Stormwater Best Management Practice

Protection of Natural Features

Minimum Measure: Post Construction Stormwater Management in New Development and Redevelopment
Subcategory: Innovative BMPs for Site Plans

Description

Undeveloped sites can have numerous natural features that provide environmental, aesthetic and recreational benefits if preserved and protected from the impacts of construction and development. These features include wetlands, riparian areas, aquifer recharge areas, mature trees, woodlands and other wildlife habitat. Site designs should also protect restricted areas such as floodplains and steep slopes.

Natural area protection can also be important on properties undergoing redevelopment. They might have attractive open space, well-drained soils or riparian areas that design engineers should identify and consider for preservation early in the planning process.

Design engineers, construction staff, and municipalities can protect natural features and open space—both during development and after a site is in use—through a combination of site planning techniques, construction site stormwater controls and post-construction stormwater controls.

A mixed-use community called Abacoa in Jupiter, Florida, puts many smart growth principles into action, including cluster design and land preservation. The community encompasses 2,055 acres, including 393 acres preserved for open space and another 260 acres reserved for green space. Local ordinances and mixed-use cluster development make this protection of open space possible. The community and surrounding landscape focus on protecting wildlife habitat and riparian buffers, including native pine woods, wetlands and habitat for the endangered gopher tortoise. Abacoa's natural features also provide stormwater management benefits by reducing stormwater discharge through natural infiltration and providing water quality treatment in streams, lakes and wetlands.

A teacher and students on an elevated path in a marshland.

Implementation

Site Planning Techniques

Developments can incorporate existing environmental features into a site's design and market them as amenities. This can be accomplished by delineating a "development envelope" for buildings and infrastructure that keeps them from affecting natural features. Current design manuals for cities like Portland, Seattle and Philadelphia (City of Portland, 2016; PWD, 2018; SPU, 2017) build on this concept through incorporation of other *smart growth* practices, which provide financial and planning incentives to combat urban sprawl, promote compact development and conserve natural lands.

The first step in urban conservation is to assemble background information by:

- Determining the local context (urban, agricultural, forested, etc.).
- Mapping significant features as candidate conservation areas, including floodplains, slopes, soils, wildlife habitats, woodlands, farmland, historical/cultural sites, views, aquifer recharge areas and others.

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- Ranking conservation areas based on how special, unique, irreplaceable, environmentally valuable, historic or scenic they are.
- Identifying areas to place buildings and infrastructure so as to minimally impact conservation areas.
- Establishing the layout of buildings and infrastructure, using techniques such as clustering buildings and designing smaller lots, shared driveways and narrower streets.

Site evaluation and design can enable the preservation of significant features while maintaining the desired overall site density (although density in localized parts of the development will be higher when open space is set aside). There can be some negative perceptions associated with high-density residential areas. Developers want to achieve a particular development density when building subdivisions or commercial sites. Also, for residential developments, lot size is an important factor in determining lot prices. Setting aside natural areas can take space away from yards, parking, transportation infrastructure and other built features. Developers can accommodate overall site density using clustering techniques, smaller lots, density increases and more efficient street layouts. To offset lost premiums from smaller individual lots, developers can market a lot's proximity to natural areas and attractive views as amenities.

Also, local zoning codes might restrict the use of clustering, reduced road widths and other techniques for natural area preservation. Developers should work with local regulatory agencies to determine whether they can obtain waivers to protect natural features.

Stormwater Controls During Construction

Design engineers and construction staff need to take extra care during site preparation to protect environmentally significant areas of the property (see Preservation of Natural or Existing Vegetation). They should indicate a limit of disturbance and the locations of protected areas in design drawings, stormwater pollution prevention plans and on-site maps. They should also post signs with prohibitions and educate workers about the importance of and special considerations for the protected areas. Without training and explicit signage, vehicle traffic, stored waste and materials, and other construction-related activities could damage areas slated for protection. Construction staff should check areas regularly to identify problems and determine if additional controls are needed (e.g., more training, explicit signage, obvious barriers). Operators should also look for signs of unintended consequences of construction activities on the natural areas (e.g., changes in hydrology, flooding, accidental spills) and take appropriate actions to mitigate the damage.

Developers and construction site operators can employ the following specific practices to protect each type of resource:

- **Mature trees or woodlands.** Surround the area to protect with bright orange fencing placed at or beyond the tree's dripline. Prohibit clearing and grubbing, limit heavy equipment traffic and prohibit material storage inside the barrier. Include signage with specific prohibitions and educate employees. Visually monitor vegetation to ensure that construction is not damaging it (e.g., soil compaction from heavy equipment traffic might cause localized flooding in nearby natural areas).
- **Steep slopes.** Protect steep slopes and vegetation. Avoid development and removal of vegetation on steep slopes. Fence off these areas and assess whether to add further erosion controls. Check erosion controls on upslope areas that will be cleared and graded; use either a pipe slope drain or a diversion (placed at the top of the slope) to divert stormwater away from or around the slope. Post signs prohibiting heavy vehicle traffic and educate crews about the sensitivity of steep slopes to erosion.
- **Well-drained soils and aquifer recharge areas.** Protect areas with well-drained soils and those that feed aquifers from compaction. Maintain vegetation if possible; for a cleared area, minimize heavy traffic by fencing the area and posting signs. Before planting permanent vegetation, aerate the soil to ensure that stormwater infiltrates. These areas may later be critical to the success of post-construction stormwater controls.
- **Wetlands and riparian areas.** Establish a buffer around marshes, swamps or other wetlands and along stream corridors in which no construction activity occurs. Avoid stream crossings wherever possible. When necessary, set up perimeter sediment controls (e.g., silt fence) and visually

monitor protected areas—especially after each storm—to check for damage from flooding and for signs of impacts from construction activities, including sedimentation, vegetation disruption, erosion, dumping, habitat destruction or fish kills. Set up stream crossings to minimize disturbance of streamside vegetation and instream habitat. Post signs and educate workers about the sensitive nature of the area; include prohibitions for storing or dumping materials. Make sure all development activities comply with Section 404 of the Clean Water Act.

The Mill Creek subdivision in Kane County, Illinois, uses mixed-use and cluster development principles. The site includes 1,500 acres with the goal of protecting natural wildlife habitats and maintaining open spaces to increase flood resiliency. The redevelopment project focused on reducing impervious spaces and maintaining 45 percent of the neighborhood as open space through cluster development. The developers conducted an economic study and determined that by increasing the housing density within the community, cluster development saved about $3,700 per lot over conventional development approaches (CRI, 2005). In addition to a reduced building footprint, using natural or existing vegetation and green infrastructure practices reduced the amount of stormwater discharge, which in turn provided further cost savings through reduced drainage infrastructure costs.

- **Wildlife habitat**. Contact a local wildlife authority if you find nests, dens or other animal dwellings on the property—if any are found, remove or relocate them before construction begins.
- The presence of threatened or endangered species or habitats critical to their survival on the site might require a consultation with the U.S. Fish and Wildlife Service or the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service. Ensure compliance with all regulations and any state or local permit requirements.
- **Floodplains**. Municipal code typically restricts the placement of buildings in floodplains because of safety concerns and the risk of property damage, so these areas should remain outside the limit of disturbance (restrictions will vary from one municipality to the next, so check with local authorities about floodplain restrictions in the area).

Establish perimeter controls, including fencing, and post signage that prohibits dumping and material storage in these areas. Inspect protected areas regularly to ensure that vegetation has not been disturbed and that no dumping has occurred.

After Site Development

After development, natural areas become amenities for the site's occupants (e.g., property owners or commercial tenants). These natural areas also become the responsibility of the owner or occupant. Developers should inform the occupant about each natural area or protected feature's importance and outline activities that the occupant should prohibit to adequately protect the resource.

Developers should also provide guidance to occupants on how to maintain these areas. For example, occupants should not mow a preserved prairie or riparian stream buffer or manicure it like turf. Property owners or maintenance crews should employ special procedures to preserve native species, such as integrated pest management practices like hand-weeding and limiting chemical use. They should use the same practices in areas where traditional landscape maintenance activities could threaten water quality, such as in or adjacent to wetlands and riparian areas or where endangered species are present. Property owners can post interpretive signage to educate occupants and visitors about the significance of the features, as well as to describe prohibited activities such as mowing, dumping and vehicle traffic. They can install barriers to protect natural areas from damage without detracting from their aesthetics and function. These barriers can include strategic placement of low fences, walls, bollards or large rocks that unobtrusively limit access to the areas.

Using Conservation Easements

Developers can use conservation easements to maintain open space over the long term. For example, the Minnesota Land Trust implements "subdivision conservation," protecting thousands of acres and hundreds of shoreline miles along various lakes. This approach involves compacting development areas and preserving part of the development area as natural land. For example, the Fields of St. Croix residential development in Lake Elmo, Minnesota, permanently protected 60 percent of the development's 226 acres

through a conservation easement granted to the Minnesota Land Trust (Anderson, 2014).

Effectiveness

A Johns Hopkins University study showed that conserving natural areas can improve stormwater quality and reduce pollutant loading to receiving streams. Specifically, riparian forest buffers and riparian grass buffers achieved a 20 to 60 percent reduction in total nitrogen, total phosphorus and total suspended solids depending on buffer width, slope and hydrogeological conditions (Baish & Caliri, 2009). Similar data from the Chesapeake Bay region show forested buffers can achieve load reductions of 6–12 lbs total nitrogen, 0.4–1.5 lbs total phosphorus and 120–1,500 lbs total suspended solids per acre of forest buffer (CBP, 2018). Preserving natural spaces and maintaining natural stream buffers will help to remove pollutants from stormwater, thus improving aquatic life, habitat and water quality.

Cost Considerations[1]

Cost comparisons for preserving natural areas and open space versus traditional development are difficult to determine because the quantity and type of natural features vary from site to site. In general, preserving natural areas can add costs for planning and inspections to meet local regulatory requirements using innovative site designs. Also, the need for smaller construction equipment could increase costs if equipment operators need to maneuver around trees and other protected features. Offsetting these higher costs are the cost savings that come with disturbing less space—costs for clearing, grading, temporary erosion control, landscaping and stormwater management. These savings can be substantial; the cost of clearing and grading alone can easily exceed $10,000 per acre (RSMeans, 2019) while the cost of implementing a new post-construction stormwater control can entail capital costs of $50,000 to $100,000 per acre of impervious surface treated (King & Hagan, 2011).

Additionally, developments that use clustering can reduce infrastructure costs by shortening road lengths, eliminating curbs and gutters, and using vegetated areas and swales instead of structural stormwater controls. Preserving forested or other natural areas can save up to $12 per square foot (or $525,000 per acre) over conventional landscape solutions, thanks to a long-term reduction in maintenance requirements for mowing grass and purchasing fertilizer (SSI, 2009).

Additional Resources

- Pennsylvania Department of Transportation, Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Department of Community and Economic Development, & Pennsylvania Land Trust Association. (2011). *The official map: A handbook for preserving and providing public lands and facilities* (PUB 703).
- U.S. Environmental Protection Agency (U.S. EPA). (2011). *Smart growth illustrated.*

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

[1] Prices updated to 2019 dollars. Inflation rates obtained from the Bureau of Labor Statistics CPI Inflation Calculator website: https://data.bls.gov/cgi-bin/cpicalc.pl.

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