



Green Infrastructure Design Considerations

Best management practices (BMPs) can be incorporated into almost any project: municipal streetscape or park projects, new residential communities, or even a “big box” shopping center. Whether you are trying these ideas for the first time, or have successful built projects to your credit, following the principles and practices below can help to ensure that your project goes smoothly.

Establish an interdisciplinary team at the start of the project – and keep this team working together through design and implementation!

One of the most common reasons that incorporating “green infrastructure” into a project becomes a challenge is failure to establish a collaborative, multidisciplinary team – one that includes the project owner, review agencies, engineers, landscape architects, and even the general contractor – and to keep this team together and “on the same page” from the earliest stages of conceptual design, through implementation.

At the outset of the project, all parties should agree on the overall goals of the project and how sustainable stormwater management techniques can be incorporated. Precedent projects should be reviewed for their potential applicability to the current setting as these may stimulate some ideas or allow “likes and dislikes” or other concerns to surface. Engineering and geotechnical concerns should be identified at the outset, and research conducted to address those concerns. Roles and responsibilities should be clarified – especially for the civil engineer and landscape architect.

It is important that the landscape architect participates fully in the site design from the outset, not at the end of the process, which can limit his or her ability to fully contribute professional expertise to the project. The civil engineer is an equally important partner. Some have more interest, and/or experience, in integrating “green infrastructure” into site design – while for others it may be a new and foreign concept. Some communities have begun to keep track of which engineers and landscape architects have an established track record of incorporating BMPs into their projects and moving them successfully through the development review process (see [Philadelphia, PA](#)). Having an experienced team, especially for a first-time project, can increase the comfort level of an owner.

This team should continue to work together through construction and even into the post construction warranty period. If problems should arise, it is more likely that a positive solution will be found if team members feel that they are equal partners with ownership in the project.

Understand the regulatory and development review environment – what’s allowed and what’s not? What criteria must be met?

Communities typically have development codes, and many have ordinances that deal specifically with stormwater management, particularly with regards to National Pollutant Discharge Elimination System Phase I and Phase II Stormwater Rules. Communities can modify these requirements to include more detailed design standards that go beyond sizing criteria. For example, a community can require developers to consider a set of “desirable” BMPs first or to incorporate specific “desirable” features. Many communities have already codified this information in the form of water quality guidelines or BMP manuals and these should be consulted to ensure that the planned project is in keeping with these requirements.

Applicable codes and ordinances for open space, public rights-of-way, parking, and related facilities should also be consulted. In some cases there may be conflicts between the codes and ordinances, and the features described in the BMP manual; this is because revising municipal code to ensure agreement can be a very time-intensive process and thus it can lag behind adoption of water quality requirements. A visit to the development review case manager can help to identify how any apparent conflicts may be interpreted, and how they can be resolved before the project design begins.

Understand which BMPs work best in which development settings – and how to combine them to maximize effectiveness

Not all BMPs are equally appropriate for each and every setting. Features that work well in a multi-family residential setting with a 15 percent open space requirement would be inappropriate for a “big box” commercial environment with mostly impervious surfaces, heavy traffic, and errant shopping carts. Whether a BMP is appropriate or inappropriate is largely driven by land use, extent of impervious surface, overall size of the development, and the associated water quality capture volume and treatment performance requirements.

Many water quality guidelines and BMP manuals are now organized by development type and identify which BMPs are or are not suitable and why. Denver’s *Water Quality Guidelines* and the Urban Drainage and Flood Control District’s *Urban Storm Drainage Criteria Manual, Volume 3* (UDFCD 1999, http://www.udfcd.org/downloads/down_critmanual.htm) are good resources and may be of use if comparable information is not available in your community. Denver’s Guidelines also indicate how multiple BMPs might be combined on a site to maximize effectiveness. You can learn more about these documents by viewing the [Denver Case Study](#).

Understand the context for your project – and the type of image and character that is desired

The style and appearance of stormwater quality facilities should reflect the surrounding land use type, the immediate context, and the proximity of the site to important civic spaces. Aesthetics is often a more critical factor in highly visible urban commercial and office areas than at a private industrial site. The standard of design and construction should maintain and enhance property values without compromising function. In some cases, this means locating a facility to preserve or enhance natural resources.

Most successful and accepted installations are properly maintained and not over-designed. Landscape beds should have clean edges and plants should be selected that have a neat, tidy appearance. These “cues to care” will indicate that the landscape has been intentionally designed and is cared for. Regular maintenance should be performed to ensure that areas do not become overgrown or weedy.

Design with the natural hydrologic cycle in mind

Many designers seek to create conditions that mimic the natural hydrologic cycle. Even if this is not feasible, striving to reduce and slow runoff as much as possible, and retaining as much water as possible on site, should be important objectives of your project.

Consider stormwater quality needs early in the design process – as initial site plan concepts are developed

Stormwater quality features are often “shoe-horned” into the site towards the end of the design process, resulting in forced, constrained approaches. Dealing with stormwater quality after other major site plan decisions have been made usually results in unsatisfactory compromises or in facilities that do not reach their civic or community potential. Opportunities to integrate stormwater quality features into a site can be fully realized, however, if water management requirements are included in the initial project planning

stages. Stormwater quality and flood control requirements are just as fundamental to good site design as other elements such as building layout, grading, parking, and streets.

Develop facilities that enhance both the site and the surrounding community

Stormwater quality areas can add interest and diversity to a site. Gardens, plazas, rooftops, and even parking lots can become amenities and provide visual interest while performing stormwater quality functions and reinforcing urban design goals for the neighborhood and community. The integration of BMPs and associated landforms, walls, landscape, and materials can reflect the standards and patterns of a neighborhood and help to create lively, safe, and pedestrian-oriented districts. The [case studies](#) give many examples of multi-use projects designed with stormwater management as a key part of the overall site design.

Other important design considerations include visibility and public education. Making water quality treatment areas visible – in building entryways or parking areas, for example – can help to educate the public about their function, and promote acceptance.

Design sustainable facilities that can be easily maintained

Stormwater quality facilities must be properly and consistently maintained to function effectively and ensure long-term viability. Regular maintenance is also key to public acceptance of these facilities. It is therefore critical that maintenance roles and responsibilities be established at the outset of the design process. Who will be responsible for maintenance? The city? A homeowners' association? The individual homeowners?.

It is also necessary to give due consideration to how and with what equipment BMPs will be maintained in the future. Facility design should provide for these operations ensuring adequate access with a minimum of disturbance, disruption, and cost. Maintenance should be planned for so that trash, debris, and sediment can be removed on a regular basis. This is especially critical if individual property owners – rather than a municipality or a Homeowners' Association, which may have the financial resources available to out-contract maintenance functions – will be responsible for maintenance.

Typical maintenance operations to consider in designing facilities include:

- Mowing, trimming, and weed control
- Pruning of shrub and tree limbs
- Trash and debris cleanup, especially at grates and flow control structures
- Sediment removal
- Removal, replacement, and re-vegetation of porous landscape detention media
- Vacuuming/replacement of porous pavement and porous pavement detention media
- Structural repair

Where individual property owners are involved, simplicity and ease of maintenance should be the rule. This does not mean, however, that the resulting facilities need be bland or uninteresting places. The [Burnsville Case Study](#) gives an interesting example of how the community was involved in a successful BMP installation project that relates to this issue.

The design team should also plan to create a maintenance manual for the project owner that describes required maintenance operations for a variety of BMPs, frequency of maintenance operations, and identifies parties responsible for maintenance.

Design with public health and safety in mind

One of the highest priorities of engineers and public officials is to protect public health, safety, and welfare. Stormwater management site elements and facilities must be designed and maintained in a manner that does not pose health or safety hazards to the public. Public access issues and concerns about stagnant water and insect breeding grounds are two of the primary concerns. Steps can be taken to address these issues to provide safe facilities that are accepted by the general public.

Public access issues

Pond edges:

- Create safe pond edges with gradually sloping banks within 10 to 20 feet of shoreline
- Reduce perimeter wall heights as much as practicable
- Include railings on vertical drops of 30 inches or more (check with City building code)
- Locate facilities with steep sides away from major pedestrian routes
- Provide an emergency egress route

Visibility:

- Avoid walled-in or steeply sloped, remote ponds that provide hiding places for illicit activity.
- Consider the need for site lighting.

Outlet:

- Use trash/safety rack to collect trash in an area that can be easily cleaned out.

Mosquitoes and West Nile Virus

The West Nile virus first appeared in the U.S. in 1999. Because the virus is spread by mosquitoes that breed in shallow standing water, it is important that stormwater BMPs that detain or retain water are managed properly to avoid becoming breeding grounds for mosquitoes, which pose both health and nuisance issues. BMP designs that reduce the likelihood and extent of shallow standing water should be implemented. If shallow standing water is unavoidable in publicly owned facilities, appropriate Department of Environmental Health, Division of Animal Control officials should be notified so that the area can be routinely treated with larvicides. Owners of privately owned facilities are responsible for treating their facilities under most circumstances.

You may also be interested in:

[BMPs from Start to Finish](#)
[How to Include BMPs in Your Project Plan](#)
[What Makes a Project Successful?](#)

Case studies cited above:

- [Burnsville, MN](#)
- [Philadelphia, PA](#)
- [Denver, CO](#)