Performance-Based Plant Selection for Bioretention

thefield.asla.org/2020/01/09/performance-based-plant-selection-for-bioretention

January 9, 2020

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Bioretention planter in Portland, OR, planted with large native plants. Oversized plantings cause visibility issues for pedestrians, cyclists, and motorists and create maintenance liabilities. / image: City of Portland

For more than two decades landscape architects and stormwater professionals have been utilizing vegetated bioretention systems to help address complex stormwater and climate change-related issues. Bioretention systems use a combination of soil and plants to collect, detain, treat, and infiltrate runoff from roads, roofs, and other impervious surfaces. It is becoming apparent that plant health is one of the major drivers of increasing life-cycle costs, and that improper plant selection is partially to blame.

Landscape architects, horticulturalists, and designers are beginning to better define which characteristics make a plant ideal for use in bioretention. Understanding the site-specific needs for plants and identifying project goals allow designers to address performance issues up front and reduce long-term maintenance liabilities. The following three issues should be considered as early in a project as possible:

1. Project Goals and Facility Design

The two major goals for most bioretention projects are pollution reduction and flow control. Projects may serve one goal or both, and this may vary across a city or region. Bioretention facilities are designed for project-specific hydraulic regimes with controlled flooding and hydroperiods that affect plant viability. This affects plant selection in several ways:

Hydroperiod: Understanding the flooding cycle of the facility, its frequency, and how it relates to the growing cycle of the plants is critical. Smaller plants often fail because they are routinely flooded during the growing season, depriving them of needed oxygen. Designers should prioritize plants that grow taller than the high-water level and take cues from native wetland plants that have evolved to tolerate similar hydroperiods.

Smaller plants can be drowned by regular flooding. / image: Montgomery County, Maryland

- **Water flow:** How water moves through a bioretention system is critically important to successful vegetation. Run-off entering the facility will slow down and drop a lot of its suspended sediment near the first inlet. Plants placed here need to be tolerant of sediment loading, as well as removal techniques. Shrubs or herbaceous plants with a bunched form are easier to shovel around than spreading groundcovers. If the facility is lined with an underdrain, shallow rooting plants may be more appropriate than deep-rooting plants that will promote infiltration in unlined planters.

- **Site context:** A successful planting accounts for the surrounding site context. In urban areas, particularly at street corners, care needs to be taken to not impede visibility between pedestrians, motorists, and bicyclists. Additionally, an enhanced aesthetic design can also go a long way toward fostering community acceptance. In a more naturalized context, larger facilities can effectively make use of smaller, cheaper plant materials like plugs and bareroots. Consideration of native plant communities can address co-benefits such as habitat for birds or insects; however, adapted plants may be hardier and more capable of withstanding variable hydroperiods and flow characteristics.

2. Plant Functions in Bioretention Systems

Plants in bioretention facilities serve many functions including minimizing erosion, containing sediment, enhancing infiltration, regulating temperature, controlling weeds, filtering pollutants, building soil, phytoremediation, and aesthetic enhancement. These vary depending on specific goals for a project and understanding them is key to identifying the characteristics of successful bioretention plants. Several functions and corresponding characteristics are described below.

> **Minimize Erosion:** One of the most important functions that plants serve in bioretention facilities is to hold the soil treatment layer in place during storm surges, when pollution and sediment filtering happens. Densely planted shrubs and evergreen herbaceous plants add roughness to the water's flow path, and extensive roots work beneath the surface to hold the soil in place.

Soil erosion and displacement in an unplanted bioretention planter. / image: City of Portland

- **Enhance Infiltration:** Plants and their root systems help draw water down through the treatment media into the subgrade, promoting infiltration and aiding groundwater recharge. Plants also help keep the imported soil media loose and permeable. It is common for new bioretention soils to drain slowly due to poor soil mixing or improper installation techniques; however, this can be greatly improved in as little as one year as the new plants establish.
- **Weed Control:** Weed cover in stormwater facilities can be a costly maintenance issue, but one that can be mitigated through proper plant selection. Plants with tighter forms planted closely together, or interspersed with groundcover layers, can achieve aerial coverage in two years or less. This can reduce maintenance costs by protecting the soil from windblown seeds and keeping existing weed seeds from germinating.

3. Characteristics of Bioretention Plants

Not all plants are appropriate for use in bioretention facilities, and a plant that is successful in one region may not grow in others. By identifying plant characteristics specific to bioretention functions a landscape architect can make the best plant choice from the available plant palette in order to solve the project's stormwater management goals.

> **Year-round Foliage:** Ensure that plants maintain dense, full foliage during the winter months to slow and calm flowing water and protect against erosion. In some areas, that may include a robust evergreen palette, and in others, leaving grasses over winter to maintain coverage. The use of perennials for color and aesthetic interest should be carefully balanced with dense grasses or woody shrubs to limit bare patches during winter months.

Grasses left uncut to over-winter help protect the soil and maintain visual interest. / image: City of Denver

> **Robust, Upright Habit:** A successful bioretention plant should have full, robust foliage and a primarily vertical growth habit. They should fill out their space without overgrowing the facility, providing coverage over the soil. Plants should be robust enough to stand up to flowing water coming into the facility. Shorter-stature groundcovers are useful; however, they should be partnered with upright shrubs, sedges, and grasses.

Dense, upright plants stand up to incoming stormwater flows. / image: City of Portland

> **Dense, Deep Root Architecture:** Bioretention plants should have a root architecture of primary and secondary roots that is dense and fibrous as opposed to a tap root structure. Dense root networks help facilitate water infiltrating throughout the soil media and into the subgrade.

By understanding the goals and design of the bioretention project, as well as the specific functions they are asking plants to perform, landscape architects can better identify the specific characteristics needed in bioretention plants, creating a built product that effectively manages stormwater run-off and is efficiently maintained.

Bioretention swale in Portland. This photograph is six years after initial planting. / image: City of Portland

This post was a collaborative effort supported by the Green Infrastructure Leadership Exchange.

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