Lincoln Center: Integrating Innovative Stormwater Management Technology Into A Mixed Use Community

A. Hayes¹, J. Heisler², E. Laramore³, M. Clar³

¹ ForeSite Associates Inc., 208, Delaware Street, New Castle, DE, 19720,
PH: 302-351-3421, Fax: 302-351-3456; email: ACH@foresiteassociates.com
² Reybold Venture Group:, 116 E. Scotland Drive, Bear, DE 19701.
PH: 302-832-7100
³ Department of Land Use, New Castle County, DE 19720, PH (302) 395-5457;
FAX: 302-395-5488; email: elaramore@nccde.us

Abstract

This paper describes the design concepts being developed for the proposed Lincoln Center site in New Castle County, DE. This project consists of a 56 acre parcel which is being developed as a mixed use commercial, office, and residential center. The project is unique in that it will feature a wide range of innovative LID practices as well as some traditional BMPs.

The innovative LID practices include bioswales, bioretention areas (rain gardens), infiltration trenches, porous paving, green roofs and water harvesting. Currently there are no other projects in New Castle County, DE that feature such a wide range of innovative practices. The traditional BMPs include wet ponds and wetland areas.

The use of the innovative LID practices is requiring the County to develop and adopt design guidelines for some of these practices; specifically green roofs, porous pavement and water harvesting. The County does have design standards for bioretention systems, bioswales, and traditional BMPs.

This paper focuses on the site analysis and how the site characteristics dictated the selection of the range of BMPs. In addition this paper will describe the interim guidelines that the County is developing to address the stormwater components of the innovative LID practices.
**Background**

In early 2006 the Reybold Group, a regional commercial, residential, and industrial real estate venture firm, approached New Castle County, Delaware with a unique mixed use community called Lincoln Center (Figure 1 – Vicinity Map).

![Figure 1. Project vicinity map](image)

The proposal was to site a development providing class A office, regional shopping, dining, entertainment, and contemporary living solutions on 56 acres in northern New Castle County. Included with the project is nearly 450,000 square feet (s.f.) of office space, 800,000 s.f. of residential living, and 250,000 s.f. of retail and dining space.

Among the Reybold Group’s core values are demonstrating responsibility and sensitivity to ecological and community needs. These values were demonstrated early on as Reybold committed to providing innovative and cutting edge stormwater treatment and traffic mitigation and also committed to bringing to fruition the community’s long standing desire for a regional public park on an adjoining 50 acre property. The project, named Lincoln Center, quickly began to build community and regulatory support.

ForeSite Associates, Inc., the civil engineering firm for the project, and the New Castle County Department of Land Use quickly set about developing a comprehensive stormwater management proposal for the project. Challenges included how to bring high level stormwater treatment to a site with such an intensive land use. The idea was to bring a wide range of treatment methods to the site and to
integrate stormwater management throughout the land plan. Preliminary discussions ranged from using conventional retention ponds, to water harvesting, to green roofs. The developer, the developer’s engineer, and the local regulatory authority agreed at an early stage that Lincoln Center would be an ideal project to benchmark creative stormwater management solutions for mixed use communities and to demonstrate the feasibility of combining multiple internal small green technology BMPs with larger external conventional BMPs.

Site Characterization

Located on the upper Atlantic Coastal Plain at it’s junction with the lower Piedmont Plateau, the Lincoln Center site has gently sloping topography with multiple isolated sump areas and three principal discharge points. Each of the three principal discharge points flow to a Delaware Department of Transportation (DelDOT) stormwater management retention pond (Figure 2 – Hydrologic map, watersheds).

Figure 2 Hydrologic map, watersheds

An eastern drainage area flows to the DelDOT basin and then to the Army Creek, a tidal tributary of the lower Delaware River. The two other principal discharge points flow to different DelDOT basins located within the Christina River watershed. Local soil survey documents indicated silt loam to silty clay loam soils overlying sandy loam. Isolated areas indicated slight variations and zones with varying gravel content (Figure 3 – Soils Map).
A model of the existing on-site watersheds was developed using an AutoCAD Civil 3D CAD file that included aerial and field shot topography, public GIS soil data, and CAD data from DelDOT. The existing hydrology was modeled using Hydroflow Hydrographs. Off-site drainage facilities and waterway information was gathered from field reconnaissance and archived DelDOT stormwater management facility design reports. The fragmented nature of the site’s drainage areas seemed to fit well with the team’s desire for multiple BMPs.

**Preliminary BMP Layout**

Along with the preliminary land plan, preliminary locations for stormwater management structures were identified and a matrix of potential treatment technologies was developed. Structures were sited to create disconnected impervious areas, and to maximize the use of areas suspected as suitable for infiltration based practices. This preliminary document was used as the basis for a site wide field investigation of shallow subsurface conditions and evaluations of the proposed technologies for each of the 25 test locations (Figure 4 – Preliminary BMP type and location).
Each test pit location was excavated to approximately 12 feet deep and analyzed to determine the general soil characteristics, estimated permeability and infiltration rate, limiting layers, and depth to seasonal high groundwater and free groundwater where encountered. While all test locations showed restrictive fine grained soils in the shallow layers, the underlying soils and groundwater conditions varied. The variation encountered did not pose a significant problem due to the flexibility of being able to choose from such a variety of BMPs. Ground water was encountered in only 3 of the 25 test locations.

The preliminary study pointed to 6 locations having groundwater, highly restrictive layers, and/or limited infiltration capacity. The remaining 19 locations appeared suitable to varying degrees for bio-retention or infiltration applications. Within the latter group depths of restrictive layers varied as did the approximate infiltration rates. Estimated infiltration rates were based on soil textures determined by laboratory analysis. This analysis confirmed some of the preliminary structure locations such as the large underground detention/infiltration structure located on the south side of the site’s northernmost entrance. The location for this structure was chosen due to mapped soils and an outfall point with capacity restrictions.

Other BMPs were re-evaluated based on the findings. The bio-infiltrations facility initially sited (Figure 4) for the southwest corner was replaced with a retention basin (Figure 5). In a similar process the suite of BMPs was revised in conjunction with revisions to the broader land plan. The fact that these two must be done in conjunction can not be stressed enough, both stormwater management and surface infrastructure improvements can take advantage of a site’s varied soil conditions. Concessions were made for the benefit of each use of the site’s land.

Figure 4. Preliminary BMP type and location
Selected BMP Layout

While the regulatory approval process is still in its preliminary stage the location and nature of each BMP began to solidify based on soil information, survey data of outfall points, and the nature of capacity to each of the site’s outfalls.

Wet Ponds. The plan proposes three wet ponds, all on the southern side of the site. The two ponds fronting on the loop road passing the site are proposed to be retention ponds and will serve as a key landscaping feature at the front of the site (Figure 5 – Preliminary BMP Layout). The pond at the southwest corner was located to take advantage of the topography and soils that are highly restrictive to infiltration practices. The second large pond along the loop road will require lining since soil testing indicated the possibility of seasonal drying. The pond at the southeast corner was sited in an area having relatively deep restrictive layers and low to very limited suitability for infiltration. It was also thought that the adjacent wetlands would serve as a seed for the ecology of this pond and that it would expand the habitat for the wetland’s inhabitants. Pre-treatment such as bio-swales, filter strips, and bio-retention are proposed for each pond.

Bioswales. Bio-swales were sited where the topography promotes the use of linear or mildly wandering swales. The principal location for these features is along the narrow strips of pervious areas along the site’s eastern frontage. Filter strips are added before the bio-swales where possible.
**Filter Strips.** The use of a filter strip is anticipated adjacent to parking lots with long lengths adjacent to landscaped areas. Filter strips are also proposed within the setback area between the condominium buildings and the adjacent proposed park. The depth of restrictive soil layers varies at each location and the infiltrative capacity of each facility is expected to vary widely.

**Bioretention.** Bio-retention areas and rain gardens are introduced throughout the site. The term rain garden was applied to indicate very small drainage areas and/or facilities with the Bio-retention designation being applied to more significant areas. The underlying soils in these areas appeared well suited for infiltration although some of them may require undercutting to remove restrictive layers. We also intend to extensively utilize planter type bio-retention areas directly adjacent to building structures. The facilities are proposed to pilot test planting media by utilizing State approved engineered soil and modified on-site material.

**Infiltration.** Infiltration trenches were called out for the interior of many parking islands. The width of the trench and filter section is proposed to vary by location. Trenches are proposed along the narrow portion of the islands and approximately 4’ of restrictive soil is expected to be removed and replaced with more appropriate on-site borrow. The area to the south of the northern entrance calls out for an underground detention and infiltration facility to manage discharge to a restrictive outfall, a storm drain leading to a community with existing drainage issues. Testing in this area indicates that it is well suited for the purpose with restrictive layers to 6’ and no evidence of groundwater encountered to a depth of approximately 13 feet. A large diameter chamber based facility below a parking lot is envisioned.

**Permeable Paving.** Large parking lots at the northeastern corner of the site propose porous curbing with under drains. For these areas we propose to utilize a curb and gutter section comprised of upright concrete curb with a reinforced grass type paver for the gutter pan. The gutter section would have an under drain leading to an underground infiltration chamber or would daylight to a bio-swale in areas with less infiltrative capacity. The runoff from larger rain events would flow in the gutter section to catch basins similar to a standard integral curb and gutter. Portions of the easternmost curb section may discharge directly to bio-swales. The areas called out as porous pavers with under drain would operate in a similar fashion allowing low flow events to infiltrate while directing heavy flows to the storm drain system. Two areas approximately 2,500 s.f. in size are proposed for the porous paving. The pavers are proposed to utilize distinct coloration so that they will also serve a streetscape function at key pedestrian crossing points.

**Green Roofs.** Green roofs are a prominent feature on the site and are called out for most office buildings and the four story condominium buildings. We anticipate that the design for several of the roofs will contain walkways for tenants to use as an amenity to the building. By having tenants see the roofs while restricted from damaging them we hope to build awareness of the technology and the building’s reduced environmental impact.

**Wetlands.** While the initial BMP schematic proposed a number of constructed wetlands, the number of constructed wetlands was reduced on this plan to reflect the State’s concern over the number of nuisance species. We intend to reintroduce wetland areas on a reduced scale mainly as forebays for ponds to take advantage of their high functionality when utilized as a nutrient treatment system. If surface water stagnation and nuisance pests remain a concern, demonstration facilities using subsurface wetlands systems may be introduced.
Rainwater Harvesting. Cistern water reuse facilities are dispersed around the site to collect roof runoff into watertight underground storage chambers. Geo-membrane enclosed cellular as well as precast concrete systems are currently being evaluated. The harvested water would be used for irrigation purposes reducing the use of potable water. We anticipate utilizing technologies for separating floatable debris and grit before each storage facility. Each system would also contain an overflow weir to direct excessive flows to the storm drain system leading to proposed or existing ponds.

Pilot Testing and Monitoring Program

With Lincoln Center bringing a wide ranging mix of green technology BMP’s along side and at time in conjunction with more traditional BMP’s the site is ideal for pilot testing and monitoring of BMP performance. The site is somewhat unique in that most of the unimproved site drains to three DelDOT stormwater retention basins providing a measure of failsafe for each discharge point. In addition to performance testing development of design and analysis guidelines for several of the treatment technologies will have to be developed. New Castle County is in the process of implementing a newly revised and expanded drainage code and developing guidelines for green technology BMPs to supplement State standards. Retention basins and underground infiltration facilities are to use standard State and County accepted methodologies. Bio-swales, infiltration trenches, and bio-retention areas are to utilize the State’s Delaware Urban Runoff Management Model (DURMM).

Unfortunately New Castle County as well as the State of Delaware Water Discharges Section has not currently adopted standards or guidelines for a number of the proposed innovative stormwater management practices including; rainwater harvesting, permeable and porous paving, green roofs, and wetland treatment options. This project has identified the need for New Castle County to develop these standards so that the absence of these standards does not continue to represent an obstacle in encouraging and promoting innovative and sustainable stormwater technology. Fortunately some of the neighboring jurisdictions including Pennsylvania, New Jersey, and Maryland are or have recently developed standards for most of these BMPs. New Castle County is currently tracking and evaluating these existing standards and has committed to using the Lincoln Center project as the initiative to adopt these standards for the County.

Pilot testing of bioretention soil media is to be conducted on a large scale at this site. Currently the state (DNREC) specifies an engineered soil media which is very high in organic content (1/3 peat moss, 1/2 double shredded mulch and 1/2 sand). The soil mix has a very high flow rate and is available only from a very small select group of certified suppliers. Critics of the media point to its high cost as a deterrent to large scale utilization of bioretention and design professionals point to its very high organic matter content as limiting the choice of planting options and the longevity of the plants. The team intends to use onsite borrow sources consisting of natural sandy loam and loamy sand combined and enhanced with composted leaf mulch to create a more natural and sustainable soil mix. Installed materials are to vary by facility testing varying degrees of organic and aggregate content. Laboratory testing of installed media will be performed for comparison to the facilities having standard State media. A testing protocol of sampling at facility inlet and at the underdrain inspection port is also being developed. Inspection reports on the vegetative cover and a photo record of plantings are to be maintained for each facility included in the pilot test.
**Project Goals and Path Forward**

Through early integration of stormwater management into the planning process the Lincoln Center project has fostered an effective working relationship between the regulatory authority and the developer. Early regulatory involvement has set the stage for introducing new design standards and guidance documents for the County and benchmark tests for the performance of installed facilities. The developer’s early goal of gaining County support for the project has largely been achieved. Direct community outreach, agency involvement with land planning, traffic, and environmental concerns has combined to create significant positive momentum at an early stage for the project.

Initial design goals of mimicking pre-development hydrology can often be seen as unrealistic in a zoning district where only 30% open space is required. Lincoln Center strives to mimic the pre-development hydrology by introducing multiple infiltration areas throughout the property following the existing condition of multiple sump areas. The principal pre-development discharge points from the property are to be maintained in the post-development condition. It is fully anticipated that the project will meet the pre-development conditions in terms of rate controls for the 2 through 100 year storms and volume controls through the 2 year storm.

It is anticipated that the project goal of a streamlined regulatory review and minimal approval delays due to regulatory negotiations will be achieved through the early involvement of regulatory agencies and consultants. While the project has yet to achieve preliminary approval significant research and evaluation have been performed on the site and a realistic comprehensive stormwater management program developed.

The next phase of the project involves the establishment of design standards or references to base designs upon for each of the proposed treatment technologies and to build a more refined preliminary post-development model consisting of:

- Typical details for each type of facility;
- Sample specifications including standards for the bio-retention media;
- Preliminary planning for quantity control;
- Creation of sample testing protocol for the facilities to be monitored;
- Selection of hydraulic modeling criteria and methods for each of the proposed BMPs;
- And discussions on construction sequencing for the proposed facilities during the site’s 8 to 10 year build out scenario.

**References**
