

Ten years ago, Larry Coffman, the visionary that created the concept of Low Impact Development (LID), convinced me to help start The Low Impact Development Center, Inc. No one can dispute the power or impact that LID, Green Infrastructure, and Green Highways are having on helping our nation and other countries to not only help, protect, and restore their water resources, but also improve the quality of life in existing urban and developing areas. The Center has completed over 200 LID, Green Infrastructure, Green Highways Partnership, and sustainable development projects. These projects have involved just about every facet of research, planning, design, construction, economic analysis, manuals of practice, policy, and training that is required to develop successful programs for sustainable planning and design that meets regulatory and resource requirements. A few years ago, when the Center was the only group working on LID and there was only two (2) other people at the Center (we've had a huge expansion there are now six (6) of us) there were a lot of detractors and skeptics. I made the statement that in a few years everyone will be an LID expert. It got a lot of laughs from the staff, but they usually laugh at me a lot anyway. With the support of our partners at EPA Headquarters, EPA Region 3, The Chesapeake Bay Program, The Navy, Natural Resources Defense Council, the California State Water Resources Control Board, DC Government, Maryland SHA, NGOs and many other organizations (my apologies if I did not list you here), and some ground breaking research projects with WERF and the National Academy and NFWF, LID has arrived and now lots of the detractors and skeptics are marketing themselves as LID experts. There are a lot of poor or inferior projects that are popping up because some consultants haven't taken the time or effort to learn even the basics. So getting many of these issues on the table now is important because we want the consultants, decision makers, and end users to learn from our experience and to have the most successful LID projects and programs in place.

We learn more about the application of LID strategies and techniques as each new project is completed by the Center and many of our partners and LID is incorporated into resource protection and community development programs. We are excited by the successes that communities, institutions, and individuals have had at developing the science and art of LID. We have often had discussions with communities or institutions about when to "release" LID programs. There is often reticence because of the many still unanswered questions about the strategies and technologies. The management of uncertainty and risk is not always done very well in the water resources field. I have always maintained that we need to move forward and have a process that is dynamic and is based on experience and monitoring. We know that maintaining or restoring hydrology and the advancement of understanding of the technology is the most sustainable way to preserve and restore water resources. We just need to continue to improve our efforts in this direction. The market place, agents of change, and the communities that we serve will make sure that we are on the right path.

Over the course of our work, we have encountered a lot of questions, and sometimes misconceptions, about the goals, objectives, principles, and practices that are the foundations of LID. One side-effect of the success of LID has been the inevitable effort by many individuals, organizations, and vendors to describe LID in terms that fit their

practices and paradigms, but that may not be entirely consistent with LID principles and which may, intended or not, misrepresent the goals, objectives, principles or practices that comprise the LID approach. To some extent, this has led to some uncertainty and to some extent unwarranted concern regarding what LID is or may be. This sort of confusion is not unusual when new approaches and technologies are being developed; however, it is worth addressing.

When the team of Larry Coffman and M.S. Cheng of Prince George's County and Jennifer Smith and I, who were working on the Tetra Tech team, developed the original LID Prince George's County manual, the precursor to the National LID manual from Prince George's County, we created five (5) key concepts and principles that formed the foundation for creating a site planning and design strategy that allows planners, designers, and engineers to have a tool to achieve overall watershed planning and resource protection goals on an individual site. After 10 years, I still believe that understanding and correctly applying these principles is the key to having successful LID projects and programs that are flexible, dynamic, and truly sustainable. I won't list those principles here because one of the key things we want you to do is really read and understand the manual.

Listed below are some of the most common and critical issues that we've encountered and our responses or perspectives on how to further explore the issues. I truly believe that our work is just beginning and that we will see some incredible advances and progress in developing sustainable watershed and community development approaches. We look forward to partnering and working with you over the next 10 years on protecting and restoring our infrastructure and natural resources in order to build healthy and livable communities. I'm sure that this list will generate a lot of discussion and debate. We may not be able to respond to you individually, but we will certainly update and refine this list

*Misconception: LID is just a bunch of green practices*

The Low Impact Development strategy involves more than just the implementation of practices; that is only one part. Strategic site design is an important part of creating a development that has a minimal impact on the hydrologic cycle. The LID site plan for a project should reflect the overall watershed goals and objectives. This requires a process that identifies appropriate strategies and techniques for the proposed land use. This can be done as a prescriptive measure (e.g., volume of storage using green roofs) or as a performance measure (e.g., reduce the volume of runoff by non-structural and structural techniques to pre-development levels or the Maximum Extent Technically Feasible). Planning and site design for LID is a critical step that requires a multi-disciplinary approach that requires expertise in more than one professional discipline. A successful LID site plan requires integration of the following concepts into the design process. They are:

- Use hydrology as the integrating framework
- Think micromanagement
- Control stormwater at the source
- Use simplistic, non-structural methods

- Create a multi-functional landscape and infrastructure

The design strategy applies to construction sequencing also. Not removing all of the site functions by mass grading and leaving the site open for long periods of time so that the soil biological functions are degraded is an important issue. I don't believe that you can just pick up a local standards manual and stamp this out of the computer. It requires a lot of work and teamwork to do this right. But that's what ultimately makes a better design and helps us to better understand how our respective professional disciplines make a contribution to preserving and restoring our environment.

*Misconception: LID promotes sprawl by specifying one acre lots*

LID is a site design strategy that mimics the natural hydrologic cycle. It is independent of land use and lot size. LID practices have been used successfully in typical single-family suburban construction, dense urban applications, linear road projects, and in new development as well as retrofit. When we did the original site plan examples we used a one-acre single family lot to illustrate the design and hydrology procedures. Some people made the assumption that we were specifying one-acre lots and that in order to implement LID, significant space was need, thus causing sprawl. Some people have expanded this to two-acre lots, presumably to make the connection that LID is a sprawl approach. Other detractors have said that LID techniques take up too much space and expand the development footprint.

There are many examples of LID in urban, space-limited locations such as bioretention planters along sidewalks, green roofs on high-rise buildings, and cisterns that capture roof runoff for non-potable uses such as toilet flushing, decorative fountains, or landscape irrigation, and permeable pavements that are decorative. With a little creativity, all sorts of solutions have been found to remedy the problem of excess runoff that comes from urban development. Most often, these solutions fit into the spaces where ordinary landscape features would go, improving water quality, reducing quantity, as well as greening the urban landscape. These techniques not only address stormwater impacts but also result in some really creative and livable urban design templates have been created that have made our communities much more liveable and healthier. In many cases, the LID techniques have replaced the need for space intensive end-of-pipe controls, such as ponds. Although ponds can be designed as amenities, most stormwater facilities have little aesthetic or habitat benefits, unless you are a styrofoam cup. Developers and communities are recognizing the value of not having "wasted" space and are replacing ponds with LID techniques to meet their regulatory requirements.

*Misconception: LID provides water related benefits only*

LID was originally recognized for its potential water quality and water quantity benefits. I realized when I was developing the initial planning approaches over ten years ago that LID was a powerful tool that could address much more than urban design. It could address multiple environmental and community development issues as well. The potential and realization of the benefits are captured nicely in the EPA Green

Infrastructure strategy document and a memorandum from Ben Grumbles, Assistant Administrator for the Office of Water, on March 5, 2007.

LID provides the opportunity to recharge groundwater supplies, protect surface water supplies, and reduce waste and disposal through the use of natural processes with waste that can be composted. It reduces potable water demand through the use of cisterns and also improves air quality and reduces urban heat island effects through the use of vegetation and trees. LID also improves neighborhoods by beautifying the common spaces and adding aesthetic value. One of the reasons that LID is a sustainable solution is the fact that it addresses more than just one issue.

*Misconception: LID can't be used on small lots*

LID was developed as a universal concept. The integration of strategies and practices that replicate the pre-development hydrology or watershed objective can be applied to any land use. Obviously, there are some limits. For example, if you have a 5,000 square foot lot that has 4,500 square feet of building coverage you may not be able to store several inches of water on the surface in a bioretention cell. However, through the use of cisterns, green roofs and permeable pavements there are additional options for reducing the “effective” impervious area. We have noticed a lot of people are starting to tackle the issue of volume through water conservation and reuse, real time controls, and other technologies or approaches that have other benefits. That is one of the strengths of LID. It encourages a creativity that advances the technology in order to solve our complex watershed issues.

*Misconception: LID addresses only water quality control*

LID strategies and techniques focus heavily on addressing the management and treatment of stormwater by volume control. Unfortunately, to date, although many of the LID practices can greatly reduce stormwater volume through infiltration, evapotranspiration, or capture and use, many communities do not give full credit for the volume control achieved by LID, despite extensive data that confirms the ability of these practices to reduce stormwater volume and peak runoff rates for single storm events as well as on an annual basis. A good deal of this misconception is because many in the scientific and community plan review fields are still trying to benchmark and analyze the performance of LID techniques as they would ponds or centralized controls, rather than considering the overall site hydrologic functions.

*Misconception: LID is infiltration*

Since the goal of LID is to mimic natural site hydrology, LID utilizes all aspects of the hydrologic cycle in order to meet the watershed objective (e.g., interception, evapotranspiration, soil storage, detention). The predevelopment water budget should be established as a benchmark. The analysis of some of these processes can be complex and may be difficult, because of time or resources, to evaluate. Many communities have taken some of the elements, such as evapotranspiration and soil storage and lumped them into infiltration. As we pay more attention to climate change, issues such as vegetative cover and soil moisture will become much more important. See one of our first grants

that we did on the topic through a NFWF grant available in the archives. Sometimes we're just a bit too far ahead of the curb.

*Misconception: LID is only for peak storm events*

The original LID analysis was done using Urban Stormwater Hydrology Technical Release 55 (TR-55). This was because many jurisdictions across the country were, and still are, using peak runoff rates as regulatory and resource protection benchmarks, and just about every municipality has some experience with NRCS methods. There are numerous continuous simulation models that are being developed and refined that can be used to look at long-term effectiveness as well as flood control issues. For example, a new Water Environment Research Foundation (WERF) report that we are completing includes guidance for using the SWMM model to analyze LID in this manner. It will be included in Phase II of Decentralized Controls for Combined Sewer Overflows this fall.

*Misconception: LID limits impervious cover*

It is not so much the land cover type, as its function. Going from forest to grass and compacting all of the soil can be just as detrimental as a parking lot if it is in the wrong place in the watershed. At the same time, even in a heavily built-up environment, a hard-surface area may be able to function in a manner that promotes infiltration or evapotranspiration. LID strategies are designed to disconnect and reduce the impacts of imperviousness by use of techniques such as permeable pavements or interception by vegetation.

*Misconception: LID can't be used on clay soils or areas with geologic and geotechnical problems*

Since the goal of LID is to mimic the natural site hydrology, if a site's soil type makes it 90% impervious than it only needs to have a 10% "effective" perviousness after development. This can be met through the use of a combination of practices on the site such as permeable pavers, bioretention planters, green roofs, and cisterns. Many LID practices do facilitate infiltration. If the soils are highly impermeable in the predevelopment condition, they will probably be that way in the post-development condition. So if you are trying to use infiltration on clay soils in order to reduce the peak runoff rate for a single event storm where the peak occurs over just a few minutes, then you are probably headed in the wrong direction. There are also long term benefits to using practices such as soil amendments that can restore soil function. Any design should consider the changes in soil moisture, such as in karst geology or unstable soils. Many design options, such as closed systems (lined practices), can be used when geology, urban or contaminated soils, or impermeable soils limit infiltration capacity. Piping the water away to a centralized facility can exacerbate the problem when leaking systems cause significant soil failures.

*Misconception: LID focuses on new development*

The current degraded state of our watersheds is a result of what we have already done. Future planning for new developments won't solve the problems that we have already built. Constructing new development in a sustainable fashion is crucial, but it is only part

of the solution. Undoing some of what has been done, is the other part. We can't ignore this problem. With all the interest in green development and watershed planning, addressing the impacts of existing development is still an enormous issue. And this is not considering other contributing factors such as Environmental Justice issues. There is a paper by Glen Moglen in the Journal of the American Planning Association that offers a great discussion on this topic. As has been demonstrated in many cases, our society has the capacity to provide affordable new development or redevelopment that also protects water quality. Another NFWF grant that we did for a prototypical affordable housing development has been repeated and refined many times in developments such as HighPoint in Seattle by SVR.

*Misconception: LID or Conservation*

LID should be viewed and employed as one important component of a broader watershed planning strategy that integrates the overall watershed conservation goals and objectives into the site plan. LID can be used to maintain or restore many of the functions that conservation areas are intended to protect, but we do not recommend, and we never have recommended, using LID to develop in sensitive areas. To fully protect valued community and ecological resources, communities develop and implement plans to manage the internal, as well as the external, impacts on sensitive areas through conservation or regulation.

*Misconception: LID sites will become contaminated*

All development has the potential to generate water pollution through changes in energy, volume, peak rate, chemistry, or temperature. Currently, unmanaged or ineffectively treated runoff is having significant effects on groundwater and downstream surface waters. The physical and biochemical treatment processes found in many LID systems are the most effective way to address our "existing" suite of pollutants of concern. There are data, both current and more than 10 years old, that show in a typical condition, the residual load is of minimal concern. In addition, it is anticipated that these systems can have a life cycle of up to 50 years for pollutant removal giving a broad time frame to further study of the issue. Even if potential issues emerge, it is important to note that the pollution is contained within a known location rather than irretrievably dispersed downstream somewhere.

*LID uses wetlands*

LID is an upland management approach. Wetlands have been proven to be highly effective at treating many pollutants, but they are a valuable resource in their own right. There are some great designs for constructed upland pocket wetlands that are not habitat areas. If the hydrology is right, they can be very effective.

*Misconception: LID is Better Site Design*

Better Site Design (BSD) is complimentary to LID and in many cases the strategies overlap. BSD techniques such as narrowing roads and reducing impervious cover are inherently good for protecting the watershed. LID has developed metrics and protocols for the use of many of these techniques and approaches and has added methods to discretely measure the benefits so that we can begin to monitor, model, and optimize the

practices. In LID design we don't use generic criteria, such as limits on impervious cover or percentage of effective impervious area. Each site is assessed on an individual basis and is viewed within the context of the watershed issues. The goal is to manage the processes by which each site responds to hydrologic and hydraulic impacts of development.

*Misconception: LID is against Smart Growth*

We believe that Smart Growth and LID are both very important societal objectives that are fully compatible and mutually supportive. Good water quality is a necessity in all communities and can also be an important resource and community amenity. In particular, when communities are redeveloping in accordance with Smart Growth Objectives, LID is one of the tools that will enable them to do so in a manner that is compatible with the full suite of environmental objectives, as well as societal objectives such as environmental equity. Failure to do so will place good water quality and associated recreational objectives outside the reach and daily living experience of many communities. We place value on creating and restoring healthy and livable environments that are accessible for everyone.

We just wrote a paper that we will publish or post on the web on this issue. Its premise is that LID is a site development technique that allows communities to redevelop existing infrastructure and sites with superior environmental and community design elements. Every site can include some degree of these elements. I've heard the argument that these approaches are too expensive and are therefore detrimental to Smart Growth objectives of encouraging redevelopment. However, recent experience demonstrates the contrary to be true. Many major cities (e.g., Seattle, Portland, Philadelphia, New York City, Chicago, Washington, D.C.) are actively pursuing LID as a fundamental component of their recent efforts to go green, further supporting the fact that it is not a choice between Smart Growth or LID but rather an integration of both of these concepts that is occurring.

*Misconception: LID is against New Urbanism*

One of the great things that Ian McHarg has taught us in Design with Nature is the uniqueness of each watershed and the sensitivity they have to anthropogenic activities. Introducing communities with form based codes on the landscape and significantly altering the topography and removing hydrologic functions isn't a good thing. Rather, we need to really consider the full set of implications of our planning efforts and figure out ways to make them more responsive to the environment.

*Misconception: LID can't be used for LEED™ credits*

LID is a performance based approach, but the results can be used to achieve LEED™ rating points in the categories of stormwater, wastewater, energy, recycling, and water use. LEED™ is a prescriptive system with pre-determined values. This is applicable for all of the current approaches and is very applicable to LEED™ ND

*Misconception: LID is more expensive than conventional stormwater management*

The conventional method of costing stormwater facilities in the same manner as ponds or centralized facilities is no longer valid. LID is making us rewrite or discount many of our

design and engineering textbooks and references, although don't throw away your Ven Te Chow books just yet. LID causes us to rethink how we place value and calculate the cost benefit of environmental protection. Communities are asking different costing questions, such as what happens at the end of a 50 year life cycle for a pond or how long can we expand or protect our stormwater infrastructure capacity using grey and green techniques. We are all still working on this framework, but think we are close to coming up with the basic answers. Ten years ago green roofs were thought to be cost prohibitive to use. Yet as of this writing, at least several North American cities (e.g., Toronto, Chicago, Portland,) have built over a hundred green roofs each, while several European cities have already placed green roofs on about 15% of all buildings. The performance based technology and market driven approach used by LID has helped to drive the costs down to the point where they can compete with conventional stormwater technologies, and in many cases LID-based approaches are proving to be less expensive than conventional stormwater controls. See, for example, the document recently published by the U.S. Environmental Protection Agency, "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices", at [www.epa.gov/nps/lid](http://www.epa.gov/nps/lid).

*Misconception: LID is difficult to maintain*

There are several levels of maintenance involved in LID. There are mechanical, institutional, and administrative maintenance considerations. Many of the LID techniques are landscape based or require simple mechanical maintenance, such as street sweeping. All management practices need to be maintained. However, if you look at the performance of bioretention cells, permeable pavers, and green roofs, which are three of the most prevalent practices, in situations where they aren't adequately maintained, they still have a high level of pollutant removal efficiency. That is important to note because very few maintenance programs for conventional systems are properly inspected or carried out. Also, LID is a distributed management approach, inherently building redundancy into the system. Therefore, even if some of the systems perform less than optimally, fail, or are not maintained, redundant practices through decentralization and the effect of failure is not catastrophic as in dam breaches or system overloads.

*Misconception: LID relies on unproven technology and is not well researched*

A quick search of the web will reveal the large number of LID research projects in the U.S. and all over the world. Many LID practices are already supported by significant data, with more being developed all the time. U.S. EPA and other entities are currently developing data bases to make this data more freely available and publicly accessible. The current research agenda needs to change to respond to the green movement and answer community questions about how these techniques function as environmental as well as community development tools:

*Misconception: LID doesn't use proprietary techniques*

The first preference is to use natural systems and their functions. LID BMPs are then used to compensate for lost functions by using elements of the hydrologic cycle. Vendors are developing proprietary systems that can enhance filtering or storage functions. These systems should be benchmarked by assessing how well they use hydrologic elements and principles and metrics in the LID manuals.

*Misconception: LID is the best watershed planning approach*

While LID is intended to mimic the natural hydrologic condition at a site level, the context of larger scale watershed planning can not be forgotten. In some cases, centralized controls may still be appropriate and in-stream measures may be required. A lot of the focus of our organization is on the development of LID strategies and techniques for institutions and governments and basic LID scientific research. But our goal is to help communities develop strategies to use LID as part of an integrated and comprehensive approach to watershed and infrastructure management. This piece of the puzzle will be critical to help restore our national infrastructure and to develop and restore healthy and livable communities that are accessible for everyone.