Conservation Design Strategies for Stormwater Management: 
Integrating Native Plants at the Rivercrest Golf Community 
Upper Providence, Montgomery County PA

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Abstract
The Conservation Design site design approach strives to prevent or minimize the creation of 
stormwater from the outset and then use natural processes provided by vegetation and soil to 
mitigate unavoidable stormwater runoff impacts once prevention has been maximized (see 
related paper on Conservation Design for a more detailed explanation of the program). An 
especially exciting opportunity afforded by the Conservation Design approach is the integration 
of natural landscaping principles into the stormwater management solutions developed for the 
program. The use of native plants and restoration of natural habitats adds an important 
ecological component to the stormwater management systems being developed, enhancing the 
benefits associated with the overall Conservation Design approach.

As growth continues, forest, stream, wetland, and estuarine ecosystems will continue to be 
impacted under conventional approaches to stormwater management. We must begin to work 
with the land and with native plants (both existing and planted) to design communities that are 
more “fit” for their environment, and that respect the quantity and quality of our water supplies, 
the potential for flood damage, and the health of terrestrial and aquatic ecosystems. The 
introduction of native plants and innovative techniques into the stormwater management 
equation means that natural areas will be retained and expanded for their natural abilities to 
reduce and filter runoff, promote groundwater recharge, and provide habitat for native plants, 
wildlife, and for people. Communities interested in maintaining a healthy living environment 
should insist that innovative stormwater management using native plants become the standard 
“Green Infrastructure” for all new development projects.

Introduction to Stormwater Management through the Conservation Design Process
Conventional stormwater management has tended to be “hard” and quite structural in nature, 
relying on curbs, drains, pipes, detention basins, and the like. Conservation Design reflects a 
totally different philosophy towards land development which integrates stormwater management 
into the very core of site design process, as opposed to stormwater management as an after the 
fact proposition. Conservation Design regards stormwater as a key component of the hydrologic 
cycle and critical to maintaining a watershed’s water balance—and groundwater reserves—rather 
than a nuisance in need of disposal.

Conservation Design systems exploit “soft engineering” solutions, including grassed swales, 
berms, vegetated filter strips, recharge gardens, wetland basins, riparian buffers) to provide a 
living filter that maximizes the recharge of groundwater and helps maintain the natural water
table supplying wetlands and streams. These systems fit the landscape and work with native vegetation and soils to maintain the natural hydrology of watersheds. Native vegetation and soils are retained and left undisturbed to the maximum extent possible. Sites are planted and seeded with native trees, shrubs, grasses and wildflowers. In most cases they can be designed, constructed and maintained for less cost than conventional systems. Ultimately, these innovative systems serve as a “Green Infrastructure” that integrates ecological design principles and native plants into the heart of the land planning and site development process.

**Some Specific Strategies and Techniques Using Native Plantings**
Conservation Design is built on an array of preventive stormwater management approaches and mitigative practices, including:

- **Minimum Disturbance/Minimum Maintenance**: retain native vegetation and soils, minimize grading; reduce amount of new paving and lawn, and associated maintenance; maximize amount of meadow, woodland, wetland areas.

- **Riparian Forest Buffers**: the “last line of defense” to buffer streams from stormwater runoff; woodlands are the natural condition of most Piedmont streams; riparian forest buffers filter pollutants, stabilize streambanks, reduce flooding, provide in-stream logs, limbs, leaf litter as habitat and food for aquatic life, cool water by shading. Minimum 75 feet of native floodplain trees/shrubs/grasses/plants recommended on each side of stream.

- **Vegetated Swales**: A “soft” alternative to piping. Unlike Eurasian, turf grasses (fescues, ryes, North American Green) with shallow, matted root systems, native grasses (little bluestem, broomsedge, indiangrass, switchgrass) have deep, clump-forming root systems that act as a natural checkdam in swales to promote groundwater recharge and reduce the velocity and erosion potential of stormwater runoff.

- **Level-Spreader Berms with Vegetated Filter Strips**: The natural contour of land can be used to avoid excavated basins. Berms and strips promote stormwater to recharge or spread out runoff as sheetflow (avoiding erosion). Berms can be carefully meandered in woodlands and planted with dry soil plants such as Virginia creeper, ferns, woodland sunflowers, grasses. Berms used in meadows can be planted with goldenrod, asters, milkweed, butterfly weed, native grasses.

- ** Constructed Wetlands (artificial marshes/wetland basins)**: A living filter for removing pollutants. Inflow/outflow devices control water depth/soil moisture. Edge experience extreme conditions of flooding/drying out. Hardy wet meadow species include common and swamp milkweed, New England aster, great blue lobelia, wild bergamot, blue vervain. Emergent species for standing water areas include dark green bulrush, cattail (may be invasive), arrowhead, blue flag iris, New York ironweed, Joe Pye weed.

- **“Recharge Gardens”**: Localized subsurface infiltration beds (sand/gravel) can be used to recharge groundwater throughout a site, with native plants serving as recharge filter. May periodically flood and dry out. Plant species include thin-leaved coneflower, wild
The Rivercrest Case Study
The Rivercrest site, located in Upper Providence Township, Montgomery County, consists of 284 acres at the highly desirable intersection of US 422 (Expressway) and PA 29 (also bounded by Black Rock Road on the northeast (Figure 1). The site includes extensive Schuylkill River frontage on the west. In fact most of the site sits atop striking palisades and can be characterized as several plateaus interrupted and incised by steep stream valleys/ravines which cut down through the palisades to the river. The plateaus drop off abruptly along the Schuykill River, creating the palisades effect. The bulk of these plateaus have been cleared and cultivated over the years (soybeans), with the steep stream valleys/ravines and palisades themselves being heavily forested and largely undisturbed. One of the tracts which has been assembled here includes older institutional buildings used by Ken Crest, an organization providing therapy for special juvenile populations.

Background
Geology, soil, topography all are important factors in understanding site design at Rivercrest. The site is basically underlain by fractured shale with interlacing fractures which intercept water and direct it to seeps and springs along the steep stream valleys. Slopes obviously range form rather mild slopes on the plateaus to the very steep slopes along the river and within the ravines. One ravine is located along the north property boundary with a second ravine occurring about halfway down the site, parallel to the first, both draining the site from east to west. Due to lack of disturbance of the ravine and palisades areas, together with the exceptional natural conditions characterizing these ecological zones, special vegetation types of particular importance and value also can be found in these areas. These areas are extremely sensitive to any type of disturbance as well.

Thickness of the soil mantle is an important consideration for development at this site. Of course, the bulk of the plateau area has been cultivated for many years, such that soil thickness is adequate to support a variety of crops. Soil thickness can be expected to decrease as one approaches the steep slopes of either the ravines or river palisades. About eighty percent of the site drains directly to the Schuylkill River through the system of ravines.

The Proposed Development at Rivercrest
Lejeune Properties has proposed to construct a full 18-hole regulation golf course along with large clubhouse and related ancillary facilities. Additionally, the developer proposes 87 custom single homes, 105 estate homes, 98 village carriage homes (290 homes). This development is being proposed to a large degree in those areas already cleared (in cultivation) in order to avoid impacting any of the sensitive ravine/palisade zones.

A Conventional Approach to Stormwater Management
Existing stormwater regulations for Upper Providence are reasonably conventional, requiring that peak rates be controlled for up to the large 100-year storm (a little over 7 inches in 24 hours). The objective of such peak rate requirements is to prevent flooding damage to adjacent...
Figure 1. Proposed Rivercrest Golf Community Site Plan.
downstream property owners. The most striking feature of this particular site, however, is that the immediate downstream property in this case is the Schuylkill River where the 100-year flow rate from the many thousands of acres comprising its tributary area vastly outproportions any flow being contributed from this particular 284 acres—even if it were to be dramatically increased. The whole notion of controlling peak rates for very large storms at this site is highly questionable.

Furthermore, the way in which peak rates would be controlled, typically through construction of large volume detention basins at low points in the site, would translate into significant environmental damage to the site. A conventional approach to stormwater management would necessitate basins in several locations. Stormwater flows would be routed and channelized and highly focused, discharging at several detention basin outfall locations. These discharge points would invariably result in more flow concentration, more erosion of the steep stream channels, all subtracting vital water volumes form being recharged in the flatter plateau areas. As this recharge would be reduced, the important seeps and springs feeding the ravines/palisades zones together with the specialized ecological species being supported there would be negatively impacted. The amount of vegetation clearing in the ravines required for this system would seriously fragment the forested slopes – the one remaining high quality natural area on the site. In short, overall site hydrology would be substantially altered—much more surface flow being discharged during wet weather events, much less being discharged during dry weather periods. Water quality would suffer as well.

**The Conservation Design Approach to Stormwater Management: Native Planting Applications**

The basic elements of the Conservation Design scheme developed for Rivercrest includes:

- Protection of environmentally sensitive areas, including palisades, stream corridor ravines, adjacent wetlands, steep slopes and wooded areas.

- Reducing/disconnecting impervious areas through reduction in setbacks, reductions in street widths, limitations in sidewalks, reducing hydraulic connectivity of impervious surfaces where feasible.

- Promoting groundwater recharge through use of “recharge garden” systems, subsurface stone-filled voids covered with appropriate planting medium and planted with native plants, also incorporating level spreading devices for overflow into naturally vegetated and undisturbed areas. These are strategically dispersed throughout the site to mimic natural recharge patterns, rather than being concentrated at low points.

The objective has been to try to get as much of the total volume of stormwater back into the ground as possible, typically designing to keep the total volume of runoff constant, pre-development to post-development, for up to the 2-year storm (In other studies this 2-year standard has been shown to give excellent water budget performance, typically maintaining more than 95 percent of total annual recharge volumes in the average year). Due to concerns offered by the Township engineer in this case, the 2-year requirement was increased to include...
the much larger 100-year storm, even though the incremental benefit to the water budget was extremely marginal.

**The Recharge Garden Concept**
For some years, Prince George’s County MD has been advocating construction of bioretention/biofiltration recharge devices which the County has dubbed “rain gardens.” In their design guidance, these BMPs are recommended to be constructed for virtually every lot/house structure—in other words, they are to be as decentralized as possible. In the adaptation developed here for Rivercrest, a variation on this rain garden theme has been developed whereby lineal recharge gardens are placed to the rear of residential structures, receiving stormwater runoff from multiple structures and street area (Figures 2 through 5). These recharge gardens are placed just downslope of the structures in areas being disturbed. At the same time, recharge gardens are placed upslope of steeply sloping wooded ravine/palisades areas which are not to be disturbed.

Recharge garden specifications include (Figure 6 provides a detailed cross-section or profile view of the recharge garden concept):

- Based on permeability results measured in the field, each recharge garden is designed to exfiltrate runoff for the 2-year storm through 100-year frequency storms for areas draining to each garden. Unlike a conventional detention basin where the outlet structure is designed to reduce runoff rates, the recharge garden is sized to utilize the underlying rate of bedrock permeability as the outlet structure resulting in no increased surface runoff volumes.

- Each stone bed is wrapped in geotextile material to prevent soil fines from migrating into the recharge bed and reducing void spaces which provide the essential volume storage.

- Stone beds are filled with AASHTO #1 stone (not compacted) providing 40 percent void space for volume storage. Variable diameter perforated pipe is provided beginning and ending 10 feet from the stone bed.

- A 6-inch diameter observation port for visual inspection and emergency overflow the recharge bed top consists of a 6-inch layer of sand and 12-inch layer of topsoil to assist with infiltration and function as an additional filter strip.

- A 1-foot deep surface depression over search stone bed to provide additional storage capacity for unexpected rainfall events.

- An emergency spillway to convey runoff from the 100-year post-development rainfall.

- Water tolerant vegetation requiring little or no annual maintenance thereby reducing risk of unexpected compaction capacity for unexpected rainfall events.
Figure 2. Typical Recharge Garden.
Figure 3. Typical Recharge Garden.
Figure 4. Typical Recharge Garden.
Figure 5. Typical Recharge Garden.
• A water quality inlet directly upstream of each stone bed to further reduce risk of unexpected materials from entering the recharge garden.

• Drainage area for each recharge garden is the sum of each contributing inlet drainage plus any overland flow which may enter the recharge garden. “C” factors become the weighted average of each individual inlet drainage are C factors. The rational method has been used to estimate inflow/outflow hydrographs given the small areas involved.

Recommended Native Planting Mix for Recharge Gardens
As can be seen from Figure 7, several different native planting zones have been established as part of the recharge garden concept. The objective of this planting system is first to match species with the conditions expected to prevail in the recharge garden environment (i.e., variation in moisture conditions in particular). Just as critical are the aesthetic needs of the development including the owners of these new residences. Care has been taken to introduce a level of seasonal texture and color variation in order to keep the development as attractive as possible. In addition, plants are chosen to provide food and cover for a diversity of wildlife species including butterflies and hummingbirds. These plantings will provide a careful transition from the rear decks of the housing units to the existing woodland areas not being disturbed, and will discourage residents from trampling and compacting the recharge beds.

Zones A and B (Short and tall wildflower/grass mix for recharge garden)
Wildflowers
Black-eyed susan (*Rudbeckia hirta*) (A)
Thin leaved coneflower (*Rudbeckia triloba*) (B)
Bee balm (*Monarda didyma*) (B)
Wild bergamot (*Mondarda fistulosa*) (B)
Common milkweed (*Asclepias syriaca*) (B)
New England aster (*Aster Novae-angliae*) (B)
Golden alexander (*Zizia aurea*) (A)

Zone C (native grass mix for berms and recharge garden)
Grasses
Broomsedge (*Andropogon virginicus*) (foreground – shorter)
Little bluestem (*Schizachyrium scoparium*) (foreground – shorter)
Indian grass (*Sorghastrum nutans*) (background edge, taller)
Switch grass (*Panicum virgatum*) (background edge, taller)

Zone D (native edge trees for accent, further definition of limits)
Eastern redbud (*Cercis canadensis*)
Flowering dogwood (*Cornus florida*)
Shadbush (*Amelanchier canadensis*)
Eastern red cedar (*Juniperus virginiana*)
Figure 6. Profile Cross Section of Recharge Garden Downslope from Residential Units and Upslope from Edge of Palisades/Ravine.
Figure 7. Typical Recharge Garden Plan with Different Native Planting Zones.