollutant reductions to impaired waters to meet waste load allocations to meet water quality standards for watersheds where TMDLs have been developed. The actual methods and minimum documentation needed to meet this requirement, however, is not elaborated. A quantitative analysis is needed to link progress made in reducing stormwater pollution loads to decrease water quality violations in impaired waters. Based on recent EPA guidance (2007), this essentially requires a MS4 to conduct a four-step analysis, which is distilled to its essence below:

Step 1. Estimate loads for Pollutant of Concern for the watershed or subwatershed
Step 2. Provide a specific list of BMPs that will be applied in the listed watershed
Step 3. Estimate the pollutant removal capability of the individuals BMPs applied
Step 4. Compute the aggregate pollutant reduction achieved by the MS4 in the watershed

Other communities in the Bay watershed have made excellent progress in reporting baseline pollutant loads by watersheds, and computing pollutant reductions due to implementation of stormwater practices and programs. For example, the watershed calculations provided in Section 10 of the Baltimore County NPDES Annual Report (BC DEPRM, 2007) presents an excellent template for reporting baseline loads and pollutant reductions achieved for TMDL watersheds.

Several practical issues come into play when the County develops its pollutant tracking system, as follows:

- *What is the baseline year against which reductions will be measured against?* This is a key issue, and should reflect the most recent year (2007) for which accurate land use, GIS and BMP data are available.

- *How will pollutant loads be computed/modeled and at what watershed scale?* A variety of simulation and spreadsheet models are available, but given the cost of simulation modeling, it is advisable to start with a simpler spreadsheet model (e.g., Watershed Treatment Model- Caraco, 2004) and focus efforts on improved characterization of land use, BMPS and other metrics within individual watersheds and subwatersheds.

- *How will flow volumes and multiple pollutants be handled in certain watersheds?* It is likely that reductions in multiple pollutants may be required in several watersheds (e.g., bacteria, BOD, nutrients, sediment and trash). In these situations, which pollutant will serve as the primary pollutant to be managed? Given that many of the same watersheds may also suffer from biological impairments caused by stormwater runoff, it may be wise to use flow volume as a surrogate measure of compliance, as recently recommended by NRC (2008).

- *How will the various pollutant reductions by individual and programmatic BMPs be calculated?* The ability to accurately track stormwater pollutant loads from the broad range of structural and non-structural BMPs is still in its infancy, and in many cases, estimates can only be made based upon best available professional estimates, as opposed to reliable monitoring data. This creates considerable opportunity for pollutant accounting tricks, unless these decisions are made in a collaborative, transparent manner involving the best stormwater science available.

- *How will loads from existing development land use categories be tracked?* Loads from existing development can be calculated with some precision for existing development, although careful adjustments are needed to reflect historical reduction/performance that is assigned to the County's existing inventory of stormwater practices (see Section 4).

- *How will loads from new development be tracked?* Estimating pollutant loads from new development depends on the rapidity by which the County adopts and implements ESD to the MEP as actually implemented and certified at real world development sites (i.e., subject to the documentation proposed in Section 6). When ESD is fully implemented at new development projects, these areas can be assumed to be fully treated and add no additional pollutant load to the baseline. By contrast, there is a considerable pipeline effect until ESD is fully rolled out in the County; in the interim the new development projects will add to the baseline load. One of the key weaknesses of the NPDES MS4 permit system nationally is that it does not explicitly address pollutant loadings from future land use change (NRC, 2008). The careful tracking of these new pollutant loads should be a major element of the overall tracking system, and will be the best means to ensure that the County has a strong incentive to fully implement ESD at new development sites, as outlined in the Stormwater Management Act of 2007.

- *How will pollutant loads from redevelopment projects be addressed?* The importance of a strong pollutant tracking system is particularly evident when it comes to redevelopment, which represents one of the prime low-cost strategies to reduce pollutant loads to impaired waters (see Section 6). The accounting system should be explicitly designed to track real reductions in pollutant loads over time as County land is redeveloped.

- *What sort of interim load reduction targets will be set for the coming permit cycle and how and when will they be developed?* It is acknowledged that full achievement of required load reductions may require several permit cycles to attain. The proposed permit contains references to as many as 9 different plans, work plans, schedules, ordinance revisions, in addition to various annual reports. What is missing is a date certain by which interim, watershed-based pollutant load reduction, trash reduction and watershed restoration targets will be developed to guide future management and implementation efforts. County stormwater managers need to have numeric and quantitative targets to guide their implementation in order to assess compliance, and more importantly, track incremental progress in pollutant and trash reduction, as well as watershed restoration activity. Consequently, it is recommended that the permit be modified or otherwise restructured to require the County to produce interim targets for the end of the upcoming permit cycle with 12 months of permit issuance, and create an open and transparent process for MDE and watershed stakeholders to review and approve them.

Detailed Implementation Recommendations: Pollutant "bean counting" issues are critical when it comes to ensuring meaningful water quality improvements occur as a result of permit compliance. Given the current status of stormwater science, it is important to ensure pollutant reductions are real and not just a paper work exercise (CASQA, 2007, NRC, 2008). Since the permit does not reference the four-step method for NPDES MS4 stormwater compliance when discharging to impaired waters (EPA, 2007), the County, and its co-permitees, will need to develop its own computational stormwater pollutant accounting system. Confidence in such an accounting system would be improved if:

- An independent expert panel of scientists and experienced stormwater managers is convened to oversee and approve the technical assumptions, spatial scale, and computational methods used to calculate baseline pollutant loads and corresponding pollutant reductions achieved by individual practice and programs.

- The County should consider additional training for its permit compliance staff to keep up with the state of the art in stormwater science and management practices, and how they are most effectively computed or modeled.

- The County should work closely with other MS4s across the Bay watershed that have similar permit requirements to share stormwater science and continue to refine and improve pollutant reduction estimates.

- The County should also get input from the existing County water quality advisory group (or other appropriate public involvement body) on the stormwater pollutant accounting system prior to submitting it's tracking data to MDE in order to gain greater public acceptance and engagement in the process.

Section 2: Apply a Broad Range of BMPs in the Right Watersheds

Overall Recommendation: *DEP should undertake a comprehensive review of the range of potential BMPs that could be applied in the County to identify the most cost effective combination of practices and programs to assure long term compliance*.

Justification: Managing stormwater at the watershed level is a complex process, and a wide range of potential best management practices (BMPs) exist that can be applied, which differ greatly in their effectiveness, cost, maintenance, public acceptance and reliability. Table 1 shows the wide range of BMPs that could be applied in the County to achieve permit compliance for pollutant removal, trash reduction and restoration.

Table 1. Range of Potential BMPs to Apply in Montgomery County (adapted NRC, 2008)

Stormwater BMP	**County Baseline**	**Ability to Model**	**MC Examples**
Product Substitution	Reduce Existing PL	Yes	County Ban on P Content in Lawn Fertilizer County Ban on Plastic Bags
Watershed and Land Use Planning	Prevents New PL and IRV		Expanded Special Protection Areas Subwatershed Restoration Plans County Stream Classification (Section 7)
New Development Practices: Conservation of Natural Areas Impervious Cover Minimization Earthwork Minimization Erosion and Sediment Control Reforestation and Soil Conservation, ESD Practices at New Development	Prevents New PL and IRV No Baseline Increase If MEP Achieved	Yes	All Practices Combined Together to Implement ESD to the MEP No net increase when MEP achieved, otherwise incremental load increased Need to review codes for ESD barriers and development runoff reduction spreadsheet tool to verify site compliance (see Section 6)
Pollution Prevention at Stormwater Hotspots	Reduces Existing PL	Moderate	County negotiates MOU with State to inspect and refer enforcement on industrial NPDES permits (see Section 9)
ESD Practices for Redevelopment	Reduces Existing PL /RV	Yes	Modify stormwater ordinance to go beyond current MDE minimum redevelopment requirements (See Section 6)
Maintenance or Retrofit of Existing Stormwater Infrastructure	Reduces Existing PL/RV	Yes	Conduct functional performance survey along with three year inspections to identify priority repair and retrofits (See Section 4)
Stream Rehabilitation	Reduces Ex. PL	Moderate	Compute load reduction for County stream repair projects
Municipal Street Sweeping and Storm Drain Cleanout	Reduce Ex PL	Moderate	Revise computational methods to reflect recent research (CWP, 2008b)
Illicit Discharge Detection	Reduce Ex PL	Limited	Targeted subwatershed surveys (Section 8)
Stormwater Education	Reduce Ex. PL	Limited	Conduct behavior surveys to target education demographics
Residential Stewardship and On-site retrofits	Reduces Ex PL/RV	Limited	See Schueler (2005) and CASQA (2007) for program design and evaluation tips

Key: PL = Pollutant Loads, RV= Runoff Volume IRV= Increased Runoff Volume

Detailed Implementation Recommendation. As can be seen from Table 1, each kind of BMP affects the County baseline load in a different manner, and also differs in how easy it is to model or quantify its benefit(s).

- Given such a wide range of choices, and their relative differences in regard to pollutant removal reliability, ease of implementation and cost, it will be important for the County to undertake an initial comprehensive review of what combination(s) of BMP strategies represents the best investment to meet the permit conditions. The CSN would be pleased to provide more information to DEP staff on the current science and economics of each of these BMPs.

Section 3 Integration of Multiple Permit Requirements at the Watershed Level

Overall Recommendation: *To prevent confusion, the County should take an integrated approach to target and implement the various permit conditions and requirements on a watershed basis, and use the considerable GIS resources it has developed over the past years to track where and when implementation actions will be targeted.*

Justification: At first glance, the permit is a six-headed monster with specific watershed conditions relating to current and future TMDL requirements, a county-wide watershed restoration target, trash reduction in Potomac watersheds, specific monitoring requirements for the Clarksburg Special Protection Area and the Lower Paint Branch, general County-wide watershed assessment requirements, and programmatic requirements for IDDE, municipal good housekeeping and environmental site design (ESD) that are best applied on a watershed basis. In addition, the permit conditions also apply to different watershed scale, County land use types and pollutants of concern, as shown in Table 2.

Table 2: The Permit Conditions: Scale, Land Use and Pollutants of Concern

Permit Condition	Scale	Land Use	Pollutants Impairments
TMDLs 20% Restoration Potomac Trash CSPA&LBP Monitoring County Shed Assessment Programmatic Permit Conditions	ESD or BMP Site Catchment Subwatershed Watershed County-wide	Exist. Development New Development. Redevelopment County Land Hotspots	Bacteria Sediment Nutrients Trash Flow Biological Impairments

One shudders to think how DEP staff, State regulators and the environmental community can possibly keep track of everything with the many confusing complexities described in Table 2.

Detailed Implementation Recommendation. The recommended approach is to integrate the many different permit conditions at the watershed level, and then assign specific implementation actions to the subwatershed. The integration would begin by simply listing the applicable permit conditions for each watershed, and providing a dozen or so metrics to measure and track permit implementation (baseline pollutant loads, interim and long term reductions needed, number of existing and planned BMPs, numbers of outfalls screened, etc.).

Detailed data for each individual subwatershed within the watershed should also be incorporated in the County watershed GIS system (current and future impervious cover, past and current biological condition, percentage of subwatershed effectively treated or restored, etc.) along with specifics of the scope and schedule for permit implementation in that subwatershed. The subwatershed GIS element could also support an enhanced stream classification and management system described in Section 7 and Appendix B.

Section 4. Assess and Retrofit County Lands and Stormwater Treatment Infrastructure

Recommendation: *Two priority actions need to be considered to meet the ambitious watershed restoration requirements in the proposed permit. The first is a comprehensive performance evaluation of the County's inventory of current stormwater infrastructure, as it will identify the largest and most cost-effective stormwater maintenance, repair and retrofit opportunities. Second, the County should conduct an extensive retrofit inventory investigation for all property owned and managed by the County in targeted watershed (e.g., schools, parks, road right of ways, etc.). Together, these actions will enable the County to identify and build the most cost effective combination of projects to meet both the TMDL pollutant reductions and the watershed restoration permit requirements.*

Justification. The proposed permit requirement to restore an additional 20% of impervious cover in the County is challenging, but is achievable if comprehensive efforts are taken to assess retrofit opportunities at publicly and privately owned stormwater infrastructure and on County owned land. For example, a review of Table III-C2 (MCDEP, 2006) indicates that approximately 3000 stormwater facilities have been installed in the County over the last four decades. Based my own rapid analysis of the Table III-C2, it is my professional opinion that at least 50% of the private and publicly owned stormwater practices are not of a type or design that provides effective pollutant removal, particularly many of the practices constructed in the 1980s and 1990s.

In addition, the actual performance of practices built in all eras in the County needs to be to be discounted to account due to inadequate design, improper installation and poor maintenance. Recent studies in the Bay watershed indicate that a significant proportion of existing practices are ineffective or are not functioning properly due to one or more of these factors. A recent detailed investigation of practice performance in the James River basin in Virginia indicates that as much as half of all stormwater practices installed are not functioning as designed (CWP, in press).

Lastly, the County owns or operates nearly 10% of the land within its own jurisdiction in the form schools, parks, road right of way and other municipal lands. These institutional land uses are often excellent candidates for new stormwater retrofits or enhancements to existing stormwater practices, using the systematic investigation ands assessment methods outlined in Schueler, et al (2007).

Detailed Implementation Recommendations.

1. Comprehensive Performance Evaluation of Existing County Stormwater Inventory. It is strongly recommended that the County undertake a comprehensive inspection of its stormwater inventory not only to assess their maintenance condition, but also their hydrologic and pollutant reduction performance. While the County does a reasonably good job of inspecting its private and public stormwater practices on the three year schedule that has been required under the past and proposed permit, the County needs to do a better job at ranking their individual function and pollutant removal performance. Such an analysis has four key benefits for the County in implementing the permit.

a. The County has several thousand older practices that are counted as being “treated impervious cover” regardless of their design or maintenance condition. By developing more accurate (and presumably lower) estimates of their actual pollutant reduction, the County will end up with a higher baseline pollutant load to work from. This more realistic and higher load creates greater opportunities to derive real future load reductions through enhanced maintenance and retrofitting.

b. Such a survey can identify hundreds of older public and private stormwater facilities whose performance can be quickly boosted through enhanced maintenance (e.g., sediment cleanouts) and low cost retrofits to improve their hydrologic, runoff reduction or pollutant removal performance.

c. Survey data would also enable County stormwater managers to devise a strategic approach to improve the maintenance and function of each element of their existing stormwater infrastructure. This stormwater asset management approach, which has been utilized by Maryland State Highway Administration over the last four years (see graph below), enables stormwater managers to make the most cost-effective decisions on where to invest their major maintenance and retrofit budgets to get the greatest increase in functional performance.

YEAR	Functioning as Designed	Major Maintenance Repair	Retrofit Design / Repair	TOTAL
2002	**688**	**264**	**101**	1053
2003	**739**	**251**	**63**	1053
2004	**857**	**224**	**135**	1216
2005	**877**	**323**	**128**	1328
2006				

d. Lastly, by undertaking the BMP survey in priority subwatersheds for TMDL, restoration and trash reduction watersheds, the County can make rapid progress in actually implementing major repairs and retrofits within the new permit cycle. This is important since the normal process for identifying, designing and building retrofits can take from three to five years from conception to completion (Schueler, 2008). The proposed BMP asset management approach, targeted to priority subwatersheds, can sharply reduce this implementation timeframe.

2. Retrofit Investigations on County Lands. It is further recommended that DEP, MCPS, MNCCPC and DPWT jointly commission a comprehensive retrofit investigation on all County facilities and properties located within priority watersheds. This investigation would involve office and field assessments at each property, followed by retrofit concept design, project ranking, and project delivery (Schueler et al, 2007).

Section 5. Define Most Effective Trash Prevention and Reduction Techniques

Overall Recommendation: *The County should work with other communities to develop real data on trash load generation and reduction rates to find the most cost effective prevention and reduction opportunities to reduce the delivery of trash to the stream network. This basic survey data can help target the most effective trash reduction practices at the critical points in the watershed to solve the problem.*

Justification: Trash and litter take a long route to get into receiving waters, such as the Anacostia, starting with the individual that litters and then continuing downstream through generating source areas, streets, storm drains, and stormwater practices and into the stream network and the ultimate receiving water (See Table 3). The real management question is at which point along this continuum it makes the most sense to reduce trash inputs.

County stormwater managers are handicapped by the fact that they have virtually no data on littering behaviors/demographics, trash generation rates, the effectiveness of various trash reduction techniques and their cost per unit of trash reduced. Consequently, it is unclear whether the program should focus on trash prevention, reduction or removal techniques (see Table 3), although it is likely that a combination of techniques will be needed. In the short term, the County may need to consult with other communities in Maryland and California that have experimented with all three techniques to reduce trash loads to their receiving waters. In the first few permit years, the County should undertake low cost surveys to define trash hotspots at each point in the upland/downstream continuum, as described in Table 3.

Table 3: A Strategic Approach to Montgomery County Trash Reduction		
	Survey Notes	**Example Reduction Practices**
Trash Prevention	Survey current County programs to prevent trash generation	Reduce, re-use and recycle
Individual Trash Generators	Survey age, income, professions and other demographics factors that influence littering or dumping behaviors	Education campaigns Littering enforcement Illegal dumping enforcement Used tire disposal
Trash Generating Areas	Survey trash loading rates by land use, commercial hotspots and individual Anacostia subwatershed	Increase trash cans Dumpster management Pollution prevention Stormwater education
Streets and Storm Drains	Identify the subset of the dirtiest streets in the County	Intensive street sweeping Storm drain marking Storm drain inlet devices Storm drain cleanouts
Stormwater BMPs	Identify the stormwater practices that are trapping or bypassing stormwater trash loads	Enhanced trash cleanouts BMP retrofit or repair
Stream	Identify individual stream segments with high trash loads in floodplains	Volunteer stream cleanups and stream adoption
Receiving Waters	Document unit area trash loading rates	Trash booms and various devices to trap, skim and remove trash (e.g., Baltimore)

Detailed Implementation Recommendations. The following recommendations would enhance program implementation:

- The County should closely coordinate with Washington, DC Department of Environment, the City of Baltimore Department of Public Works and others to learn from their experience in trash prevention and reduction techniques, and to acquire some of their long term data on trash and gross solids loading rates. In addition, the County should consider establishing a municipal trash working group with other Bay communities during the upcoming permit cycle to share data about trash generation and reduction rates, and the most effective management techniques.

- The County is also advised to learn from the experience of the numerous California communities that have been complying with zero trash TMDLs over the past five years. Their successes and failures should be helpful in crafting a better trash reduction program (In particular, their targeted, multilingual, multi-media education campaigns). CSN would be pleased to provide some key individuals that County staff could contact.

- The County should commission targeted trash surveys in a test subwatershed in the Anacostia, using the basic protocols outlined in Appendix A, but modified using more specific trash surveys now in use by CWP/DPW in the Harris Creek watershed in Baltimore. The surveys are performed by local watershed groups as a means of reducing program costs.

- The foregoing survey recommendations should be completed within six months so that the trash reduction decisions in the plan can be based on the best currently available trash data. The imperfections of the data should not be cause for inaction, but allow for adaptive future trash monitoring to improve future management decisions.

Section 6. Undertake Process to Remove Local Barriers to ESD

Overall Recommendation: *The County should undertake a Countywide ESD roundtable that includes all key stakeholders in the development/redevelopment process that has a defined time-line, a transparent public involvement process and strong agency accountability to actually make consensus code changes. The County will also need to become an early adopter and invest in developing its own ESD compliance tool, new design specifications for ultra-urban ESD practices, and training/testing by the plan review and design consultant community in order to accelerate the shift to ESD.*

Justification: A rapid shift to ESD by the County has two major implications with respect to the requirements of the proposed permit. First, the sooner that individual future new development projects can be verified to have met MDE's requirement that they are designed to the ESD as MEP, they can be assumed not to add additional pollutants to the County's baseline load. This is important since each additional pound of pollutants added to the baseline is essentially a future costly pollutant reduction liability. Second, impressive future pollutant reductions can be achieved by applying ESD to redevelopment projects which may comprise as much as 40% of future County development by the year 2030 (USEPA, 2008). When cost-effective green ESD practices are applied to redevelopment projects on a widespread basis, as much as 20 to 40% pollutant reductions can be attained in a few decades, with minimal public investment (based on detailed modeling in Philadelphia, Seattle and Vancouver BC, see Neukrig, 2008).

To realize these benefits, the County will need to undertake a comprehensive review of its development codes and review process to accelerate the shift to ESD. Over the past decade, seven Maryland communities have engaged in the local site planning roundtable process and reached consensus on model development principles related to environmental site design: Frederick County (2000), Cecil County (2001), Harford County (2003), Worcester County (2004), Calvert County (2005), Baltimore County (2006) and Carroll County (2007). The recent progress by the Montgomery County Road Code stakeholder workgroup has also been encouraging. It is important to note, however, that achievement of consensus alone in a roundtable process does not necessarily lead to the widespread implementation of new development codes or the removal of barriers in existing codes.

The recurring problem involves the numerous agencies engaged in the local development review process often do not follow up on needed code or review changes (see Table 4).

Table 4: Some Primary ESD Practices and Key Agency Stakeholders

Key ESD Practices	**Primary MC Agencies ****
Rain Tanks and Cisterns*	DPS/WSSC
Rooftop Disconnections *	DPS/DEP/DHCA
Green Roofs*	DEP/DHCA
Expanded Tree Pits/Foundation Planters*	MNCCPC/WSSC/DPS/DEP/DPWT
Soil Compost Amendments*	MNCCPC/DEP/DPS
Dry Swales *	DEP/DPWT/
Permeable Pavers *	DPWT/MNCCPC/DEP
Narrower Street Widths *	MNCCPC/DPWT/MCFRS
Zoning Geometry *	MNCCPC/DPWT/DHCA
Narrow Sidewalks/Driveways/Cul-de-Sacs *	MNCPPC/DHCA/DPS/DEP

* indicates an ESD practice for which more detailed guidance will be needed for actual implementation beyond what has been provided by MDE (2008)
** indicates key agencies with some approval authority for the indicated ESD practice

The second key element to shifting to ESD is developing a new stormwater ordinance, compliance tools and ESD design specifications in Montgomery County to respond to the pending MDE stormwater regulations. As of this writing, the regulations and design guidance promulgated by MDE (2008) are not sufficient in detail to allow County planners and design consultants to actually verify that ESD has been maximized on the ground at each development site. Some immediate upfront County investment will be needed in the coming year to create these new tools and provide the requisite training to County staff and local engineers. The CSN is willing to offer free training assistance on a limited basis.

Detailed Implementation Recommendations

1. ESD Roundtable. Based on my personal involvement in many of these roundtables over the years, I would recommend four basic changes to make the roundtable process more effective in the County.

> *a. Executive and Council Leadership*: The roundtable process should be coordinated by the CEX, and have clear, time-based reporting milestones to County Council, with an ultimate goal of producing a revised ESD stormwater ordinance and related package of compliance tools and ESD design specifications within one year's time.
>
> *b. Accountability for Individual Agencies*: While it is important to include the normal range of non-governmental stakeholders in the process (e.g., developers, engineers, environmental groups, etc.), it is also essential that department heads be accountable to sign off on consensus changes and commit to their

implementation (i.e., DEP, DPW, DPWT, MCPS, MCFRS, DHCA, MNCPPC, WSSC).

c. Focus on Straw man Codes and Design Specs. The roundtable process works best when participants can react to draft codes and design specifications, and test them on real world development and redevelopment sites, to find the real and perceived barriers to change. This will require more upfront staff and/or consultant analysis than is normal in the roundtable process, but should result in greater focus on the underlying issues.

d) Superceding Codes Package. Many agencies are reluctant to open up their code-writing process since it is a complex, time consuming and often politically charged task. One alternative would be to assemble the superceding code changes in the form a Special Protection Area overlay zone for all the different watershed types in the County.

2. Supplemental ESD Tools: The transition to ESD in the County will require development of a detailed package of plan review and design materials as described below:

a) Develop ESD compliance spreadsheet. The County will need to develop a spreadsheet compliance tool to verify that the combination of ESD practices that is spatially applied to a development site actually meets the MEP criterion outlined by MDE (2008). While MDE has outlined minimum requirements for ESD, it has provided such a tool to local governments. A good model for such a compliance tool has been developed for communities in Virginia by Hirschman et al (2008). The Virginia spreadsheet has gained wide acceptance among both plan reviewers and engineers because it is simple, allows multiple practices to be evaluated, provides transparent estimates of runoff reduction achieved and sets a clear threshold for what MEP compliance means. The County could quickly modify the Hirschman et al spreadsheet in a matter of a few months.

b) Emphasis on Infill and Redevelopment. As noted earlier, the nature of development in the County is rapidly shifting toward redevelopment and infill projects, as the acreage of remaining buildable land diminishes. One of the weaknesses of the 2000 Maryland Stormwater Manual and the 2008 Supplement is that they are more oriented to suburban “green-field” developments than the more demanding conditions present in the built environment. Consequently, state stormwater guidance needs to be creatively adapted to reduce the costs and increase the performance of ESD practices at redevelopment projects. The CSN is informally working with several other large cities across the Bay watershed to develop improved redevelopment guidance, and invites the County to participate in this voluntary collaboration.

c) Develop Detailed Urban ESD Design Specifications. While the technical standards and design criteria outlined in MDE (2008) are a good start, they need to be significantly enhanced to increase the performance, longevity and maintainability of these continuously evolving practices. The CSN, in collaboration with dozens of researchers, engineers and plan reviewers, have engaged in a process to continuously update design standards for the following practices: Rooftop Disconnection, Filter Strips, Grass Channels, Soil Compost Amendments, Green Roofs, Rain Tanks and Cisterns, Permeable Pavers, Infiltration, Bioretention, Urban Bioretention, Dry Swales, Filtering Practices and Constructed Wetlands. The current edition of each design specification can be accessed at www.chesapeakestormwater.net. These peer-reviewed design specifications are being adapted by the State of Virginia, and are under consideration by other Bay States. The County is strongly encouraged to participate in this collaborative process, and adapt the peer-reviewed practices in its own local stormwater manual.

d) Increased ESD Training. Once the tools and design guidance has been adapted for the County, extensive training will be required for the hundreds of professionals responsible for designing, reviewing, installing and maintaining ESD practices. The CSN and other NGO service providers are currently developing a stormwater training alliance to help communities across the Bay watershed meet this key need.

Section 7. Stream Classification and Protecting the Healthiest Waters

Overall Recommendation: *To prevent future degradation of remaining high quality aquatic resources, the County should seek to maintain excellent stream health in the seven percent of the streams in the County with this designation, using exceptional land and riparian management practices. Current stormwater or ESD practices alone may not be capable of providing reliable long-term protection for these healthy, but vulnerable waters.*

Justification: Montgomery County DEP has extensively sampled the biological and habitat quality at more than 400 stream stations in the past decade. Initial results have been published in MCDEP (1998) and MCDEP (2003) and the monitoring effort is ongoing. Since monitoring began in 1996, 35% of streams have declined in quality, 55% have stayed the same and 10% have improved in quality. Land development and past urbanization are identified as the leading cause of stream degradation in the County (MCDEP, 2003). The overall quality of County streams in 2003 is profiled in Table 5.

Table 5: Summary of Stream Quality in Montgomery County

Stream Quality Rating	Total Stream Miles	% of Streams Sampled
Excellent	129	7%
Good	680	55%
Fair	391	28%
Poor	143	10%
Not Sampled	171	--

Source: MC DEP, 2003

Two recent research studies have specifically explored the impervious cover stream quality relationship in headwater streams located in Montgomery County (Goetz et al 2003 and Moore and Palmer, 2005) and concluded:

> *"We found a stream health rating of excellent required no more than 6% impervious cover in the watershed and at least 65% tree cover in the riparian zone. A rating of good required less than 10% impervious cover and 60% tree cover in the riparian zone"*.
>
> *"Taxa richness was related negatively and linearly with the amount of impervious cover"* with a pronounced shift to poor richness values at around 20 to 25% subwatershed impervious cover.
>
> Agricultural streams possessed the best taxa richness, which *"suggest that, if managed properly, that preservation of agricultural may conserve stream invertebrate diversity."*

Detailed Implementation Recommendations. Protecting the remaining healthy waters in the County should remain a strong water resource priority, and is consistent with anti-degradation provisions of the Clean Water Act, of which the MS4 permit is but one element. Consequently, the following actions are recommended:

- The County should identify the top ten percent of streams with excellent or good to excellent ratings, according to the most recent County-wide Stream Protection Strategy (DEP, 2003).
- These streams should be designated for additional land use control and riparian management efforts, as described in Table 6 below, and further detailed in Appendix B.
- The County should track and report any changes in stream quality for these streams as a reportable condition in its annual or end of permit reports, using the proposed biological reporting scheme outlined in Section 10.

Section 8 Illicit Discharge Detection and Elimination (IDDE) Requirements

Overall Recommendation*: The alternative methods for outfall screening to find and fix illicit discharges (Part 3.E.3) should be utilized to give the County maximum flexibility to strategically search for problem discharges from all outfalls in key subwatersheds*.

Justification: The base IDDE requirements contained in the proposed County permit (screen 150 outfalls/year) is not adequate to perform the detailed stormwater detective work needed to find and fix the worst discharges that contribute to water quality impairment. A series of improved options for this discharge detective work can be found in national guidance by Brown et al, (2004). The proposed permit does allow the County to develop an alternative plan, and some of the key components are described next:

Table 6. Management strategies to protect high quality streams
Subwatershed Outcomes Need to Protect High Quality Streams
• Restrict subwatershed IC to less than 10% (or regional IC threshold), and disconnect it wherever possible • Retain more than 65% forest or native vegetative cover in subwatershed • Ensure forest or native cover on at least 75% of stream network • Do not allow more than one crossing per stream mile, and none that create a barrier to migration • Require full runoff reduction for all storm events up to the two year storm for all new IC by maximizing the use of runoff reduction practices and discouraging conventional detention ponds and large diameter storm drain pipes • Establish wide stream buffers for the entire drainage network, including zero-order streams (100 to 200 feet) • Apply conservation practices to all croplands and keep livestock out of streams • Use site or subwatershed IC caps, extremely large lot zoning, watershed based zoning, farm preservation or conservation easements to limit subwatershed IC • Limited stream restoration to restore habitat, remove fish barriers and correct past mistakes • Protect healthy streams using anti-degradation provisions of the Clean Water Act • Monitor the geomorphic stability and biological diversity of the streams to verify compliance • Continue use of County TDR program to encourage long-term farmland preservation • Reduce public infrastructure investments such as water, sewer and roads in these subwatershed to discourage growth • Increase technology and permit requirements for private water and sewer infrastructure • Designate these subwatersheds as receiving areas for IC mitigation fees to finance restoration and secure conservation easements
Source: CSN (2008a)

Detailed IDDE Implementation Recommendations

- Focus search efforts in a few subwatersheds located in targeted TMDL or restoration watersheds each year.

- Use the Outfall Reconnaissance Investigation (ORI) in conjunction with other rapid stream and upland investigations as described in Attachment A to find problem discharges and pollution sources.

- Evaluate all outfalls in the stream network, and not just the large 36 inch outfalls originally recommended by US EPA. Experience has shown that smaller diameter outfall pipes are typically the source of the most severe illicit discharges.

- Survey work in target subwatersheds should be repeated as least twice a year to ensure that all continuous, episodic and transitory discharges are discovered.

- Experience has shown that many illicit discharges are reported through properly advertised citizen hotlines. The County should review the recommendations on water pollution hotlines and response times contained in Brown et al (2004) to ensure that County staff can quickly respond to citizen reports.

Section 9 Local Inspection of Industrial Stormwater Hotspots

Overall Recommendation: *The County should take a more aggressive approach to inspect industrial, commercial and municipal stormwater and trash hotspots, and require improved pollution prevention and stormwater treatment from confirmed high risk sites. This may require the County to revisit the 1994 Water Quality Ordinance and also execute a MOU with MDE to allow County inspectors to visit industrial NPDES stormwater permitees*.

Justification: Several hundred commercial, industrial and municipal facilities in Montgomery County can be classified as stormwater hotspots. These facilities conduct operations or activities that produce higher pollutant concentrations in stormwater runoff and/or a higher risk of spills, trash generation and illicit pollutant discharges. Some facilities are subject to industrial stormwater permit conditions under the Clean Water Act as administered by MDE, others are non-filers, and others are subject to regulation under the 1994 Montgomery County Water Quality Ordinance (although, as shown in Table 7, this is not always clear for all land use types).

The failure of the industrial stormwater permitting system was a major finding of the recently released NRC (2008) report on Urban Stormwater Management in the United States (see Box-2.4, Box 2.5, pages 86-88, and pages 430 to 442). A series of audits in numerous states found that many industries had not filed for permits and those that had were not complying with their self-reported visual monitoring requirements, or more importantly, were not implementing pollution prevention practices and stormwater treatment requirements.

Due to workload, state inspections of industrial stormwater sites were rare or non-existent. As a consequence, major opportunities to reduce discharges from these high risk sites have been missed. Several communities in the Pacific Northwest have developed MOUs with the State industrial stormwater permitting authority allowing them to supplement state industrial NPDES stormwater inspections. These programs have uniformly led to greater compliance, and more importantly, reduced pollutant loads (NRC, 2008).

Consequently, the historical regulatory inaction in controlling stormwater hotspots, actually represents the most immediate and cost effective strategy to reduce pollutants in the County. Significant improvements in compliance can be achieved at individual sites through inspections, technical assistance and enforcement referral (Schueler, 2005). Estimated pollutant reductions from stormwater hotspots could then be deducted from the County's existing baseline stormwater pollution load.

Table 7: Regulatory Status of Stormwater Hotspots in the County			
Potential Stormwater Hotspot Operation	Industrial Permit?	MC 1994 WQ Ord?	Trash Hotspot?
Facilities w/NPDES Industrial permits	Yes	--	
Public works yard	Yes	MS4	
Railroads/ equipment storage	Yes	--	
Auto and metal recyclers/scrap yards	Yes	--	Yes
Petroleum storage facilities	Yes	--	
Highway maintenance facilities	Yes	MS4	
Wastewater, solid waste, composting facilities	Yes	MS4	Yes
Industrial machinery and equipment	Yes	--	
Trucks and trailers storage	Yes	--	
Airfields and aircraft maintenance areas	Yes	--	
Fleet storage areas	Yes	MS4	Yes
Car dealerships	No	Maybe	
Gas stations	No	Maybe	Yes
Highways (2500 ADT)	No	Maybe	Yes
Construction business (paving, heavy equipment storage and maintenance)	No	Maybe	
Retail vehicle/ equipment dealers	No	Maybe	
Convenience stores/fast food restaurants	No	Maybe	Yes
Shopping Centers	No	Maybe	Yes
Vehicle maintenance facilities	No	Maybe	Yes
Nurseries and garden centers	No	Maybe	
Golf courses	No	Maybe	
Notes For a full list of potential stormwater hotspots. please consult Schueler et al (2005) MS4: County facilities in this category are regulated under the current MS4 permit			

Detailed Implementation Recommendations: Three low cost actions are recommended to improve compliance at stormwater hotspots.

- *Secure Hotspot Inspection Authority:* Although as a MS4. the County possesses the implied authority to inspect and regulate stormwater hotspots, it would be advisable to execute a memorandum of understanding with MDE to enable County staff to conduct inspections of industrial stormwater hotspots, and also search business databases to identify non-filers for state enforcement. The County may also want to revisit the 1994 Montgomery County Water Quality Ordinance to designate a specific list of potential stormwater hotspots for inspection and technical assistance (see shaded section of Table 7).

- *Develop Quantitative Inspection Tools:* A key recent improvement has been the creation of detailed site checklists to gauge the severity of a stormwater hotspot through visual benchmark assessments and quantitative scoring (NRC, 2008, CSN 2008c and Schueler et al 2005). The County should adapt and adopt these inspection tools to isolate the worst sites that require improved pollution prevention plans and/or stormwater treatment retrofits.

- *Provide County Technical Assistance for Pollution Prevention*. Many owners of stormwater hotspots are unaware that their operations and activities are causing water quality problems. Simple changes in daily operations and employee training can greatly reduce their impact. Once again, small County investments to provide technical assistance to owners, as described in Schueler (2005) can result in significant pollutant reductions.

Section 10 Monitoring Recommendations for Compliance Assessment

Overall Recommendation. *The proposed chemical, physical and biological sampling requirements outlined in the draft permit should be modified to improve capability to determine compliance, without increasing the overall cost of monitoring for the County, with a greater emphasis on using continued biological sampling to measure permit compliance*.

Justification: Changes to Chemical Sampling. The scope of the chemical sampling in the proposed stormwater permit is statistically inadequate to measure compliance with watershed restoration requirements or pollutant reductions (Section H.1.a.) Past stormwater quality research increased our capability to accurately characterize runoff quality, but the limited additional sampling is not particularly useful in assessing MS4 compliance (Pitt et al 2003, CSN 2008b). The consensus of the scientific community is that basic outfall monitoring is inadequate (NRC, 2008), and should be replaced with one or more of the following options:

- Intensive performance sampling to establish pollutant reduction achieved by innovative stormwater practices or programs (particularly those denoted as "moderate" or "limited" in Table 1). A series of excellent guidance documents have recently been published on to obtain scientifically credible estimates of stormwater performance through carefully designed monitoring experiments and surveys (see CASQA, 2007 and Law et al, 2008). To ensure the most transferable results, it is recommended that the County to be able to pool its monitoring funds with other MS4s in order to hire the best academic researchers to perform this more sophisticated monitoring (CSN, 2008b)

- Extensive sampling for fecal coliform bacteria in a large number of outfalls during wet and dry weather to identify "hotspot" catchments that exceed the 75th percentile mean concentration for bacterial counts, and therefore deserve more intensive source area sampling (Pitt et al, 2004 and NRC, 2008).

Justification. Greater Reliance of Biological Sampling. As noted earlier, MCDEP has employed a long term program for stream sampling to develop indexes of stream health, based on aquatic insects, fish and stream habitat. This program is one of the most scientifically rigorous and expansive of any community in the nation, and provides the best long-term gauge of progress made in permit compliance within individual streams and subwatersheds. The major change recommended for the stream sampling program is to improve characterization of subwatershed metrics for each stream station (impervious cover, riparian cover, effective stormwater treatment, road crossings, etc). This would enable long-term tracking of stream health scores for subwatersheds with similar ranges of impervious cover (see Table 8). This type of compliance reporting would be extremely helpful to document progress made in protecting or restoring County streams (CSN, 2008a).

Table 8: Proposed County Stream Biological Quality Reporting & Management System

Subwatershed IC Cover (%)	County Stream Miles	Biological Target Score [1]	Allowable % of Streams Miles Below Score	Remedial Action When Action Level Exceeded
1 to 5% IC	XXX [2]	Excellent	None	Protection
6 to 10% IC	XXX	Good to Excellent	5%	Investigation
11 to 24% IC	XXX	Good	10%	Restoration
25 to 39% IC	XXX	Fair to Good	15%	Restoration
40 to 59% IC	XXX	Fair	20%	Restoration
60 to 100% IC	XXX	Fair-Poor	25%	

[1] using actual numerical scores for range reported in CSPS
[2] 2007 stream mileage in indicated subwatershed category

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Appendix A
Example of Proposed Study Design to Investigate Priority Pollution Source Areas

Pollution source control seeks to modify homeowner behaviors and business operations to reduce the potential generation of nonpoint source pollution and illicit discharges in urban watersheds. EPA's recent NPDES MS4 storm water permit program requires both small and large communities to engage in watershed and storm water education programs to promote effective source control, but little quantitative data currently exists to guide their efforts. While urban source control programs are thought to reduce storm water pollutants and improve dry weather water quality, their actual impact and delivery have never been quantitatively assessed. Consequently, local storm water managers currently lack reliable data to guide their source control investment decisions to get the greatest pollutant reduction and water quality improvement.

In order to meet this critical gap, the County will comprehensively inventory and assess the pollution potential of every residential neighborhood, storm water hotspot and storm water outfall in a test watershed to provide quantitative and transferable data to craft better source control programs to implement their Phase I NPDES MS4 communities.

The project will utilize a series of rapid and quantitative tools to help local stormwater managers to inventory pollution sources in individual subwatersheds. These include the Neighborhood Source Assessment (NSA), Hotspot Site Investigation (HSI) and Streets and Storm Drain Analysis (SSD) methods, which together comprise the Unified Subwatershed and Site Reconnaissance (USSR)[1.] Initial field testing of these methods has shown they can be effective in shaping and targeting residential and business source control programs. For example, the USSR can prioritize which neighborhoods and businesses have the most severe nonpoint source pollution potential, and can identify the most prevalent behaviors and operations causing potential water quality problems. This comprehensive and synoptic survey would be the first of its kind to assess all of these potential sources within a single watershed, and will enable watershed managers to craft more targeted and effective source control and education programs.
The project will consist of the following tasks:

Task 1 Desktop Watershed Source Control Characterization. In the first task, the County will select a test watershed that is about 30 to 50 square miles in area, and encompasses the full range of ultra-urban, urban, suburban and low density development conditions. Working with cooperating local watershed groups, the County will develop a master GIS file to characterize the watershed. The detailed watershed GIS will contain layers such as storm water and sewer infrastructure, SIC codes, and neighborhood and subwatershed characteristics. In addition, The County will use new desktop database screening methods to locate potential storm water hotspots and generating land uses in the watershed. The watershed GIS file will be used to generate field maps for subsequent field investigations, and become the basic template for the watershed atlas of pollution sources to be developed in Task 6.

Task 2 Local Fingerprinting of Flow Types and Transitory Discharges. A key forensic tool to find illicit discharges are local fingerprint databases that measure the chemical composition of different flow types and transitory discharges. Transitory discharges are frequently observed in urban storm drain systems, but little is known about their water quality significance. Examples of transitory discharges include flows from car washing, driveway cleaning, power washing, dumpster juice, and non-target irrigation water. Data is extremely scarce about the pollutant levels and flow associated with each of these common discharges.

Under this task, the County will characterize the water quality and flow volume produced by each of these discharges by directly collecting and analyzing water quality and flow samples at the point where each activity occurs. For example, water quality samples would be directly collected at up to 20 different residential car washing “events” under controlled driveway or curb conditions. Samples will be analyzed for sediment, nutrients, metals, oxygen demand, hydrocarbons and total flow, and an average “event” concentration computed to determine the strength or “fingerprint” associated with each type of transitory discharge. In addition, a local fingerprint library will be assembled for more conventional flow types, such as sewage, septics, tap water, wash water and groundwater. The product of this task will be a technical report describing the unique fingerprint of each discharge and flow type.

Task 3: Outfall Reconnaissance Inventory. Under this task, the County will survey up to 75 miles of stream in the test watershed to find and test suspect storm water outfalls using recently developed IDDE protocols[2]. All flowing and suspect outfalls will be sampled with the full range of water quality sampling methods to identify and characterize any illicit discharges.

Task 4: Hotspot Source Investigation Survey. In this task, the County will conduct Hotspot Source Investigations (HSI) at up to 250 commercial, industrial, institutional and municipal and transport-related operations across the test watershed. The HSI is a field assessment developed by the Center that quickly evaluates the severity of both regulated and unregulated storm water hotspots. The HSI survey data will be processed to develop a comprehensive database of all potential, suspected and confirmed hotspots in the watershed, that will be subsequently integrated into the watershed GIS system.

Task 5: Neighborhood Source Assessment. Under this task, the County will sample up to one hundred different neighborhoods in the test watershed using the Neighborhood Source Assessment (NSA). The NSA is used to identify specific pollution sources and source control opportunities within individual neighborhoods, and derive quantitative indexes of nonpoint source severity. The goal of this task is to establish relationships between neighborhood characteristics (e.g., age, lot size, tree cover, downspout connection) and nonpoint pollution severity index scores, that improve the targeting of residential education and enforcement efforts.

Task 6: Watershed Pollution Source Atlas. The product of this task will be a comprehensive watershed atlas that shows the distribution of storm water pollution source areas, hotspots, and illicit discharges, and quantifies flow sources and discharge types. The GIS system will be extensively analyzed to establish relationships between subwatershed, land use, and neighborhood “metrics” and the severity of storm water and illicit discharges. These relationships will be used to identify the critical screening factors the County should consider when crafting their local pollution prevention, post-construction storm water and illicit discharge programs.

APPENDIX B
EXCERPTS FROM CSN TECHNICAL BULLETIN NO. 3
IMPLICATIONS OF THE IMPERVIOUS COVER MODEL: STREAM CLASSIFCATION. SUBWATERSHED MANAGEMENT AND WATERSHED PERMITTING

A PROPOSED URBAN STREAM MANAGEMENT SYSTEM

Once realistic expectations have been set for a subwatershed, the specific combination of planning, engineering, economic and regulatory tools that are needed becomes more obvious. Some potential combinations for each subwatershed management category are detailed in Tables 4 through 6. It should be strongly emphasized that these are a starting point for developing a local watershed management strategy, and that they will always need to be modified for local conditions.

Management Strategies to Protect High Quality Streams

One of the more troubling findings of the ICM, and much of the recent urban stream research, is that it does not take very much subwatershed development to degrade high quality streams – depending on the ecoregion, as little as 3 to 7% IC. Many high quality streams have evolved in response to the forest (or native cover) of their subwatersheds, and have unique habitat conditions that support trout, salmon or spawning of anadromous fish.

Given the vulnerability of these streams, watershed managers must commit to an aggressive protection strategy to mitigate the impacts of land development (Table 4). The comprehensive strategy involves watershed zoning, land conservation, preservation of the riparian network and stormwater practices that create no net increase of runoff volume or velocity up to the two year design storm event.

Additional regulatory and economic tools are also needed to protect and maintain the quality of exceptional streams, as shown in Table 4. While the proposed strategy is much more stringent than what most communities currently allow, it is technically achievable, and provides greater reliability in meeting the objectives of maintaining exceptional stream biodiversity and function. From the standpoint of implementation, it is important to formally designate these subwatersheds as being exceptional, and then using the anti-degradation provisions of the Clean Water Act to provide regulatory support for the development restrictions.

Management Strategies for Suburban Streams

Stream quality in suburban subwatersheds (10 to 25% IC) exhibits a great deal of variability or scatter. Indicator scores can range from poor to fair to good (but not excellent). A reasonable management objective is to achieve both good indicator scores and maximize stream function to adequately protect downstream receiving waters from degradation (e.g., flood storage, instream nutrient processing, biological corridors, stable stream channels, etc.). Given the relatively light development intensity of suburban watersheds, there is room to apply a broad range of management practices in the uplands and the stream corridor (Table 5).

Table 4. Management strategies to protect high quality streams
Subwatershed Outcomes Need to Protect High Quality Streams
• Restrict subwatershed IC to less than 10% (or regional IC threshold)* • Retain more than 65% forest or native vegetative cover in subwatershed • Ensure forest or native cover on at least 75% of stream network • Do not allow more than one crossing per stream mile, and none that create a barrier to migration
Recommended Watershed Planning and Engineering Practices
• Require full runoff reduction up to the two year storm for all new IC by maximizing the use of runoff reduction practices and discouraging conventional detention ponds and large diameter storm drain pipes • Establish wide stream buffers for the entire drainage network, including zero-order streams (100 to 200 feet) • Apply conservation practices to all croplands and keep livestock out of streams • Use site or subwatershed IC caps, extremely large lot zoning, watershed based zoning, farm preservation or conservation easements to limit subwatershed IC • Limited stream restoration to restore habitat, remove fish barriers and correct past mistakes
Recommended Regulatory and Economic Measures
• Protect healthy streams using anti-degradation provisions of the Clean Water Act • Monitor the geomorphic stability and biological diversity of the streams to verify compliance • Reduce public infrastructure investments in subwatershed to discourage growth • Increase technology and permit requirements for private water and sewer infrastructure • Designate these subwatersheds as receiving areas for IC mitigation fees to finance restoration and secure conservation easements

The basic upland management prescription for suburban streams is to maximize tree canopy and minimize both turf and impervious cover across the subwatershed. Stormwater practices that achieve full runoff reduction up to the two year storm event are applied in a roof to stream sequence to reduce channel erosion and maintain recharge. The prescription for the stream corridor is to protect and enhance buffers around streams, wetlands and floodplains, with special emphasis on minimizing the enclosure of zero order streams (i.e., maintaining them as a open stormwater treatment system). Some elements of the stream corridors may require stream repairs, reforestation or wetland creation.

Table 5. Management strategies to protect impacted subwatersheds (suburban)
Recommended Watershed Planning and Engineering Practices
• Require full runoff reduction up to the one year storm for all new IC created in the subwatershed • Minimize subwatershed IC, maximize forest cover and conserve soil quality using runoff reduction practices from roof to stream • Conserve and protect stream buffers, floodplains, wetlands and river corridor in a natural state and in public ownership • Adjust zoning to limit IC to meet 20 to 25% subwatershed IC caps • Use Better Site Design roundtable process (CWP, 1998a) to seek 25% reduction in average IC and turf cover produced by each zoning category • Implement selected stream restoration and storage retrofits to mitigate effect of existing development in the watershed • Establish an ultimate subwatershed tree canopy goal of 40 to 45%
Recommended Regulatory and Economic Measures
• Utilize IC-based TMDLs to set specific targets for runoff reduction and removal of pollutants of concern • Invest in public infrastructure to enhance the quality of drinking water, wastewater and stormwater • Designate these subwatersheds as receiving areas for IC mitigation fees to finance retrofits and other restoration practices • Impose IC mitigation fees for both new and existing development to discourage creation of needless impervious cover, finance restoration and maintain stream protection and stormwater infrastructure

Table 5 also outlines the regulatory and economic tools needed to implement and maintain watershed practices for suburban streams. The key management challenge is to prevent a gradual “creep” in IC over time through rezoning, redevelopment and homeowner expansions. Consequently, watershed managers should set clear goals for maximum future IC, and track it over time to ensure it remains within prescribed limits.

Strategies to Manage Highly Urban Streams

The quality of highly urban subwatersheds will be inevitably degraded by the combination of IC creation, soil compaction and stream alteration. Highly urban streams can have one of two management designations -- non-supporting (25 to 60% IC) and urban drainage (60 to 100% IC). Urban drainage subwatersheds generally have little or no remaining surface stream network, whereas non-supporting streams still have some surface streams, although they are often highly degraded and fragmented. The management goal for both stream classes is to limit the extent of degradation, while at the same recognizing these subwatersheds are an intense human habitat, both in the uplands and the remaining stream corridor. The proposed management strategies for non-supporting and urban drainage subwatersheds are presented in Table 6.

Table 6. Strategies for Non-Supporting and Urban Drainage Subwatersheds [1]
Recommended Watershed Planning and Engineering Practices
• Encourage intensification and redevelopment • Require runoff reduction for the 90th percentile storm as part of the redevelopment process (NS subwatersheds) or a fraction thereof (UD subwatersheds) • Provide sufficient upland retrofit, discharge prevention, and pollution prevention practices to treat stormwater hotspots • Utilize street cleaning and storm drain inlet cleanouts to remove gross pollutants from the dirtiest source areas. • Maintain a forest canopy goal of at least 25% and 15% for NS and UD subwatersheds, respectively • Manage the remaining stream corridor as a greenway and protect/restore large natural area remnants
Recommended Regulatory and Economic Measures
• Utilize conventional TMDLs to reduce pollutants of concern at the most polluted subwatersheds and urban source areas. • Conduct dry weather water quality monitoring in streams (NS) or receiving waters (UD) to assure progress towards goals • Designate these subwatersheds as sending areas for IC mitigation fees to finance retrofits and other restoration practices in less dense subwatersheds • Impose IC mitigation fees for redevelopment when full site compliance with runoff reduction targets cannot be attained.
1 for space purposes, the strategies for non-supporting (NS) and urban drainage (UD) have been combined together since they differ primarily in the scope or extent of treatment, except where noted

The basic approach is to protect public health and safety through stormwater management, pollution prevention and discharge prevention practices in the uplands, and to use the stream corridor as a greenway and a conduit for floodwaters. While it is not possible to achieve high levels of aquatic diversity, the watershed practices can reduce pollutant export to downstream receiving waters, and ensure safe water contact during dry weather periods. The land use planning strategy for these subwatersheds encourages both intensification and redevelopment. The impacts from increased IC can be ameliorated by green buildings, expanded urban tree canopy, and selected stormwater retrofits and watershed restoration projects.

For some, this strategy sacrifices urban streams, and enables municipalities to violate existing water quality standards. The key point, however, is that IC and associated infrastructure has such a dominant influence on these streams that aquatic diversity and water quality standards could never be met, regardless of the investment. Implementation of the stringent measures outlined in Table 6 can result in incremental improvements in local waters and substantial pollutant reduction to downstream waters.

PART 4
INTEGRATING WATERSHED PLANS INTO ENFORCEABLE PERMITS

As noted earlier, most of the planning, engineering, and regulatory responses to the ICM are not effective unless they are applied together in the context of a local watershed plan. The mere existence of a plan is also not effective unless it is fully implemented. Relatively few watershed protection or restoration plans have progressed into actual implementation, primarily because there is no mechanism for accountability and enforcement. The clear implication is that local subwatershed plans must be translated into a long term watershed-based permit to ensure implementation. The best permitting vehicle appears to be the municipal NPDES stormwater permit system. With some adaptation, these permits can be implemented on a subwatershed basis, using the process outlined below:

Step 1. Define interim water quality and stormwater goals (i.e., pollutants of concern, biodiversity targets) and the primary pollutant source areas and hotspots that cause them

Step 2. Delineate subwatersheds within community boundaries

Step 3. Measure current and future impervious cover within individual subwatersheds

Step 4. Establish the initial subwatershed management classification using ICM

Step 5. Undertake field monitoring to confirm or modify individual subwatershed classifications)

Step 6. Develop customized management strategies within each subwatershed classification, that will guide or shape how land use decisions are made at the subwatershed level, and how watershed practices will generally be assembled at individual sites

Step 7. Undertake restoration investigations to verify restoration potential in priority subwatersheds

Step 8. Agree on the specific implementation measures that will be completed within the permit cycle. Evaluate the extent to which each of the six minimum management practices can be applied in each subwatershed to meet municipal objectives

Step 9. Agree on the maintenance model that will be used to operate or maintain the stormwater infrastructure, assign legal and financial responsibilities to the owners of each element of the system, and develop a tracking and enforcement system to ensure compliance.

Step 10. Define the trading or offset system that will be used to achieve objectives elsewhere in the local watershed objectives in the event that full compliance cannot be achieved due to physical constraints.

Step 11. Establish sentinel monitoring stations in select subwatersheds to measure progress towards goals.

Step 12. Revise subwatershed management plans in the subsequent NPDES permitting cycle, based on monitoring data

Table 7: Examples of Customized Subwatershed Management Strategies

Subwatershed Management Issue	Sensitive Streams (2 to 10% IC	Impacted (IC 10 to 24%)	Non-Supporting (IC 25 to 59%)	Urban Drainage (60% + IC)
Land Use Planning and Zoning	Extensive land conservation and acquisition to preserve natural land cover. Site-based or watershed IC caps	Reduce IC created for each zoning category by changing local codes and ordinances	Encourage redevelopment, and intensification of development to decrease per-capita IC utilization in the landscape. Develop watershed restoration plans to maintain or enhance aquatic resources	
Site-Based Stormwater Reduction and Treatment Objectives	Treat runoff from two year design storm using practices to achieve 100% runoff reduction volume	Treat runoff from one year design storm using practices to achieve 75% runoff reduction volume	Treat runoff from the 90% annual storm and achieve at least 50% runoff reduction volume	Treat runoff from the first flush storm and achieve at least 25% runoff reduction volume
Site-Based IC Fees	Establish Excess IC Fee for projects that exceed IC zoning category		Allow IC Mitigation Fee	Allow IC Mitigation Fee
Subwatershed Trading	Receiving Area for Conservation Easements, Restoration Projects and Retrofit		Receiving or Sending Area for Retrofit	Sending Area, for Restoration Projects
Stormwater Monitoring Approach	Measure instream metrics of biotic integrity	Track subshed IC and measure practice performance	Check outfalls and measure practice performance	Check municipal actions levels at outfalls
TMDL Approach	Protect using anti-degradation provisions	IC-based TMDLs that use flow or IC as a surrogate for traditional pollutants	Pollutant TMDLs to identify problem subwatersheds	Pollutant TMDLs to identify priority source areas
Dry Weather Water Quality	Check for failing septic system	Outfall and channel screening for illicit discharges	Dry weather sampling in streams and outfall screening	Dry weather sampling in receiving waters
Addressing Existing Development	Ensure farm, pasture and forest best practices are used	Stream repairs, riparian reforestation & residential stewardship	Storage retrofits and stream repairs	Pollution source controls and municipal housekeeping

The core of the approach is to customize management strategies for each class of subwatershed so as to apply the most appropriate planning, engineering and regulatory tool (see Table 7). The benefit of subwatershed-based permits is that it also provides accountability mechanism in the form of compliance monitoring on a subwatershed basis. In all subwatersheds, it makes sense to measure and track changes in both IC created and IC treated. Within individual subwatersheds, however, the focus of monitoring efforts may differ. For example, monitoring of biological metrics is recommended in sensitive and impacted streams to ensure they are meeting their objectives. Outfall monitoring continues to be important for non-supporting streams, particularly if stormwater quality data are compared to action levels to identify the most polluted subwatersheds for greater treatment.