

Assessment of Stormwater Management in Coastal South Carolina: A Focus on Stormwater Ponds and Low Impact Development (LID) Practices

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This report addresses strengths and weaknesses of two stormwater management strategies: stormwater ponds and low impact development (LID) practices. It also addresses issues such as water quality, the permitting process, and the design, construction, and maintenance of stormwater-management projects, and measures to improve them. This report is based on 19 interviews of stormwater professionals and the input gathered from 51 workshop attendees. Stormwater professionals include:

- engineers,
- developers,
- contractors,
- landscape architects,
- regulatory staff, and
- land planners.



The workshop, Stormwater Management in Coastal S.C.: A Focus on Stormwater Ponds and Low Impact Development (LID) Practices, was held on January 22, 2009. The workshop identified informational, regulatory, and educational needs of stormwater professionals regarding both traditional and alternative stormwater-management technologies. Previous research and the responses provided by stormwater professionals were analyzed. The purpose of this report is to assist coastal communities and other stakeholders with making decisions regarding the selection and implementation of stormwater-management strategies.



Stormwater management is one way to protect our local waterbodies from the impacts of coastal development. Photo/NOAA-HML

South Carolina Stormwater Management

Southeastern coastal regions have adopted and implemented the use of Best Management Practices (BMPs) as a means of controlling stormwater quantity and quality. Generally, stormwater regulations in South Carolina require stormwater-management systems to retain the first ½ inch of runoff on site or 1 inch of runoff from the built upon area (whichever is greater), maintain pre-development discharge rates, and remove 80 percent of suspended solids during construction (SMSRA, 1991; SCDHEC, 2002; 2003; 2006). The selection and implementation of BMPs in the South Carolina coastal zone must take into consideration regional characteristics such as the flat coastal topography, shallow water tables, and minimal soil storage.

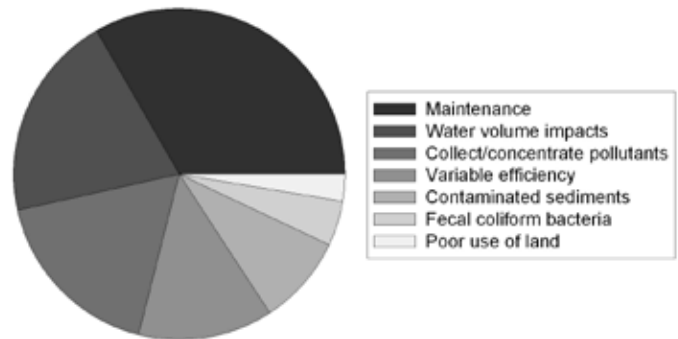
Stormwater Ponds

Stormwater ponds were initially designed and implemented to manage localized flooding. But as the impacts of urbanization on adjacent streams and water bodies became better understood, ponds have been required as a mechanism to treat stormwater and protect adjacent water quality (SCDHEC, 2004). Stormwater ponds can be categorized into two general types: 1) detention ponds with a permanent pool of water that is gradually discharged into adjacent water bodies through an overflow structure or 2) retention ponds with a permanent pool of water

that is discharged through infiltration and groundwater transport. South Carolina regulations, coupled with regional geography and hydrology, result in stormwater-detention ponds serving as the most commonly used BMP in the South Carolina coastal zone. In 1999, more than 8,000 stormwater ponds were estimated to be located within the eight coastal counties of South Carolina (Siewicki et al., 2007). Interviews with engineers of this region suggest that additional stormwater ponds will be located in the region because of ease of designing, permitting, and constructing them. Ponds also serve a critical role in providing fill material for development within topographically low-lying areas. In addition, ponds can be marketed as an amenity to a development, providing both practical management of stormwater runoff, while also serving as open space and offering recreational opportunities such as fishing, boating, and sometimes even swimming.

Although national research suggests that these ponds are effective in reducing stormwater peak flows and retaining pollutants (Table 1), recent regional research suggests that the efficiency of these ponds may be less than nationally reported (Messersmith, 2007). It is important to note that BMP efficiency is dependent upon several factors, including storm characteristics (rain volume, intensity, and frequency), pond age, pond size, and pond design (length, width, and placement of inlet and outlet) (SCDHEC-OCRM, 2007). In addition to the broad question of regional efficiency of stormwater ponds, other more specific concerns suggest a need to re-evaluate the impact of stormwater ponds on water quality. Since ponds are designed to retain stormwater, they receive high loadings of nutrients, pesticides, chemicals, and fecal coliform (SCDHEC-OCRM, 2007). As a result, the surface waters and sediments of these ponds become

Limitations of Stormwater Ponds



compromised and can lead to problems such as harmful algal blooms (HABs) or fish kills within the ponds. These conditions can be expected (given the purpose of the pond) and might not be problematic. But these ponds attract humans and wildlife, and there is often exchange between the pond and adjacent tidal creeks. These conditions can create a health hazard for those exposed to the pollutants (e.g., toxins and pathogens). In addition, these ponds are often neglected and not regularly maintained, which leads to sedimentation, reduction of the storage capacity of the ponds over time, and increased discharge of polluted water to adjacent water bodies (Messersmith, 2007).

Attendees of the workshop said that maintenance is the biggest disadvantage to relying on stormwater ponds (33%). It was noted that pond failure is often not apparent and that many ponds are maintained only for aesthetics. As a result, pond maintenance can be easily overlooked. In many cases, maintenance costs serve as a disincentive to Homeowners Associations (HOAs) to address problems. Therefore, homeowners need to be informed and educated about the importance of maintaining their ponds. Monitoring and enforcement of pond maintenance must be addressed through education and the development of guidelines for local municipalities. Additional disadvantages to relying on stormwater ponds include water-volume impacts of ponds (20%) (e.g., conveying stormwater to one location rather than promoting natural infiltration and groundwater recharge throughout a site), the collection and concentration of pollutants (18%), and variable efficiency of ponds (13%). The attendees were also concerned about sediment contamination (9%), fecal coliform bacteria (4%), and the fact that ponds are a poor solution to small sites and can be seen as a waste of developable land (3%).

The attendees indicated a need to address the concerns associated with ponds and offered solutions, such as retrofitting ponds through the use of other BMPs, tightening pond-design guidelines, or addressing maintenance educational needs. The majority of



Stormwater ponds are designed to collect and concentrate pollutants and can promote algal blooms, such as these found in a pond in Berkeley County, S.C. Photo/SCDHEC-OCRM



Researchers from NOAA's Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) enlisted the assistance of volunteers to plant a vegetated buffer along a stormwater pond on James Island, S.C. Photo/NOAA-CCEHBR

responses suggested that ponds should be used in concert with other BMPs (38%) to minimize the quantity and improve the quality of stormwater leaving a site. One engineer noted that a typical pond in the lowcountry is not capable of achieving the regulatory standards of discharging stormwater over 24 hours due to the low relief and shallow water tables of this area. Therefore, by incorporating ponds as a component of a stormwater management plan, one can benefit from the advantages of ponds while also improving the performance of a stormwater-treatment system of a site. Respondents said that problems related to ponds are primarily due to a lack of maintenance, which if addressed could improve the performance of ponds (27%). Specifically there is a need for better enforcement of maintenance plans and education of the homeowners. Additional options for improving the performance of ponds were suggested, including forebays (15%), better pond design (9%), flow control devices (7%), littoral shelves (3%), and improved design criteria (e.g., design storm event) of ponds (1%).

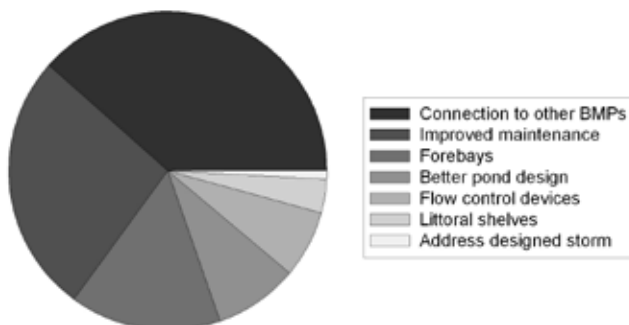
LID Practices

LID strategies integrate the use of site planning (e.g., clustering, reducing impervious cover, and preservation of open space) and alternative stormwater management strategies (e.g., bioretention swales, pervious pavement, and rainwater harvesting) to promote the infiltration and retention of stormwater runoff at the source to foster maintenance of a site's pre-development hydrologic condition (Prince George's County DER, 1999). For the purposes of this report, subsequent use of the term LID practices will refer to the stormwater-management technologies utilized to minimize the impact of development on a site.

LID practices were first implemented in Prince George's County, Maryland, in the 1990s. Since then, there have been a handful of research projects to evaluate the efficiency of these LID practices in reducing stormwater runoff and maintaining pre-development discharge rates. These projects have found that bioretention swales, pervious pavement, surface sand filters, vegetated roof tops, and gravel wetlands are effective at reducing runoff rates and removing selected pollutants (e.g., total suspended sediments [TSS], nutrients, metals, polyaromatic hydrocarbons) from stormwater runoff (EPA, 2000; Hsieh and Davis, 2005; Hunt and Lord, 2006; Roseen et al., 2006; UNH Stormwater Center, 2007; Dietz and Clausen, 2008). LID practices can generally reduce stormwater peak flows and pollutant loads to levels similar to traditional stormwater-management techniques (e.g., detention ponds), suggesting they may be a reasonable alternative to ponds (see Table 1; EPA, 2000, UNH Stormwater Center, 2007; Dietz and Clausen, 2008).

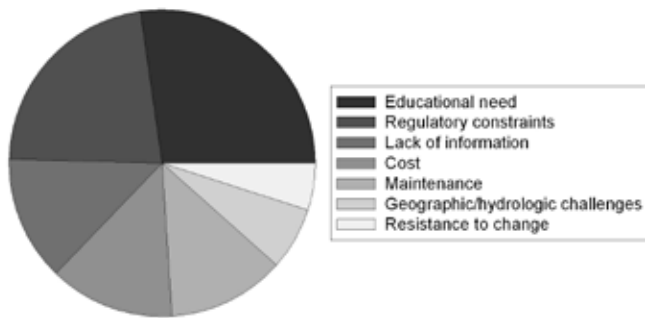
Although there have been several studies that suggest LID practices may be a useful alternative to traditional stormwater management, these studies were conducted in areas outside of

Options to Address Limitations of Stormwater Ponds



The Clemson Extension Carolina Yard constructed at the Charleston Exchange Park incorporates the use of pervious pavers, pervious walkways, a rain barrel, and a rain garden to educate the general public on the site-scale use of LID practices. Photo/USC

Obstacles to Utilizing LID Practices



the Southeast coastal region and may not apply to regional soils and shallow water tables. Scientists, developers, managers, and engineers are uncertain whether LID systems will be efficient at retaining stormwater volume and pollutants along the southeastern coast where soil storage is generally minimal and rain events are flashy and often intense. The regional geographic and hydrologic limitations of the Southeast coast have also resulted in a suite of perceived and real concerns among the professional stormwater community regarding the use of LIDs. Consequently the prevalence of LID practices is limited along the Southeast coast.

When questioned about the obstacles that may inhibit the regional implementation of LID practices, workshop attendees indicated that the educational needs of stakeholders (27%) and the regulatory process (22%) were the primary obstacles. Attendees suggested that there is a need for education across all sectors including consumers, developers, engineers, and local elected and appointed municipal officials. Most notably there is a need for marketing of LID to promote their implementation. From the regulatory side, the lack of collaboration between the South Carolina Department of Health and Environmental Control (SCDHEC), local municipalities, and intra-governmental departments of those municipalities (e.g., fire, building codes, zoning, and planning) creates initial obstacles when attempting to implement something new and unfamiliar, such as LID practices. The creation of guidelines for the design, permitting, and maintenance of LID practices would assist in the intergovernmental struggles between the state and local municipalities. Attendees also suggested a need for flexibility in federal and state regulations to accommodate regional needs and provide “regulations based on science,” rather than their current prescriptive basis. Additional obstacles were identified and included a need for information (e.g., standard models and guidelines) (13%), costs associated with LID (13%), maintenance concerns (12%), regional geographic and hydrologic challenges (7%), and a general resistance to change (5%).

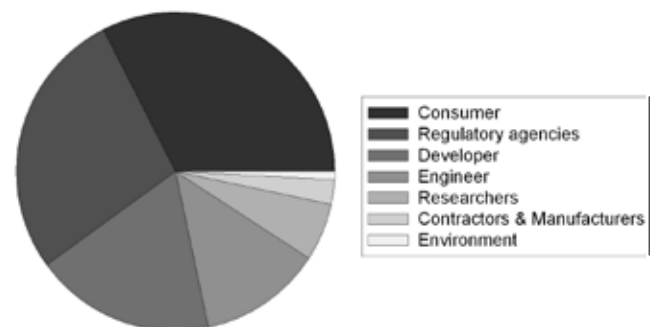


Researchers from Clemson University have recently designed, installed, and are currently studying water retention capacity and performance of bioretention cells at their new Baruch Institute facility in Georgetown, S.C. Photo/Clemson University

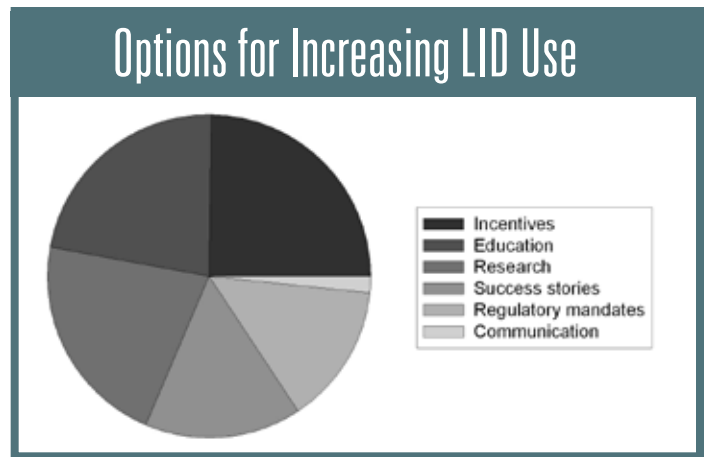
Of all potential stakeholders that can influence the implementation of LID practices, attendees suggested that both consumers (33%) and regulatory agencies (28%) would have the greatest impact. It is necessary for the consumers to have initial buy-in to LID practices, and then regulatory backing of those stormwater features would assist in the selection of LID over more traditional stormwater features and improve the permitting process. With support from consumer and regulatory agencies, developers and engineers would more likely select, design, and implement LID practices within their development.

Attendees suggested that the creation of incentives (e.g., bonus density, tax incentive, expedited review, flexibility in enforcement while LIDs are new, and lower impact fees) would offer opportunities to increase the prevalence of LID practices in the region (25%). Specifically, it was suggested that linking LIDs with Leadership in Energy and Environmental Design (LEED) certification

Stakeholders that Have the Biggest Influence on LID Implementation



could serve as a marketing tool for LID practices among developers, engineers, and contractors/suppliers. Since the consumer must initially buy-in to LID practices, it was also suggested that there could be a need for incentives for the consumer such as reduced stormwater utility bills for treating stormwater on site. Due to the lack of knowledge and information regarding the regional use of LID practices, education (22%), research (21%), and success stories (16%) are needed to provide the information and knowledge dissemination necessary to promote the use of LID practices. This information should be disseminated across all stakeholders, including stormwater professionals and the general public through forums such as the Urban Land Institute, American Society of Civil Engineers, American Society of Landscape Architects, American Planning Association, Carolina Clear, and Lowcountry Earth Force. Attendees also felt that regulatory mandates (14%) would assist in the regional implementation of LID practices, but there is a need for regionally relevant information to support such mandates. It was also noted that the internal politics of municipalities can serve as an obstacle to implementing LIDs. Therefore, increased communication between municipal departments would assist in their implementation (2%). Until then, Planned Unit Developments (PUDs) can serve as an amendment to local zoning and a means for implementing LID practices within larger developments.



The Oak Terrace Preserve community in North Charleston, S.C., was zoned and permitted under a PUD ordinance that allowed the developers to employ LID principles in the development and preserve up to 95% of the older, healthy trees on site. Photo/City of North Charleston

Table 1

Summary of the percentage of stormwater retention and pollutant reduction of various stormwater treatment systems.							
Stormwater Treatment System	Reference	Stormwater	TSS	Phosphorus	Nitrogen	Metals	Other
Retention Pond				-16% (Total)	-54% (Total)	93% (Total Zn)	83% (Total HMW PAHs)
Single Detention Pond	Messersmith, 2007	7.5% (volume)	19%		-2.5% (Total)	n/a	14% (Fecal Coliform)
Series of Detention Ponds	Messersmith, 2007	-9% (volume)	88%	71% (Total)	39% (Total)	n/a	55% (Fecal Coliform)
Bioretention Swale	UNH Stormwater Center, 2007	82-85% (peak flow)	97-99%	5% (Total)	29-44% (DIN)	99% (Total Zn)	82-85% (Total HMW PAHs)
	Hunt & Lord, 2006 (tested soil media with varying P levels)	n/a	n/a	-240%-68% (Total)	33-68% (Total)	56-99% (Cu and Zn)	> 90% (Fecal Coliform)
	EPA, 2000	n/a	n/a	85-89% (Total)	3-27% (Nitrate)	32-54% (Cu) & 22-100% (Zn)	n/a
	Dave, 2007; Davis, 2008	49-58% (peak flow)	47%	76% (Total)	83% (Nitrate)	57% (Cu) & 67% (Zn)	n/a
Porous Pavement	UNH Stormwater Center, 2007	68%	99%	38% (Total)	n/a	96% (Zn)	99% (Total HMW PAHs)
Cumulative use of LIDs	EPA, 2000	n/a	91%	3% (Total)	42% (Total Nitrogen)	81% (Cu) & 75% (Zn)	n/a



University of South Carolina researchers are studying the cumulative impacts of LID practices (e.g., bioretention swales, pervious pavers, pocket parks, pervious walkways) at Oak Terrace Preserve in North Charleston, S.C. Photo/City of North Charleston



The J Banks building on Hilton Head, S.C., uses pervious pavers to assist in achieving LEED Silver certification. The LEED Rating System has recently placed more emphasis on environmental factors which increase credits for LID stormwater strategies. Photo/J Banks

Conclusion

Input at the workshop from stormwater professionals and regulatory officials demonstrated agreement that ponds will continue to be a feature of future stormwater treatment systems. However, the current limitations of ponds should be addressed through homeowner education and regulatory enforcement regarding pond maintenance. In addition, ponds should be coupled with additional BMPs (e.g., created wetlands, LID practices, and grassy swales) to enhance the retention and removal of stormwater and its associated pollutants leaving a site. Overall, attendees agreed that stormwater management cannot be addressed through a “one-size-fits-all” prescriptive approach. Instead there should be more flexibility in state and

local regulations to allow for site-scale management of stormwater based on the needs of a particular location (e.g., stormwater quantity or quality control) and the hydrologic conditions of the site (e.g., water table depth, soil storage capacity, soil infiltration rates, and proximity to adjacent water bodies).

Attendees agreed that LID practices could be a reasonable addition to ponds. However, LID practices should not be mandated at this time because there are still too many questions and uncertainties related to their performance, construction, and maintenance. Instead there needs to be more research, success stories, education of stakeholders, and incentives to promote the implementation of LID practices.

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