The Northern Shenandoah Valley Regional Urban Manual for Low Impact Site Design
A Proposal

Prepared for:
Northern Shenandoah Valley Regional Commission
103 East Sixth Street
Front Royal, Virginia 22630

Prepared by:
Ecosite, Inc.
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Columbia, MD 21045

February 4, 2004

Ecosite, Inc.

Scoring Sheet for RFP 04-01: Northern Shenandoah Valley Regional Urban Manual for Low Impact Site Design

Evaluation:

1. The skill, experience, and training of the specified key personnel who will be performing the tasks contained in the scope of work:

Possible: **35 Pts.** Awarded: 35

Summary of Points: _____

2. The consultant's understanding of the objectives and final product that is to come from the undertaking of this study as reflected in the work plan approach.

Possible: **35 Pts.** Awarded: 35

Summary of Points: _____

3. Prior Experience and reputation on projects or studies of similar scope and complexity as obtained from references.

Possible: **15 Pts.** Awarded: 15

Summary of Points: _____

4. Ability to mobilize, initiate, and organize the study and dedicate adequate resources and staff to achieve the overall study objectives in a timely manner.

Possible: **15 Pts.** Awarded: 15

Summary of Points: _____

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TOTAL: _____

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INTRODUCTION

Ecosite, Inc., is pleased to submit this proposal to the Northern Shenandoah Valley Regional Commission (NSVRC) for the development of the Regional Urban Manual for Low Impact Site Design. This proposal addresses the requirements of the request for proposals. In accordance with these requirements this proposal provides the following information:

1. Project background and understanding
2. Technical approach
3. Schedule
4. Qualifications and experience of the project team
5. References

BACKGROUND AND UNDERSTANDING

The Northern Shenandoah Valley Region like many of the regions in the Chesapeake Bay watershed, is experiencing steady growth in its population and the conversion of rural land to urban conditions. The NSVRC is aware that this continued growth can lead to water quality impairment of its water resources which are vital to the long term ecological sustainability of the region.

For the past 20 to 30 years storm water management professionals have assumed that peak discharge based approaches using mostly end of pipe technologies such as ponds were providing adequate protection for receiving waters. Unfortunately this assumption was not field verified. Recent biologic assessments by Jones in Northern Virginia showed that there was the same degree of biologic impairment in streams with no stormwater management control as with streams controlled with stormwater management ponds (Jones, 1997). Similar results were reported by Maxted in Delaware (Maxted, 1997), Mays and Horner in the Seattle region (Mays, Horner, 1997) and Stribling, et al, in Prince George's County, MD (Stribling, 2002). In addition studies by McCuen (1987), Ferguson (1998) and more recently Emerson and Traver (2003) have pointed out that the combination of peak discharge control using stormwater management ponds does not provide downstream flood control.

In response to these shortcomings of traditional stormwater management technology alternative approaches that focus on integrated and ecologically sensitive solutions, such as Low Impact Development (LID) have been developed. LID differs from traditional end of pipe control technologies in a number of significant ways. Rather than allowing hydrologic changes to occur and then trying to find solutions at the downstream portion of the watershed, LID focuses first on the prevention of impacts through the use of numerous better planning tools and protective ordinances such as stream buffers. A second phase of LID consists of reducing impacts that are unavoidable such as the use of narrow streets and the disconnection of impervious areas. The third phase of LID consists of managing unavoidable impacts by using landscape based micro scale practices such as bioretention systems and grass swales that are distributed throughout the upland areas of the watershed rather than concentrated in the riparian zones. A final and crucial phase of the LID approach is the use of hydrologic and hydraulic computational methods that allow planners and engineers to document that the pre-development hydrologic regime is being maintained and that impacts, physical, chemical and biologic are either avoided or mitigated.

These changes are quite profound and present a substantial change and challenge to established land development practices for most communities. This in turn presents challenges to regulatory

agencies, the public and private sectors of the community. NSVRC has properly identified to need to create a collaboration between the various parties that are involved. The success of this project will be strongly influenced by the participation of the steering committee.

The Ecosite project team is currently involved in similar efforts with a number of local agencies in Maryland, Delaware and Pennsylvania. Our experience with these projects will be very valuable in helping NVSRC achieve its intended objectives. Our current efforts in New Castle County to integrate the conservation design approach with LID technology is unique and will prove very valuable to this effort. In addition our project team has been involved with the design, permitting, and construction of the Pembroke Woods LID subdivision in Frederick County and can make this experience available to the steering committee.

TECHNICAL APPROACH

The development of the Regional Urban Manual for Low Impact Site Design will be conducted in a series of four tasks as outlined in the RFP. These tasks will include:

- Task 1 – Coordination with Steering Committee
- Task 2 – Study of Karst Issues and LID techniques
- Task 3 – Identify Impediments to a Regional Manual for Low Impact Site Design
- Task 4 – Manual Preparation

Task 1 – Coordination with Steering Committee

Good coordination with the steering committee organized by NSVRC has been identified as a critical element in achieving the two objectives of this project which include; 1) promoting regionalism and, 2) combining the public and private sectors viewpoints into a regional document that will be used to better protect the region's watersheds and water quality. Thus the project will be initiated with a kick-off meeting with the steering committee organized by the NSVRC, and additional meetings will be scheduled throughout the project duration particularly at all the key points in the project. At a minimum the following meetings with the steering committee are anticipated:

1. Project kick off meeting
2. Submission of study on karst issues and LID techniques
3. Submission of report on impediments to regional manual
4. Submittal of detailed table of contents of regional design manual
5. Submittal of draft regional design manual

Additional meetings can be scheduled as needed.

Task 2 – Study of Karst Issues and LID Techniques

Ecosite will conduct a study that will specifically analyze the karst issues, fractured rock nature of the region's geology and the types of LID techniques that can be utilized to meet existing site stormwater management requirements and protect water quality.

Karst terrain is encountered in many areas of the Mid Atlantic region and communities have been developing guidance documents to identify karst terrain that is prone to sinkhole formation, damage to structures and contamination of groundwater. The Virginia Stormwater Management

handbook contains a supplement, Technical bulletin No. 2 which provides guidance related to hydrologic Modeling in Karst Terrain. This guide includes some guidance related to conventional stormwater management facilities such as stormwater management ponds, but does not address LID measures. Some additional references related to karst terrain are provided in Table 1.

Table 1. References on Karst Terrain Issues

Kalmes, A, and E. Mohring. 1995. Sinkhole treatment to improve water quality and control erosion in southeastern Minnesote, in: Karst Geohazards, Beck, (ed) Lakema, Rotterdam.

Kochanov, W.E. 1995. Storm-water management and sinkhole occurrence in the Palmyra area, Lebanon, County, Pennsylvania, in: Karst Geohazards, Beck, (ed) Lakema, Rotterdam.

Natural Resources Conservation service, USDA. 1995. Sinkhole and sinkhole area treatment. Sinkhole treatment 370.

American society of Civil engineers, 1988. Geotechnical Aspects of Karts terrain, proceedings of a symposium sponsored by the Committee on Engineering Geology, ASCE, New York, N.Y.

White, E.L., Aron, G., and White, W.B. 1984. "The Influence of Urbanization on Sinkhole Development in Central Pennsylvania," in Sinkholes: Their Geology, Engineering and Environmental Impact, proceedings of the First Multidisciplinary Conference on Sinkholes, Orlando, FL.

Brown, T. 1996, Living On Karst, A Refrence Guide for Virginia Communities, Virginia department of conservation and recreation, Division of Natural Heritage.

Guidelines on BMP Design and SWM Geotechnical testing in Karts Areas. 1996. Carroll County Water resources Management Manual and Ordinance, Westminster, MD

A number of LID practices have now been documented. Table 2 provides a partial listing of these practices. Some of these practices such as grass swales and infiltration trenches have been in use for some time, while others such as the bioretention cell (raingarden) and the landscape planter are relatively new.

Many of the low impact development BMPs such as the bioretention system are well suited for use in karst terrain, because they are limited to small drainage areas and are typically designed to pond only six to twelve inches of water which is then filtered through a soil media of two to three foot depth. Inspectors in Frederick County, Maryland report that they have experienced good success with the use of these practices in the karst terrain areas of Frederick County.

However, some of the other low impact development measures such as infiltration trenches may be unsuitable or will require special design and construction guidance to be used in karst terrain.

Ecosite will research and review available literature on the issue of karst terrain and LID measures. A checklist of LID practices that can and cannot be used in karst terrain will be developed. Any special design and construction requirements associated with the use of these practices in karst terrain will be identified.

Table 2. Types of LID BMPs (Modified from P.G. Co. , 2002)

Conservation & Minimization	Storage	Filtration & Infiltration	Conveyance	Landscaping
Site fingerprinting	Cisterns		Grassed channels - dry swale - exfiltration -infiltration trench	Bioretention - Islands -Linear - Bench
Narrow streets Street parking	Roof top detention	Infiltration trench	Bioretention channels	Riparian buffers
Porous pavement	Green roofs	Below pavement infiltration basin	Disconnection of impervious areas	Backyard raingardens
Traffic calming w/ SWM	Subsurface storage	Exfiltration devices (dry wells)	Landscape swale (P)	Wetland restoration & enhancement
Pedestal sidewalks	Pedestal sidewalks	Vegetative filter (P)		Slope reduction
Sidewalk Reduction	Rain barrels	Stormwater planter (P)		Filter strips
Hydraulic disconnection	Yard storage	Landscape infiltration		Fish pond
Concave medians	Inlet restriction	Sand filter (P)		Dripline planter box
Grated infiltration system	Curb storage	Filtera *		Native groundcover
Parking groves				Green alleys
Grid pavers				

(P) – From City of Portland Stormwater Management Manual, 1999 (Portland, 1999)
* - Proprietary system, Americast, Ashland, VA

Task 3 – Identify Impediments to a Regional Manual for Low Impact Site Design

Ecosite will identify the impediments to actively using a Regional Manual for Low Impact Site design in regards to the physical and policy constraints by looking at zoning ordinances that conflict with new measures of better low impact site design techniques. More specifically Ecosite will identify how the counties in the region can adopt and enact the practices that are set forth in the low impact site design manual and still meet state guidelines for site design and stormwater management. Ecosite has gained considerable experience in this area, and is currently working with a number of local jurisdictions to address this issue and enable the use of LID technology.

Currently the only local agency in the region that has a specific process to enable the use of LID is Prince George's County, Maryland, where the LID design process was developed. In Prince George's County, developers are required to justify that they cannot use the LID design process before they are allowed to use conventional stormwater design techniques. In all other counties and jurisdictions in Maryland, there is no procedure and many impediments to the use of LID technology.

In order to conduct LID designs in other jurisdictions, such as the Pembroke Woods LID subdivision in Frederick County, Maryland, (one of the very few LID subdivisions built to date), Ecosite has had to go through a process similar to the one called for in this task. Ecosite has been successful in developing design overlays that enable us to use LID design techniques while complying with and usually exceeding the minimum requirements in the Maryland 2000 Stormwater Management Design Manual. Ecosite has applied this process successfully in

Frederick and Anne Arundel Counties and is currently under design in Cecil County, Maryland. In addition Michael Clar of Ecosite and John Gaadt are currently providing technical support to the Land Use Department of New Castle County, Delaware in the integration of LID technology with the Conservation Design approach documented by Randall Arendt (Arendt, 1996). As part of this effort Ecosite is helping New Castle County develop a new drainage code that will enable the use of this technology.

Ecosite with the assistance of the steering committee will conduct a survey of the codes and ordinances of all jurisdictions within the region (5 counties, one city, fourteen towns) using the Codes and Ordinances Worksheet developed by the Center for Watershed Protection This survey will provide the study team with an assessment of the needs of these jurisdictions related to the implementation of better site design standards. Model codes and ordinances will be developed and provided by Ecosite which can be used by the jurisdictions to make their development standards more environmentally friendly. Model ordinances and codes will be developed that address the following topics:

- Clearing and grading
- Open space design
- Tree conservation, land conservation incentives
- Stream and riparian buffers
- Steep slopes
- Setbacks and frontages
- Streets (width, length, right-of -way, cul-de-sacs)
- Driveways, sidewalks
- Parking (ratios, codes, parking lots, structured parking)
- Stormwater runoff, outfalls.

It is important to note that the LID hydrologic analysis is based on managing both the volume and the peak discharge associated with runoff. Currently the Virginia Stormwater handbook only addresses primarily peak discharge requirements. While it does not prohibit volume control, it does not provide much guidance on this issue, it does allow local jurisdictions to adopt more detailed or stringent criteria if they desire.

Ecosite will document and present to the steering committee a number of approaches that can be used to implement the regional manual. These approaches will include at a minimum, 1) the LID design process developed by Prince George's County, 2) the drainage code model being developed by New Castle County, DE, 3) the use of LID design overlays currently being used in other Maryland jurisdictions, and the use of the "LID Qicksheet" spreadsheet method developed for Milwaukee. The steering committee will advise Ecosite on the method or methods that are considered suitable for use on the Northern Shenandoah Valley Region.

Task 4 – Regional Urban Manual for Low Impact Design

The regional urban manual for low impact design will be developed in a sequence of four subtasks which will include; 1) a predesign meeting, 2) development of a detailed manual outline, 3) a draft of the manual, and 4) a final manual document

Subtask 4.1 Predesign Meeting

The first step will consist of a meeting between the Ecosite project team and the steering committee. Ecosite will make a presentation to the committee that will describe various approaches that can be taken to the development of the manual.

One of these approaches will consist of adapting the LID design manual currently in use in Prince George's County, Maryland for use by the NSVRC. The advantages and disadvantages of this approach will be identified.

The second approach will consist of developing a simpler design tool such as the "LID Quicksheet" spreadsheet model developed by Paul Koch for Milwaukee. The use of this spreadsheet model will be described and the advantages and disadvantages of this approach will be discussed.

Other approaches may also be presented as they are developed, and any design preferences offered by the steering committee will be discussed and considered.

Subtask 4.2 Detailed Regional Design Manual Outline

After a consensus has been achieved on the general approach and format of the design manual, Ecosite will prepare a detailed outline of the contents of the manual. This document will be submitted to the steering committee for review and comment.

Subtask 4.3 Draft of Regional Design Manual

After review comments on the detailed outline of the manual have been received from the steering committee, Ecosite will prepare a first draft of the regional design manual. This draft will be submitted to the steering committee for review and comment. A meeting with the steering committee will then be scheduled. Ecosite will present and discuss the major elements of the manual to the steering committee and also discuss any major comments related to the contents of the manual

Subtask 4.4 Final Version of Regional Design Manual

Ecosite will incorporate all review comments received from the steering committee on the draft version of the regional design manual and incorporate these comments into a final version of the design manual that will be submitted to the steering committee for review and acceptance.

References

Arendt, G.A., 1996, Conservation Design for Subdivisions: A Practical Guide to Create Open Space Networks, Natural Lands Trust, American Planning Association, and American Society of Landscape Architects, Island press, Washington, D.C.

Emerson, C. H., C. Welty, R. Trvaer, "*Application of HEC_HMS to Model the Additive Effects of Multiple Detention Basins over a range of Measures Storms*," paper presented at the World Water & environmental Resources Congress 2003, June 23-26, Philadelphia, PA , American Society of Civil Engineers, Reston, VA

Ferguson, B. K., 1995. *Downstream Hydrographic Effects of Urban Stormwater Detention and Infiltration*, in Proceedings of the 1995 Georgia Water Resources Conference, Kathryn J. Hatcher, editor, pp128-131, Athens, University of Georgia Institute of Government.

Jones, J.E. 1997. *Bioassessment of the BMP Effectiveness in Mitigating Stormwater Impacts on Aquatic Biota.*.In: In L. A. Roesner (ed.), Effects of Watershed Development and Management on Aquatic Ecosystems, American Society of Civil Engineers, New York, NY.

May, C. R. Horner, J. Karr, B. Mar, and E. Welch. 1997. *Effects of Urbanization on Small Streams In the Puget Sound Lowland Ecoregion.* Watershed Protection Techniques, 2(4): 483-494.Center for watershed Protection, Ellicott City, MD

Maxted, J., and E.Shaver, 1997. *The Use of Retention Basins to Mitigate Stormwater Impacts on Aquatic Life.* . In L. A. Roesner (ed.), Effects of Watershed Development and Management on Aquatic Ecosystems, American Society of Civil Engineers, New York, NY.

McCuen, R.H., G. Moglen, E. Kistler, and P. Simpson, 1987. *Policy Guidelines for Controlling Stream Channel erosion with Detention Basins,* prepared by the Department of Civil Engineering, University of Maryland, College Park, MD, prepared for the Water Management Administration, Maryland Department of the Environment, Baltimore, MD

Stribling, J.B., 2002, *"Relating Instream Biological Condition to BMP Activities in Watersheds*", paper presented at the Conference on Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, Snowmass, CO, United Engineering foundation, New York, N.Y.

SCHEDULE

The entire project will require ten months to complete. The schedule for each of the tasks is summarized below.

TASK	SCHEDULE
Task 1:	
Coordination with Steering Committee.	
Kick-off meeting	Within two (2) weeks after start of project
Meeting to review tasks 2 and 3	Two (2) weeks after submittal of tasks 2 & 3 reports
Predesign Meeting	Held in conjunction with review of tasks 2 and 3
Review of draft of manual	Two (2) weeks after submittal of draft of manual
Other meetings	As needed
Task 2:	Two (2) months after start of project.
Study of Karts Issues and LID techniques	
Task 3:	Two (2) months after start of project.
Identify Impediments to Regional Manual	
Task 4:	10 months after start of project.
Regional urban Manual for LID Site Design	
Subtask 4.1	
Predesign Meeting	In conjunction with meeting on tasks 2 and 3
Subtask 4.2	
Detailed outline of regional manual	Three (3) months after start of project
Subtask 4.3	Eight (8) months after start of manual
Draft copy of regional design manual	
Subtask 4.4	
Final copy of regional design manual	10 months after start of project

QUALIFICATIONS AND EXPERIENCE

Project Organization

Ecosite has assembled a well qualified project team for the proposed project. The project team organization is shown on the attached project organization chart. Ecosite has the required resources and manpower to mobilize, initiate and organize the study and dedicate adequate resources and staff to achieve the overall study objectives in a timely manner.

Key Staff

The key staff proposed for this project are shown on the proposed project organization chart and are listed below and brief resumes are provide in Attachment A :

Michael L. Clar. P.E. – Project manager
Paul Koch, Ph.D., P.E. – Senior Project Engineer, task leader for preparation of regional LID design manual
John Gaadt – Senior Environmental Planner, task leader in identification of impediments to a regional manual for LID site design
Bryan Stuller – Project Geologist
Marcus Hall – Civil / Environmental Engineer

Michael L. Clar, P.E. – Project Manager
Michael Clar, P.E. is well qualified to direct this effort for the NSVRC. He is a recognized national expert in stormwater management technology and one of the leaders in the development of Low Impact Development technology. Mr. Clar has experience working with federal, state and local government agencies, community associations, consulting engineers and land development companies.

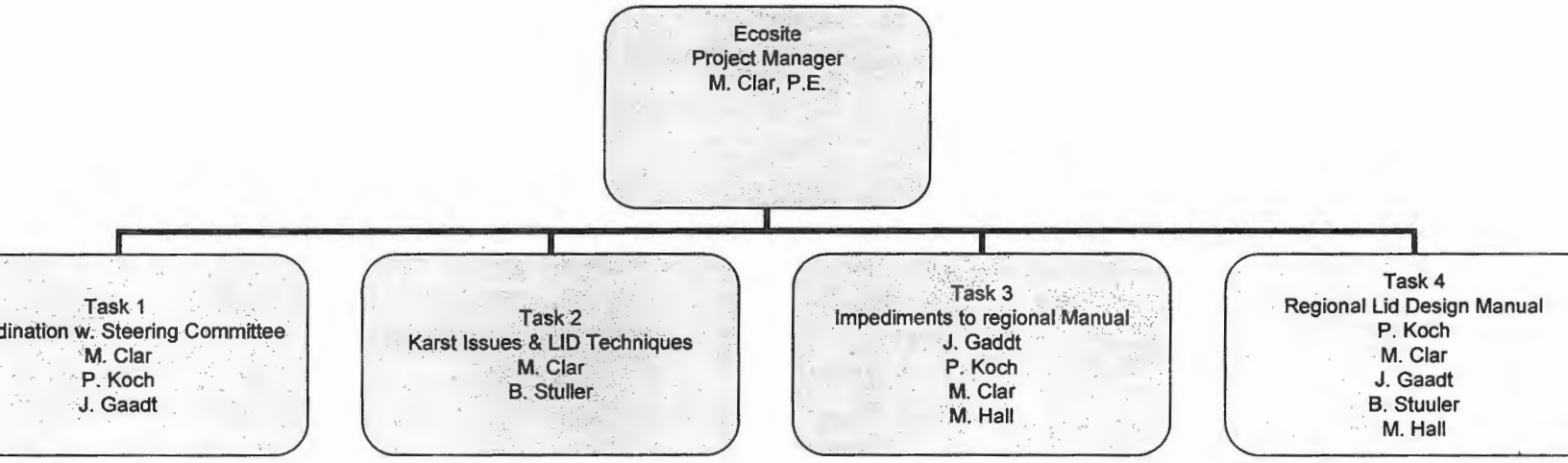
Mr. Clar recently completed a 3 year term as chair of the Urban Water Resources Research Council (UWRRC), the leading national authority on stormwater management issues. He has conducted national assessments of stormwater management technology including detailed evaluation of the Virginia Stormwater Handbook. He served on the Maryland stormwater regulations steering committee which directed the development of the Maryland 2000 Stormwater Management Design Manual.

Mr. Clar serves as the co-chair of the LID technical committee of the UWRRC along with Larry Coffman of Prince George's County, Maryland. He was a contributing author to the Prince George's County LID design manual and a lead author for the EPA publication, "Low Impact Development Design Strategies", and "Low Impact Development Hydrologic Analysis". He also directed the project team that developed the "Design Manual for Use of Bioretention in Stormwater Management".

He currently serves as a technical advisor to the Land Use department of New Castle County, Delaware and is helping the County staff integrate LID into its conservation design approach to stormwater management. This work includes sitting in on major subdivision reviews and assisting developers and their engineers in the use of LID for better project design.

Mr. Clar served as the lead engineer in the design and construction of the Pembroke Woods subdivision, one of the few LID subdivisions built to date. This subdivision is located in the town

Project Organization



of Emmitsburg in FredericK County, Maryland in a geologic and geographic setting that is very similar to the Northern Shenandoah Valley region.

Paul Koch, Ph.D., P.E. – Senior Project Engineer
Dr. Koch is a highly qualified and experienced water resources engineer. He has gained considerable experience in Low Impact Development technology while working with the Low Impact Development Center, Beltsville, MD, and Greenhorne and O'Mara, inc. in Beltsville, MD. A few of his recent accomplishments related to LID are summarized below:

- He developed the "LID Quicksheet" a spreadsheet tool that allows a design engineer to quickly and efficiently determine the degree to which LID features can reduce peak runoff rates. This work was performed for the Milwaukee Metropolitan Sewerage District
- He compiled and edited a project report featuring LID site designs involving a detached home subdivision, a townhouse subdivision, and a commercial lot. The report included technical drawings, a runoff volume and hydrograph comparison, and a cost comparison. This work was performed for Prince George's County, MD
- Prince George's County, MD, saw a need to revise their stormwater management design manual to supply updated guidance, remove outdated information, and incorporate new LID guidelines. During the initial planning phase of the project, Dr. Koch designed a survey for stormwater engineers in the County. He also facilitated a daylong stakeholder meeting to identify and articulate multiple objectives associated with the guidelines revision. As the guidelines were being revised with detailed input from another engineering consultant, Dr. Koch provided ongoing editorial feedback to ensure clarity and readability in the final draft.

John Gaadt – Senior Environmental Planner
Mr. Gaadt is a highly qualified and experienced environmental planner. He has gained considerable experience with the integration of LID technology with the Conservation Design approach to stormwater management. A few of his recent highlights related to environmentally sensitive site design activities are summarized below;

- New Castle County, Delaware: Developed Conservation Design initiative consisting of a series of holistic land development design tools that maximize protection of key land and environmental resources, preserve significant concentrations of open space and greenways, evaluate and maintain site hydrology, and ensure flexibility in development design. The initiative involves an integrated development process that respects natural site conditions and strives to replicate or improve the natural hydrology of a site.
- New Castle County, Delaware: Prepared County Conservation Plan and natural resource protection ordinance language addressing floodplains, surface waters, drainageways, riparian buffers, woodlands, steep slopes/erosion hazard areas, freshwater wetlands, critical natural areas, air quality, and landscaping, among others.
- Willistown Township, Chester County: Prepared stormwater management ordinance incorporating rate, volume, infiltration, and quality components with an emphasis on non-structural best management practices (BMPs).
- *Watersheds*, An Integrated Resources Plan and Water Resources Compendium for Chester County, Pennsylvania: Evaluated local and national approaches to stormwater management; developed conservation design process for new land development; developed model stormwater management ordinance for county's 62 municipalities.

Experience

The Ecosite project team has acquired considerable experience on numerous projects that are similar to the needs of the proposed project. This experience base includes experience with the Virginia Stormwater Management handbook, knowledge of the limitations to karst topography, fractured rock and heavy clay nature found in the Northern Shenandoah Valley Region, as well as knowledge of Low impact Development Techniques. The project team also has considerable experience in writing LID manuals and working with localities and large groups with various backgrounds striving for a common goal.

A few representative examples of this project team experience are summarized below.

Project: Low-Impact Development (LID) Strategies: An Integrated Design Approach.
Client: Prince George's County, DER; US EPA Nonpoint Source Management Program
Mr. Clar, in his capacity as a senior engineer, was a lead author in the development of a national guidance document on Low-Impact Development (LID) technology. LID is an ecologically sustainable approach to stormwater runoff control which was developed as an alternative to existing conventional end-of-pipe approaches to stormwater management. It uses micro scale management practices which are integrated into the landscape to produce a hydrologically functional site design which mimics the pre development site hydrology and provides pollution prevention measures to compensate for land development impacts on hydrology and water quality.

Under a research grant from the US EPA the contents of the Prince George's LID Design Manual were expanded and modified into a national LID guidance document titled, "Low Impact Development Design Strategies: An Integrated Design Approach" (USEPA, 2000). The national manual organized the LID design process into four major groupings that are summarized in Figure 1. These include 1) site planning, 2) hydrologic analysis, 3) selection and design of integrated management practices(IMPs), 4) erosion and sediment control requirements for LID, and 5) public outreach activities. The manual provides more detailed guidance on the incorporation of LID technology into the site planning process than is found in the Prince George's design manual. Also it provides more detail on a range of micro-scale landscape based practices termed integrated management practices (IMP's).

Project: Low Impact Development (LID) Design Manual
Client: Tetra Tech, Inc. / Prince George's County, MD
Mr. Clar served as a contributing author in a subcontract effort to Tetra Tech, Inc., which resulted in the Development of Prince George's County LID Design Manual. Low Impact Development (LID) is a new approach to stormwater management and site design that has been adopted in the Prince George's County and the State of Maryland. It is being promoted by USEPA and has also been adopted by other states and local jurisdictions. Low Impact Development incorporates a design strategy of prevention of impacts by precision planning and engineering and then compensation of impacts by the use of sustainable integrated Best Management Practices. Another important aspect of this program is the promotion of pollution prevention and owner maintenance through public education programs. The goal of this design approach is to maintain the pre-development hydrologic regime of a site in order reduce impacts of development to receiving waters and to protect living resources.

New standard design details were developed to accomplish the overall design objectives. This included modifications to street design, stormwater inlets, grading, and sediment and erosion control approaches. A complete understanding of the existing County regulations and technical

requirements for development in the public right-of-way and other Department of Public Works and Transportation standards was required. The project team worked closely with land developers, private engineering and design consultants, County officials, and plan reviewers to develop these new details and regulations.

The design manual included the methods and approach to design a site. This included several examples on the process, including design examples for single family residential, commercial and industrial uses. The design examples included detailed hydrologic and hydraulic analysis for stormwater management requirements, site analysis techniques, site detail selection, and BMP design.

A significant portion of the design manual is devoted to the County permit application and review process. This required the investigators to have an in-depth understanding of the County regulations and requirements and development process. Several meetings
and workgroups were conducted with review agency representatives in order to develop strategies for implementation of this new approach. Agency representatives included plan reviewers, department heads, administrative personnel, and bonding reviewers.

Project: Technical Guidance for LID Hydrologic Analysis
Client: Milwaukee Metropolitan Sewerage District
Dr. Koch performed this project for the Milwaukee Metropolitan Sewerage District (MMSD) which encompasses 420 square miles and serves over a million people. Prior to the beginning of this project, the MMSD had established new requirements for peak runoff control and was interested in developing an analytic tool that would determine the degree to which LID features could reduce peak runoff rates and the need for conventional detention ponds. Ideally, this tool would be technically sound without encumbering the development engineer or the storm water plan reviewer with an unnecessarily complex analysis.

After examining five different adaptations of the NRCS unit hydrograph method, one approach was selected for incorporation into a user-friendly spreadsheet. The simple spreadsheet interface allows the user to create a hydrograph for a site on the basis of the curve number and time of concentration – parameters already familiar to most storm water engineers – and then examine how the hydrograph shape will change as the capacity of storm water retention features is increased on the site. The peak runoff rate and estimated detention pond capacity are recalculated instantaneously in response to user input.

The development of this tool involved three meetings with the MMSD Steering Team to obtain input on project scope and comments on draft deliverables. The Steering Team consisted of representatives from six communities; three design engineers; three developers or development officials; MMSD staff; and a representative of the State Department of Natural Resources, who has authority for water quality issues in the State of Wisconsin.

In addition, Dr. Koch made presentations at five workshops that more than 60 individuals attended. The participants included developers, design engineers, and local government officials. The workshops provided opportunities for the attendees to provide additional input concerning desirable features for the analytic tool as it was undergoing development.

The spreadsheet, which is being referred to as the "LID Quicksheet", has received a very favorable response from the MMSD and its stakeholders. Follow-up discussions with the MMSD are underway to further enhance and customize the approach to suit the District's program.

Official adoption of the tool and the accompanying technical guidance is expected to take place by the end of 2004.

Project: Technical Support Related to the Use of Low Impact Development (LID) with New Castle County, Delaware's Conservation Design Ordinance.
Client: Land Use Department, New Castle County, Delaware
Ecosite has been retained by the Land Use Planning Department New Castle County Delaware to provide technical assistance to the Department in incorporating Low Impact Development (LID) techniques as part of the implementation on its new conservation design ordinance.

The work involves a wide range of activities that include:

- Identifying LID techniques that can be incorporated into the Conservation design process
- Serving as part of a technical review panel that is meeting with developers to assist them in identifying appropriate conservation design strategies
- Preparation of workshop materials and presentation of workshop for developers describing the design methods and benefits of integrated conservation design and LID methods

In a related effort, Mr. Clar is assisting the Department in the development of an updated drainage code that enables the use of conservation design and LID technology on a watershed basis.

Project: Pembroke Woods: A Low Impact Development (LID) Subdivision
Client: Buckeye Development, Inc., Frederick, MD
The Pembroke Woods Subdivison is a ½ acre residential development located in northern Frederick County Maryland and is not only the first LID subdivision permitted in Frederick County, but also the first subdivison designed and under construction using the LID Design Manual developed by Prince George's County, Maryland (P.G. 1997, EPA, 2000). LID is an innovative approach to stormwater management (SWM) that attempts to mimic the pre development hydrology of a development site thus maintaining the hydrologic functions of the site and precluding the environmental impacts especially the water quality degradation of receiving streams, lakes and estuaries that are normally associated with land development activities.

The LID design process integrates SWM controls into a site's landscape by using a series of innovative micro-scale practices such as; raingardens, bioswales and rain barrels in conjunction with better site planning techniques such as; reduction and disconnection of impervious areas and fingerprinting techniques for site grading. This approach to stormwater is being adopted as the standard for green building site design on a nationwide basis, and is also perceived as part of the smart growth toolbox by the State of Maryland.

Pembroke Woods was originally designed in the early 1990's as a ¼-acre lot conventional subdivision with 97 lots, 2 SWM ponds and closed section streets. The origional design also required a sewage pump station and most of the wooded site would have been required to be cleared. When redesigned as an LID subdivison, it exhibits and benefits from the win/win attributes of the LID process which include:

1. The use of LID allowed the site design to eliminate the use of two SWM ponds which had been envisioned in an earlier concept plan for the site. This represents a reduction in infrastructure costs of roughly $200,000.
2. In place of the SWM ponds 2.5 acres of undisturbed open space and wetlands were preserved. Again a considerable savings in wetlands mitigation impacts were realized.

3. Also the site plan gained two additional lots increasing the 43 acre site yield from 68 to 70 lots. This added roughly $90,000 in additional value to the project.
4. Extensive use of site fingerprinting techniques (Figure 2), an elemental LID design feature, and a green building design feature, allowed the site design to preserve approximately 50% of the site in undisturbed wooded condition. This design feature was essential for maintaining the pre- development curve number (CN), which is very difficult on a wooded site.
5. Approximately 3000 linear feet of roads were converted from an urban road section to a rural road. This design feature replaced curb & gutter with grass bioswales, a savings in construction costs of $60,000. Also the rural road section is a green building design feature that reduces the paving width from 36 to 30 foot width, a 17% reduction in paving costs.

In order to satisfy County criteria for adequate downstream conveyance a downstream impact analysis was conducted. The analysis examined the ability of an LID site design to maintain predevelopment peak discharge conditions for a range of storms including the 1, 2, 10, 50 and 100 year storms. Many public works personnel perceive innovative SWM techniques such as LID capable of addressing water quality issues, but insufficient to provide downstream peak discharge control for the larger flood flows associated with the 10, 50 or 100-year storms.

Initially the site LID hydrologic analysis was based on the 1-year storm (2.5 inch rainfall) that was Frederick County's criteria for water quality control. The downstream analysis revealed that the 1- year storm design was not sufficient to maintain predevelopment peak discharges for the 10, 50 and 100-year storms. An incremental iterative procedure was then used to determine the additional control requirements that would be required to provide the required downstream control. The analysis showed that by increasing the design storm to the 2 year storm (3.0 inches of rainfall), the required downstream protection for the complete range of flood events (10, 50 and 100-year storms) was achieved.

Plans are being considered to monitor this unique site as the other phases of the site are built to verify the benefits of this approach.

A few lessons learned during the construction of the first phase of the development include:

- The site finger printing process creates a tight building site for contractors and needs to allow for some flexibility in its implementation
- Contractors have a tendency to drive equipment over and damage the bioswales requiring frequent repair and reconstruction

These results have great significance for future SWM policy and design criteria. It clearly illustrates the tremendous advantages achieved by the volume control approach. It cannot be sufficiently emphasized that this innovative development project could not have been accomplished without the outstanding cooperation and desire for excellence displayed by the Agency Review team that included Ms. Betsy Smith (Director) and David Ennis and David Crable of Development Design Office of the Frederick County Department of Public Works, and David Haller, Town Manger of Emmittsburg, MD

Project: The Annapolis Technology Park, an LID Commercial Development, Annapolis, MD

Client: MIE Properties, Co, Baltimore, MD

The MIE Properties Company retained the services of Ecosite, Inc. to develop an LID design to address the stormwater management requirements of this 30-acre commercial property. The MIE Co selected to adopt this higher level of stormwater protection for this commercial development in response to community concerns for the potential impacts of the development to Gingerville Creek, a small stream that has been previously impacted and eroded by development in the watershed.

This project represents the first commercial application of the LID technology in Anne Arundel County. The Anne Arundel permits processing staff expressed concerns related to the review staff's ability to review and approve a new design technology of this type, particularly in view of the fact that the County staff was already burdened with trying to get up to speed with the new MDE statewide stormwater management design manual. In order to address this problem, Mr. Clar developed an LID overlay process that allows the design of LID within the parameters of the new MDE 2000 design manual, so that the review staff can simply review the design as if it were a routine SWM design.

Project: **City of High Point, NC, Low Impact Development (LID) Feasibility Study.**
Client: **Tetra Tech, Inc.**
Ecosite was retained by Tetra Tech, Inc., to assist in a watershed based feasibility study to demonstrate that Low Impact Development (LID) technology represents a viable and improved technology to current stormwater BMP technology. Ecosite prepared three case studies that compared the use of LID concepts with traditional SWM approaches. The case studies included a single-family residential (1/2 acre lots) site, as well as a commercial and industrial site.

In addition Ecosite provided a daylong workshop on the fundamentals of LID technology. The topics covered included; LID overview; LID site planning techniques; LID hydrologic analysis; LID BMP selection and design; and LID public outreach and implementation issues.

Project: **Bioretention Study and Design Manual Development.**
Client: **Prince George's County, MD**
Mr. Clar served as the project manager for this project performed under a multi-engineering services contract with Prince George's County. The work involved first a feasibility study, second a case study evaluation and third the development of a design manual for the use of bioretention techniques for stormwater management. Bioretention is an innovative stormwater management technique, which makes use of native plantings and soil conditioning methods. Bioretention areas can be used either on-line or off-line in the treatment of the first flush of runoff from impervious areas. Pollutant removal is accomplished through physical and biologic treatment processes occurring in the plant and soil complex: transpiration, evaporation, storage and nutrient uptake.

While bioretention designs are principally performed to provide water quality storage and infiltration for the first 1/2 -inch of runoff from small drainage areas, ETA has also demonstrated designs that provide retention and infiltration of the 2-year storm event.

The following inter-related elements associated with the application of bioretention systems were addressed in the manual:

- Landscape architecture/ site planning
- Plant materials suitability
- Hydrology and hydraulics
- Water quality.

Design criteria or parameters were developed for bioretention related to:

- Use of bioretention practices in landscaped or graded green space areas at commercial and industrial sites;
- Development of plan and section details for bioretention practices in parking islands, parking edge, and perimeter areas;
- Guidelines for water storage for uptake by vegetation;
- Selection of plant materials based on ecological considerations;
- Water quality control guidelines and performance;
- Minimum surface area requirements.

The Bioretention Design Manual developed in this project received a 1993 Merit Award from the Potomac and Maryland Chapters of the American Society of Landscape Architects.

Project: **Update and Revision of the District of Columbia's Stormwater Management and Erosion and Sediment Control Laws and Regulations**
Client: **Watershed Protection Division, Department of Health, District of Columbia**

Ecosite was awarded a contract by the Watershed protection Division of the District of Columbia the revise and update its existing laws and regulations relating to Soil Erosion and Sediment Control and Stormwater Management. Ecosite is being assisted in this effort by Dr. Robert Traver of Villanova Univ, Professor Bill Barfield of Oklahoma State Univ, and Professsor Shaw Yu of the University of Virginia.

These regulations enable The District of Columbia to prescribe minimum levels of non point source pollution control for land use activities within its incorporated boundaries. These regulations are also essential to comply with numerous federal statutes such as the Clean Water Act, the Coastal Zone Management Act, and the Chesapeake Bay Program, and thus allow the District of Columbia to meet its water quality goals. The regulations need to be upgraded and revised on a periodic basis to reflect our increasing understanding of the impacts of pollutants to our receiving waters as well as developments in pollutant control technology.

The project involves a number of tasks including:

Task 1. Review and analysis of soil erosion and sedimentation control and storm water management related legislation from adjoining jurisdictions (Maryland, Virginia, Pennsylvania and Delaware), federal, and selected national urban program such as Miami, Oklahoma City and Seattle.

Task 2. Review of Fee-In-Lieu of Storm Water Management Report for the District, and incorporate appropriate sections of the Fee-In-Lieu of Storm Water Management Report recommendations into the storm water management regulations.

Task 3. Research and thoroughly review non-sanitary landfill regulations from adjoining jurisdictions and incorporate non-sanitary landfill regulations from adjoining jurisdictions into existing District soil erosion and sedimentation control regulations.

Task 4. Review definitions in the existing regulations and include additional definitions where appropriate.

Task 5.Review the new DC Building Codes and DC floodplain regulations to ensure consistency with the soil erosion and sedimentation control and storm water management regulations.

Task 6. Update the Civil Infractions Schedule of Fines to reflect the revisions of the soil erosion and sedimentation control and storm water management regulations.

Task 7. Draft of revised District of Columbia soil erosion and sedimentation control and storm water management regulations for DOH review and comments

Task 8. Final District of Columbia soil erosion and sedimentation control and storm water management regulations which are legally sufficient for final rulemaking .

Project: US EPA BMP Design Guidelines Manual.
Client: US EPA Urban Watersheds Management Division

Ecosite was awarded a contract by the Urban Watersheds Management Division of the US EPA. This project involves the development of design guidelines manuals for stormwater management ponds, vegetated swales and vegetative filter strips. The principal investigators for Ecosite on this project include Michael L. Clar, P.E.; Professor Bill Barfield, Oklahoma State University; and Professor Shaw Yu, Univesity of Virginia

To date drafts of three volumes including: Volume 1 – General Considerations in BMP Design; Volume 2 – Design of Vegetative Biofilters BMPs; and Volume 3 – Design of Pond BMPs, have been submitted to the US EPA for review and comment.

REFERENCES:

1. Larry Coffman
   Assistant Deputy Director
   Programs and Planning Divison
   Department of Environmental Resources
   Prince George's County, MD
   9700 Peppercorn Place
   Landover, MD 20785
   Tel: 301-883-5983

2. George Haggerty
   Assistant Land Use Manager
   Land Use Department
   87 Reads Way
   New Castle, DE 19720
   Tel:302-395-5405

3. Collin Burrell, P.E.
   Chief, Inspection and Enforcement Branch
   Watershed Protection Division
   Department of Health
   51 N Street, N.E.
   Washington, D.C.
   Tel: 202-535-2243

4. Mr. Edward Smariga, P.E.
   Buckeye Development, LLC
   125 S. Carroll Street, Ste 150
   Frederick, MD 21701

5. Mr. Richard Field
   Urban Watersheds Management Branch
   US EPA
   2890 Woodbridge Avenue
   Edison, N.J. 08837-3679
   Tel: 732-321-6674

ATTACHMENT A: KEY STAFF RESUMES

Michael Clar, P.E.

Paul Koch, Ph.D., P.E.

John Gaadt, AICP

Marcus Hall

Bryan Stuller

MICHAEL L. CLAR, P.E.

Education

University of Maryland, College Park	B.S.	1971	Civil Engineering
Pennsylvania State University, University Park	M.S.	1978	Mining Engineering

Research and Professional Experience

President / Owner, Ecosite, Inc., 1998 – Present
Consultant, Tetra Tech, Inc., 1998 – 2001
Executive Vice President / Owner, Engineering Technologies Associates, Inc., 1984-1998

Selected Professional Societies and Related Activities

Chair, Urban Water Resources Research Council, EWRI, ASCE, 1999-2002
American Society of Civil Engineers, 1999 – present
President, Maryland Society of Professional Engineers, 2000-2001
Member, Maryland Water Quality Advisory Committee, 1994 - present
Registered Professional Engineer, Maryland #22621
Registered Professional Engineer Pennsylvania # 033229
National Society of Professional Engineers (NSPE)
Suburban Maryland Engineers Society (Past President)
Water Environment Foundation (WEF)
Maryland Department of the Environment, Stormwater Regulations Technical Committee
ASCE Committee of the Preservation and Restoration of Riverine Corridors in Urban Areas

Recent Related Research Activities

BMP Design Guidelines Manual, US EPA. 2001-2002.
Stormwater BMP Technology Assessment Protocols: Construction and Development Effluent Guidelines Regulatory Support. US EPA, OST. 1999 -2001
MD 2000 Stormwater Management Design Manual Workshops, Maryland Society of Professional Engineers / Anne Arundel Co., MD, 2001- present
Low Impact Development (LID) Roundtable, P.G. Co., MD / US EPA, 2001
LID Strategies: An Integrated Design Approach. P.G. Co., MD /US EPA, 2000
City of High Point, NC, LID Feasibility Study., 2000
Stream Corridor Restoration Workshops, Tetra Tech, Inc. / US EPA / USFWS, 2000 –
LID Design Manual, Prince George's Co., MD, 1997
Fluvial Geomorphology and Stream Restoration Workshops, 1994 -

Selected Publications

Clar, M., and B.J. Barfield; (In Draft), BMP Design Guide: Volume 1, General Considerations, prepared for The Urban Watersheds Management Branch, Water Supply and Water Resources Division, National Risk Management Research Laboratory, Office of Research and Development. Cincinnati, Ohio 45268 (In Draft).

Clar, M., and B.J. Barfield; (In Draft), BMP Design Guide: Volume 2, Vegetative Biofilters BMPs, prepared for The Urban Watersheds management Branch, Water Supply and Water Resources Division National Risk Management Research Laboratory, Office of Research and Development. Cinicinnati, Ohio 45268 (In Draft).

Clar, M., and B.J. Barfield; (In Draft), BMP Design Guide: Volume 3, Ponds BMPs, prepared for The Urban Watersheds management Branch, Water Supply and Water Resources Division National Risk Management Research Laboratory, Office of Research and Development. Cinicinnati, Ohio 45268 (In Draft)

Coffman, L.S. and M. Clar, 2003, Low-Impact Development: An Ecologically Sensitive Alternative for Stormwater Management, Chapter 10 in Wet-Weather Flow in the Urban Watershed: Technology and Management, D. Sullivan and R. Field, Editors, CRC Press, LLC, Boca Raton, FL 33431

Cheng, M.S., L. Coffman, and M. Clar, 2003, Low-Impact Development: Hydrologic Analysis, Chapter 11 in Wet-Weather Flow in the Urban Watershed: Technology and Management, D. Sullivan and R. Field, Editors, CRC Press, LLC, Boca Raton, FL 33431

Clar, M., 2003, Geomorphic Considerations in Stream Protection, Chapter 12 in Wet-Weather Flow in the Urban Watershed: Technology and Management, D. Sullivan and R. Field, Editors, CRC Press, LLC, Boca Raton, FL 33431

Clar, M., 2002, Applications of low-impact development techniques (Maryland), Chapter I.15 in Handbook of Water Sensitive Planning and Design, R. L. France, Editor, Lewis Publishers, Boca Raton, FL

Clar, M. 2001, Low Impact Development (LID) Technology for Ultra Urban Areas, Case Studies, paper presented at the 3rd International Conference on Watershed Management, December 11 – 14, 2001, National Taiwan University, Taipei, Taiwan.

Clar, M. 2001, Stormwater BMP Technology Assessment Protocols – Preliminary Findings, paper presented at the Conference, "Re-thinking Comprehensive Stormwater Management - Integrating Quality, Volume, and Peak Controls, proceedings of the 2001 Pennsylvania Stormwater Management Symposium, Editor, Robert J. Traver, Villanova University, PA

Clar, M. 2001, Low Impact Development Case Studies, paper presented at the Conference, "Re-thinking Comprehensive Stormwater Management - Integrating Quality, Volume, and Peak Controls, proceedings of the 2001 Pennsylvania Stormwater Management Symposium, Editor, Robert J. Traver, Villanova University, PA

Clar, M., 2001, Low Impact Development Technology and Case Studies, workshop presented at the Annual Exposition and Conference, American Society of Civil Engineers, Houston, Texas.

Clar, M. 2001, Stream Corridor Protection and Restoration Workshop, presented by Tetra Tech, Inc., for the US EPA National Risk Assessment Laboratory, University of Cincinnati Conference Center, Cincinnati, Ohio.

Pritts, J.W, K. Maher, J. Swanson, J. Collins, and M. Clar, "*Environmental Assessment of Construction and Land Development*", 2001. Paper presented at the Conference on "Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, August 2001, Snowmass, CO, United Engineering Foundation, New York, N.Y.

Clar, M., et al., 2001. "*Stormwater BMP Technology Assessment Protocols*", poster session presented at the Conference on "Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, August 2001, Snowmass, CO, United Engineering Foundation, New York, N.Y.

Collins, J, M. Clar, et al., 2001. "*Compilation of Regulatory Requirements for Stormwater Runoff*" poster session presented at the Conference on "Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, ,August 2001, Snowmass, CO, United Engineering Foundation, New York, N.Y.

Clar, M., and B. Rushton, 2001, "*Low Impact Development (LID) Case Studies*", poster session presented at the Conference on "Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, ,August 2001, Snowmass, CO, United Engineering Foundation, New York, N.Y.

Clar, M. and L. Coffman, 2001. *"Applications of Low Impact Development (LID) for Ultra Urban Areas"*, paper presented at the First international Water Congress, environmental and Water Resources Institute (EWRI), American society of Civil Engineers, Orlando, Florida.

Clar, M., 2001, Alternative Measures of Evaluating Effectiveness an NPDES Phase I Permit Program, prepared by Tetra Tech, Inc., Laurel, MD, and Center for Watershed Protection, Ellicott City, MD, prepared for Howard County, MD.

Clar, M., et al., 2001. SWM Pond Retrofit Study for the Middle Patuxent River, Howard County, MD, report prepared by Tetra Tech, Inc., Laurel, MD for Howard County, MD

Clar, M., 2000. Total Impervious Area (TIA) as a Predictor of Stream Quality: Fact or Fiction, White paper prepared for Prince George's County, MD. November, 2000

Clar, M., et al., 2000. Deep River 1 Watershed Assessment and Stormwater Plan: City of High Point, NC, report prepared by Tetra Tech, Inc., RTP, NC, February, 2000

Loftin, H., M. Clar, E. Gemmill, and R. ElFarhan, 2000, "*Conceptual Ecological and Physical Framework for Evaluating Receiving Water Impacts*", paper presented at the ASCE /EWRI,Joint Conference on Water Resources Engineering and Water Resources Planning and Management, Minneapolis, Minnesota, August 2000.

Clar, M., 2000, "*Maryland Applications of Low Impact Development Techniques*", paper presented at the International Symposium on Water Sensitive Ecological Planning and Design, presented by the Department of Landscape Architecture, Graduate School of Design, Harvard University, Boston, Massachusetts, February, 2000

Clar, M., et al., 2000. "*Low Impact Development Design Strategies: An Integrated Design Approach*" manual prepared by Tetra Tech, Inc., prepared for Prince George's County, Maryland under funding by the U.S. EPA, January 2000

PAUL R. KOCH, Ph.D., P.E.

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OVERVIEW and OBJECTIVE

Water resources engineering professional with 8 years of technical and project management experience in watershed modeling for municipal, state and federal agencies. Seeking new opportunity in the development of robust engineering solutions and environmental policy for surface water management.

EXPERIENCE

Senior Scientist/Engineer, Low Impact Development Center, August 2002 - October 2003.

- *Hydrologic Modeling*
  -- Adapted NRCS unit hydrograph method to evaluate the composite effect of distributed retention volumes within a drainage area. Presented original software product and user guidance to several stakeholder groups affiliated with the Milwaukee Metropolitan Sewerage District.
  -- Developed design concept and computational approach for optimizing the arrangement and capacity of a tiered retention system to control peak runoff. Article submitted for peer-reviewed publication.
  -- Created dynamic simulation model that routes a runoff hydrograph through a bioretention cell.
- *Technical Instruction and Communication*
  -- Gave workshop presentations on Low Impact Development features and methods of analysis.
  -- Authored technical guidance manuals and web-based informational materials.
  -- Provided technical consultation on bioretention design and construction.

Senior Project Manager, Greenhorne & O'Mara, Inc., 1997-2002.

- *Large-Scale Hydrologic and Hydraulic Modeling using GIS Applications with Digital Terrain Models*
  Coordinated start-up phase and initial production activities in the delineation of more than 1600 miles of riverine floodplains across a 3300-square-mile watershed.
  -- Evaluated software for hydrologic analysis, hydraulic analysis, and digital floodplain delineation.
  -- Interviewed and hired project staff.
  -- Devised production enhancements that significantly increased efficiency of LIDAR data processing.
  -- Regularly facilitated resolution of technical questions among four engineering teams in three firms.
  -- Developed and implemented quality control procedures.
  -- Produced regular technical reports and special issue reports for the client.
  -- Wrote scopes of work and served on contract negotiation team.
  -- Assessed project progress relative to schedule and budget. Reviewed subcontractor invoices.
- *Technical Instruction and Communication*
  -- Taught 3-day classes in Practical Highway Hydrology at state departments of transportation, under the auspices of FHWA's National Highway Institute. Revised instructional materials for both the hydrology course and a new NHI course featuring the Watershed Modeling System.
  -- Facilitated workshop of stakeholders concerned with county stormwater design manual revision.
  -- Presented findings of flood mitigation and dredging studies at public meetings.
  -- Showed results of Low Impact Development case studies at two conferences.
  -- Drafted agenda for workshop to facilitate federal interagency LIDAR standards development.
- *Stormwater Management Design*
  -- Co-authored revision of a county stormwater management design manual in conjunction with the county's NPDES initiatives.
  -- Wrote and presented a report for three case study designs in Low Impact Development.
  -- Conducted flood mitigation study for a suburban watershed. This study included a wetlands assessment at a prospective stormwater management site. Presented results at a public meeting.

EXPERIENCE (Greenhorne & O'Mara, cont'd)

- *Environmental Assessment*
  -- Oversaw subconsultant performance in river sediment sampling and biological assessment in a dredging reconnaissance study.
  -- Performed water budget computations for wetlands design.
- *Marketing and Administration*
  -- Drafted, edited and provided quality control for contract proposals and task order proposals.
  -- Developed cost estimates, work plans, corporate and personnel résumés.
  -- Delivered marketing presentations to prospective clients.

Hydraulics Instructor, Catholic University, Washington, DC, 1999.
- Substituted for regular instructor in an upper-level undergraduate hydraulics course.

Civil Engineer, Michael Baker Corporation, Alexandria, VA, 1996-1997.
- Reviewed hydrologic and hydraulic analyses for proposed revisions to FEMA flood zone maps.
- Produced a closed-form analytic solution to sediment volume computation problem previously requiring iterative computations.

National Research Council Fellow, NOAA/NWS Office of Hydrology, Silver Spring, MD, 1995-1996.
- Established correlations between remotely sensed river basin characteristics and hydrologic parameters in calibrated runoff models.
- Presented study results at conference of the American Geophysical Union.

Water Resources Engineer Overseas (Volunteer), Engineering Ministries Int'l., Guatemala, 1994.
- Helped A&E team evaluate technical needs for social service operations at 3 sites in ten days.

Math and Science Teacher Overseas (Volunteer), El Camino Academy, Bogotá, Colombia, 1994.
- Taught secondary mathematics, chemistry and geometry for one semester.
- Spearheaded school participation in international class projects facilitated by e-mail.

University Instructor, 3 different institutions of higher learning, 1986-1992.
- Taught introductory physics, land surveying, irrigation and drainage.
- Completed graduate level course on college teaching methods.

Research Associate, EPA (NNEMS Fellowship), Kansas City and Boston, 1990.
- Generated literature review of environmental consequences of levee construction.
- Authored recommendations for protecting floodplain wetlands in Missouri.
- Organized material for manual describing waste streams in selected industries.

Graduate Research Assistant, University of Michigan, Ann Arbor, 1989-1990.
- Created ArcInfo database for overlay analysis of land features within selected lines of sight.
- Devised and documented procedure for converting GIS files between two different formats.

Faculty—Specialist, Michigan State University, East Lansing, 1988.
- Wrote Fortran code for experimental two-dimensional finite element model of surface runoff.

Civil Engineer, Harza Engineering Company, Chicago, 1985.
- Assisted in analysis and design of stormwater management and drainage systems.
- Created spreadsheet model of water supply system responding to catastrophic damage.

PROFESSIONAL LICENSES
- Professional Engineer, Maryland #25880
- FHWA/NHI Certified Instructor, 1999-2002

EDUCATION

Ph.D. Agricultural and Biological Systems Engineering, University of Nebraska, 1994.
-- Specialization: Agricultural water resources management.
-- Dissertation: *Artificial Neural Network Configurations for Predicting Corn Yield as a Function of Water Regime.* (Presented at conferences in agricultural engineering and crop modeling.)
-- Coursework: Water resources development, soil physics, groundwater modeling, econometrics, limnology, college teaching methods, educational administration.

M.S. Technology and Policy, Massachusetts Institute of Technology, 1990.
-- Specialization: Pollution prevention.
-- Thesis: *Broadening the Environmental Scope of Design: A Policy for More Comprehensive Undergraduate Engineering Education at MIT.*
-- Coursework: Engineering systems analysis, environmental law, public policy, management of chemicals in the environment, case studies in technology and policy.

M.S. Agricultural Engineering, Texas A&M University, 1987.
-- Specialization: Soil and water management in arid climates.
-- Thesis topic: *A Conceptual Model for Determining Yield Loss Due to Drought Stress in Sorghum.*
-- Coursework: Irrigation and drainage, operations research, crop physics, biosystems simulation, crop management, environmental regulation of plant growth, higher math.

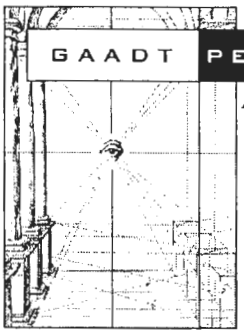
B.S. Civil Engineering (with honors), George Washington University, 1984.
-- Specialization: Environmental engineering.
-- Coursework: Multidisciplinary curriculum with elective studies in environmental science.

CONTINUING EDUCATION

- 2002 Skillpath Seminar: Managing Multiple Projects, Objectives and Deadlines
- 2001 Project Management Bootcamp, facilitated by PSMJ, Inc.
- 2001 Stream Restoration Workshop, Northern Virginia Soil and Water District
- 1996 Total Quality Management, Michael Baker Corporation
- 1989-1990 University of Michigan: Stream ecology, environmental economics, pollution modeling

COMMUNITY ACTIVITIES, MEMBERSHIPS AND HONORS

- Current Professional Memberships: ASCE, UCOWR, IAHS
- ASCE National Representative on Environmental Task Force of the Engineers' Public Policy Council of the American Association of Engineering Societies, 1999-2000
- President, National Capital Area Lutheran High School Association, Inc., 1996-1998
- Anacostia Watershed Toxics Alliance
- ASCE-NCS: Engineering Management; International Affairs; Education (Chair)
- Maryland State Water Quality Advisory Committee
- Finalist in ASCE/AAAS Congressional Fellowship Program, 1999 and 2000
- 1984 Tau Beta Pi Laureate



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EXPERIENCE

Gaadt Perspectives, LLC — April 1995 to present
Environmental Planning and Consulting — *Principal*

- Provide environmental services to a wide range of clients in the public, private and nonprofit sectors
- Areas of specialization include: water quality/quantity, wastewater, natural resource protection, land use planning, open space/agricultural lands preservation, solid waste and recycling, project management, grant writing, technical writing

Environmental Management Center (EMC) — February 1988 to March 1995
Brandywine Conservancy — *Program and Project Manager,*
Chadds Ford, Pennsylvania — *Senior Planner*

- Co-managed the Environmental Management Assistance Program (EMAP), which provides technical assistance to Local Governments, Private Landowners, and State and Federal Agencies on Land Use and Environmental Planning Issues
- Consulted on Natural Resources Protection, Water Quality/Quantity Issues, Sewage Facilities Planning, Comprehensive Planning, Solid Waste Planning and Recycling, Scenic Resource Analysis and Protection, Agricultural Lands Preservation, Open Space Planning, and Public Policy Issues
- Managed innovative Water Based Land Use Regulatory Program (WBLUR) conceived by the Conservancy
- Conducted topical Planning Workshops for Local Governments, State/Federal Agencies, and other professionals
- Contributed regularly to EMC publications Environmental Currents and Environmental Management Handbook

Montgomery County Planning Commission — January 1985 to January 1988
Norristown, Pennsylvania — *Assistant Chief of County Planning*

- Coordinated County Environmental Planning Efforts, including Project Management, Budgeting, Administration, and Recruiting
- Conducted Environmental Reviews of Sewage System Proposals, Solid and Hazardous Waste Facilities Permit Applications, Water Quantity/Quality Projects, and Utility Projects in Accordance with State and Federal Laws and County Policies
- Provided Technical Assistance to Local Municipal Officials and Representatives of Private, Civic, and Governmental Agencies
- Managed PA Act 167 Storm Water Management Planning Effort for a Seven-Municipality Watershed
- Guided Sewage Facilities Plan for a Six-Municipality Regional Sewage System

New Resource Group, Incorporated — February 1983 to August 1984
Milford, New Hampshire — *Planner*

- Provided water resources planning, education and public service programs on the merits of conservation as an alternative to water system expansion

EDUCATION

University of North Carolina
Chapel Hill

Master of Regional Planning
Environmental Planning Concentration, 1982
Research Assistant

West Virginia University
Morgantown

Bachelor of Arts
Geography, Regional Planning, Energy, 1980
Magna Cum Laude, Honors Thesis

Additional Studies:
U.S. Environmental Protection Agency Courses
American Planning Association Seminars
Pennsylvania State University

University of Delaware
University of Arizona

SELECTED ARTICLES

Brandywine Valley Association/ Red Clay Valley Association ***"State of the Watershed Reports,"*** Annual Assessments of the Environmental Health of Two Pennsylvania Watersheds, Editor, Writer and Project Manager, 1997 to present

Exchange, The Journal of the Land Trust Alliance, "Wastewater Reclamation and Reuse: Opportunities for Land Protection through Waste Management," Volume 13, Number 3, Summer 1994

Environmental Currents, Publication of the Environmental Management Center, Brandywine Conservancy

- "Spray Irrigation on Golf Courses: Toward a Symbiotic Relationship"
- "Clustering Lower Merion Style - The Open Space Preservation District" (Montgomery County, PA Planning Award)
- "The Red Clay Valley Scenic River and Highway Study"
- "To Throw Away or Not To Throw Away, Can There Be Any Question?"
- "Water Based Land Use Controls: Regulating in Response to a Primary Resource"
- "Natural Features Conservation - The Lower Merion Township Example"
- "Grappling with Solid Waste Issues - One Township's Approach"

SELECTED PRESENTATIONS

"Watersheds, An Integrated Water resources Plan for Chester County, Pennsylvania," Presentations to County Water Resources Task Force, Commonwealth of Pennsylvania, and General Public, January 1999 to present

"Sandy Run Creek Watershed Conservation Plan," Presentations to Commonwealth of Pennsylvania and General Public, January 1999 to January 2001

"Natural Resource Protection Measures in New Castle County, Delaware," Presentations to State of Delaware, New Castle County Council, New Castle County Planning Board, and General Public, 1996 to present

"Alternatives to Conventional Sewage Treatment," Presentation at Pennsylvania State University, Delaware County Campus, October 19, 1995

"Water Based Land Use Regulatory Program," Presentations at the Annual Mid-Atlantic Council of Watershed Associations Conference, Chadds Ford, PA, December 1, 1993 and Pennsylvania Planning Association Conference, Pittsburgh, PA, October 12, 1993

"Wastewater Reclamation and Reuse in the Red Clay Valley," Presentation at the Red Clay Creek Conference V, Delaware Nature Society, November 1, 1993

"Innovative Sewage Treatment Alternatives," Presentation at Montgomery County, PA, Sewage Facilities Workshop, September 15, 1993

"The Lower Merion Township, PA, Natural Features Conservation Ordinance," Presentation at the Land Trust Alliance Rally 1990, Villanova, PA

"Natural Features Conservation," Presentation at the Southeastern Pennsylvania Urban Forestry Conference, Morris Arboretum of The University of Pennsylvania, April 18, 1990

PROFESSIONAL AFFILIATIONS & PUBLIC SERVICE

- American Institute of Certified Planners (AICP), full member by examination
- American Planning Association (APA)
- Pennsylvania Planning Association (PPA); Delaware Chapter – American Planning Association
- Kennett Township (Pennsylvania) Land Trust Board of Directors
- Brandywine Valley Association (Pennsylvania) Energy Committee
- "Up With People" Alumnus (International Musical/ Educational/ Community Service Organization)
- Red Cross Volunteer and merit award recipient

COMPUTER SKILLS

Word, Excel, PowerPoint, WordPerfect, Lotus Spreadsheet, Quicken, Introductory GIS

Additional information available upon request.

MARCUS PHILLIP HALL

EDUCATION: B.S. / 1999 / Civil Engineering/Howard University

EXPERIENCE:

August 2001 -Present **ECOSITE, INC. / Columbia., MD**

Mr. Hall serves a an assistant vice-president with Ecosite, Inc. He serves as the group leader for the design / build operations related to functional landscaping services. A few representative projects are described below:

- *DISCOVERY CREEK CHILDREN'S MUSEUM LID DEMOSNTRATION PROJECT.* Ecosite is currently working as a subcontractor to the Discovery Creek Children's Museum in a project that involves the design and construction of an LID demonstration project at three elementary school sites in the District of Columbia. Mr. Hall serves as the group design leader and field superintendent for the construction operations

- *ANNAPOLIS MALL LID RETROFIT DEMONSTRATION PROJECT* – Under a grant from the Chesapeake Bay Trust and in a joint effort with the Severn River Watershed Association, and the Alliance for Community Education, Ecosite, Inc, recently completed the design and construction of an LID retrofit project at the Annapolis Mall. The retrofit consisted of converting an existing landscape area into a functional bioretention system that treats approximately 1.5 acres of road runoff. A unique aspect of this retrofit included the use of the technique developed by Professor Frank Gouin of the University of Maryland School of Horticulture to rejuvenate disturbed urban soils using a ditch witch and pine bark fines. Mr. Hall served as the design engineer and filed superintendent for the construction operations

- *BENNING SERVICE STATION LID DEMONSTRATION PROJECT* - Ecosite, inc. was retained by the Potomac Electric Power Co. (PEPCO) to design and build an LID demonstration project at the Benning Service Station Facility within the Anacostia watershed. The work involved the development of a conceptual plan to use LID practices to manage the runoff from the 32 acre site. In addition construction plans were prepared for four individual LID sites and one of the sites was fully permitted and cosntructed.

July 1999- August, 2001 **C.C. JOHNSON & MALHOTRA, Columbia, MD**

Mr. Hall served as a design and field services engineer. A few representative projects are described below:

Engineer, Stormwater Management and Erosion and Sediment Control, Bureau of Water And Wastewater, Baltimore, MD

Mr. Hall familiarized himself with regulatory changes by the Maryland Department of the Environment (MDE), Water Management Administration. Mr. Hall then assisted in the revision of Baltimore City's Stormwater Management and Erosion and Sediment Control ordinances and manuals to bring them into compliance with the new State regulations. Mr. Hall coordinated with representatives of various City agencies, representatives of MDE, and local water departments.

Engineer, Water Meters, Bureau of Water And Wastewater, Baltimore, MD

Designed and oversaw study of the degradation of water meter accuracy based on usage, age, and manufacturer. Researched automated meter reading (AMR) for the City's water meter system. Prepared

specification for an AMR system for 30,000 water meters. Coordinated with representatives of the City, meter and AMR vendors, Contractors, local utility companies, and local water departments.

Engineer, Bryant Street Pumping Station, Water And Sewer Authority, *District of Columbia*
Mr. Hall entered manholes and vaults at Bryant Street Pumping Station to aid determine existing contents, designed replacements of valves, planned removal of existing water main, designed sump pumps, designed irrigation system, and completed research for the 100 year old facility.

Engineer, Cleaning and Lining of Water Mains, Water And Sewer Authority, *District of Columbia*
Services involved designing and drafting plans for the Cleaning and Lining for 2,100 feet of water mains, researched As-Buitls, field verification of existing conditions, design and draft plans for the elimination of cross connection of sewer and water lines, designed 400 foot water main extension, and coordinated with representatives of WASA.

Engineer, Large Valve Replacement, Water And Sewer Authority, *District of Columbia*
Mr. Hall researched, designed, and drafted replacements for large water main valves; checked the drafting of the AUTOCAD operators, field verified dozens of valve locations, contacted utility companies to determine location of existing utilities, and coordinated with representatives of WASA.

Engineer, Odor Control at Patapsco Waste Water Treatment Plant, Bureau of Water And Wastewater, *Baltimore, MD*
Mr. Hall obtained Permit to Construct at Patapsco Waste Water Treatment Plant for Odor control system.

Engineer, Fine Screens, Bureau of Water And Wastewater, Baltimore, MD
Mr. Hall designed replacements for two fine screens at the Patapsco Wastewater Treatment Plant. The Screens service channels with average daily flows of 6 MGD and maximum flow of 30 MGD. Coordinated with representatives of the City, Screen vendors, Contractors, and local water departments.

Engineer, Montebello Water Treatment Plant Turbidimeters, Bureau of Water And Wastewater, Baltimore, MD
Mr. Hall designed a turbidity monitoring system for 8 separate turbidity monitoring networks. Each network was composed either 7 or 8 sensors.

COMPUTER SKILLS: Microsoft Office, AutoCAD

BRYAN STULLER

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Elkridge, MD 21075
stuller@hammondhs.org
443-755-9840

Education:

Master of Science (Thesis: Metals in ore systems), Geology, August 2001
University of Maryland, College Park

Bachelor of Science (Thesis: Crystallization textures of magmas) Geology, December 1996
University of Maryland, College Park

Profile:

- Design of experimental equipment
- Analyzed glass & sulfides for metals
- Fieldwork in Colorado, California & Nevada
- Sample preparation for chemical analysis

Work Experience:

Hammond High School, Howard County Public Schools Maryland (8/01-present). 8815 Guilford Road, Columbia, MD 21046. High school science teacher: Earth Science, Biology and Physics

Department of Geology, University of Maryland (9/98- 8/01). Graduate Research Assistant and Teaching Assistant. Supervised & advised teaching assistant staff 2000-2001, lab instructor for physical geology, 50 students per semester. Helped to maintain and manage hydrothermal experimental lab.

KCW Civil Engineers & Land Surveyors (9/97-7/98) 3104 Timanus Lane, Suite 101, Baltimore, MD, 21244. Completed hydrology reports for site plans, designed site plans for commercial and residential development, drafted site plans on AutoCAD, assisted survey department, directed by Walter Patterson.

English China Clay International (1/97-4/97) P.O. Box 125, 10,000 Beaver Dam Road, Cockeysville, MD 21030. Contractual position at a $CaCO_3$/aggregate quarry in Texas, MD. Assisted mine engineer (Selwin Gray), updated daily mine advance on AutoCAD, conducted sampling programs of the quarry, prepared $CaCO_3$ for chemistry tests.

Publications:

Stuller, B., Piccoli, P.M. and Candela, P.A. (2000) The partitioning behavior of Mn, Co, Ni, Zn, Mo, W and Au between pyrrhotite and a rhyolitic melt. EOS-Transactions of the American Geophysical Union 81, 440.

Goldschmidt Conference 2001. P.M. Piccoli, B. Stuller, T.Rocca and P.A. Candela. "Evaluating the Behavior of Metals in Porphyry-Type Ore Systems: Evidence from Experimental Studies." Accepted & Invited.

Computer skills:

AutoCAD 12-14, JEOL 8900R Electron probe micro-analyzer, Sigma Plot, spreadsheet & word processing programs, power-point, familiar with PC and Macintosh software.

Honors:

Distinguished Teaching Assistant, 1998-1999 (College of Math & Physical Sciences, U of MD)

Activities:

Ice Hockey Team, Highland Bagpipe Band