

Bioretention and Infiltration Facilities Utilized at PHL Airport Parking Lot Expansion

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Abstract

Gannett Fleming, Inc. provided design services to the City of Philadelphia, Division of Aviation for a new parking lot expansion on a 12.7 acre vacant parcel located adjacent to an existing employee parking lot. Preliminary subsurface investigations indicated the site was underlain by suitable soils for infiltration. In order to satisfy the applicable stormwater management regulations, the proposed grading and site layout was developed to allow for the incorporation of bioretention areas in between the parking aisles to provide runoff volume and rate control. In total, thirteen separate bioretention stormwater treatment areas were incorporated throughout the site, each containing a layer of permeable soil planted with appropriate shrubs and wildflowers to clean the stormwater runoff. Where feasible, a sub-layer of gravel was included to provide infiltration for the increase in runoff volume generated during a two-year storm event. In addition to the thirteen bioretention areas, one subsurface infiltration trench was located below the parking lot where insufficient space existed to construct a bioretention area. Construction started in late Summer 2007 and is anticipated to be completed by Spring 2008.

Background

Gannett Fleming, Inc. was contracted by the City of Philadelphia, Department of Commerce, Division of Aviation to design a parking lot expansion. The project is located on a 12.7 acre open lot on the southwest corner of Bartram Avenue and Tinicum Boulevard directly adjacent to an existing employee parking lot. The proposed parking lot will provide approximately 1,350 new parking spaces for employees of the Philadelphia International Airport. The new lot will tie directly to the existing parking area and utilize the existing signalized ingress/egress access point at 84th Street and Bartram Avenue.

Stormwater Requirements

Pursuant to newly adopted Philadelphia City Stormwater Regulations and consistent with Pennsylvania Department of Environmental Protection (PaDEP) newly issued Pennsylvania Stormwater Best Management Practices Manual, the proposed parking area had to employ innovative stormwater management techniques to manage the increased rainwater runoff from the proposed impervious coverage. Predevelopment impervious coverage consisted of approximately 12,200 square feet of abandoned roadways traversing the vacant lot which was previously bisected by Tinicum Avenue, Brewster Avenue and 85th Street (see Figure 1). The proposed layout results in 424,870 square feet

of impervious coverage. The control requirements of both governing agencies had to be satisfied.

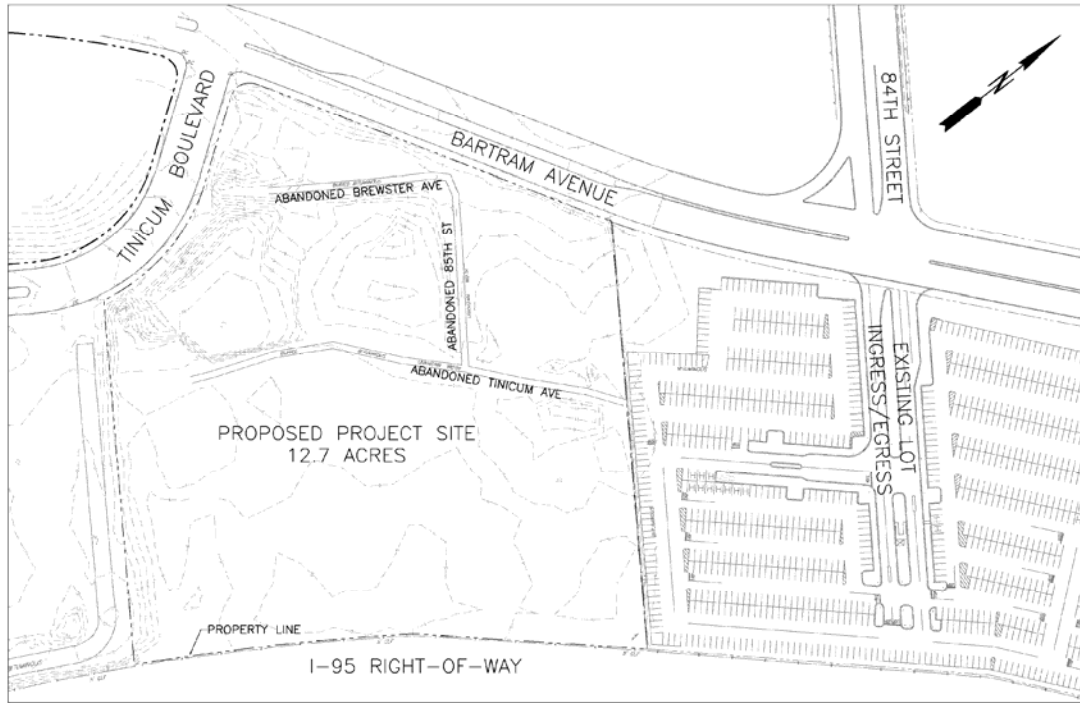


Figure 1. Predevelopment Site Conditions

Philadelphia Water Department (PWD) Stormwater Regulations applicable to this site include water quality and runoff rate control. The water quality component requires that, where feasible, the first one inch of runoff generated from all proposed “directly connected” impervious surfaces must be captured to address water quality concerns. This resulted in a total volume of 35,406 cubic feet of stormwater to be infiltrated or otherwise treated in an acceptable BMP. Regarding the required runoff rate control, this project is located in Philadelphia City’s ‘Mingo Surge Basin Sewer Shed’ which requires the post-construction stormwater runoff rates to match pre-construction runoff rates assuming 65% existing impervious coverage. Additionally, the Philadelphia Stormwater Management Guidance Manual shows the project site is located in watershed district ‘A’ which requires the post-development site runoff rate for the two-year storm event to be equal to or less than the pre-development site runoff rate for the one-year storm event. Additionally, the post-development site runoff rates for the five, ten, twenty-five, fifty, and one hundred year storm events must not exceed the respective pre-development site runoff rates.

PaDEP’s National Pollutant Discharge Elimination System (NPDES) permit requires, where feasible, the increase in stormwater runoff volume generated during a two-year storm event be controlled to the pre-construction runoff volume during the same storm event. Using a two-year storm event of 3.36 inches (per PWD), this yields a volume of 69,977 cubic feet.

Based on Code comparison, the stormwater design had to incorporate 69,977 cubic feet of stormwater infiltration while also meeting rate and water quality control requirements.

Subsurface Investigation

Geotechnical and infiltration testing was completed early in the project design to determine the feasibility of infiltration throughout the site. A total of eighteen (18) borings extending 8 to 12 feet deep were completed to evaluate the subsurface conditions. The borings revealed three material strata. Stratum one extended from the surface to a depth of 2 to 4 feet and consists primarily of construction debris materials. Stratum two, an alluvial silt/clay/sand, extended to depths of 4 to 6 feet below grade. Stratum three was typically encountered at a depth of 4 to 6 feet below grade and was a natural sand with gravel. No ground water was found in any of the borings.

Based on the results of the soil borings, additional test pits and infiltration testing was completed throughout the property. Ten test pits identified soil layers consistent with the soil borings. Eight infiltration tests were done at a depth of approximately twenty-four (24) inches, into the native soil layer adjacent to test pit locations. Test results concluded that over the majority of the property, infiltration BMP's could be located at a minimum depth of twenty-four (24) inches into native soils with a maximum depth of thirty-six (36) inches in order to remain two feet above the shallowest evidence of the seasonal high water table. The recommended design infiltration rate was 1.5 inches per hour in these areas. Due to an excessive amount of construction debris found in the northwest corner of the property (near the corner of Tinicum Boulevard and Bartram Avenue), infiltration testing could not be completed and therefore, it was recommended that stormwater structures incorporate positive outflow in this area.

Site Layout and Design

Based on the geotechnical investigation, which indicated the majority of the site was underlain by soils suitable for infiltration and the existing topography lending itself to appropriate grading, the primary method of stormwater control for the proposed layout was chosen to be the incorporation of bioretention areas located between several parking rows. In order to conform to the elevation of the adjacent parking lot, the center of the parcel had to be raised approximately three feet. This central high point allowed for the placement of a 'ridge line' along the center of the lot causing runoff to sheet flow in both a north and south direction. The parking rows were laid out parallel to the contours with 'pervious depressions' in between the rows, allowing runoff to sheet flow directly into the bioretention areas (see Figure 2). By creating these 'pervious depressions' between the rows, the parking lot was divided into multiple sub-drainage areas allowing infiltration structures to be spread throughout the site. Where previous design philosophies would have used pavement or raised islands in these areas to direct all stormwater to one location, this new design approach decentralizes the collection and treatment of surface runoff, better mimicking natural conditions.

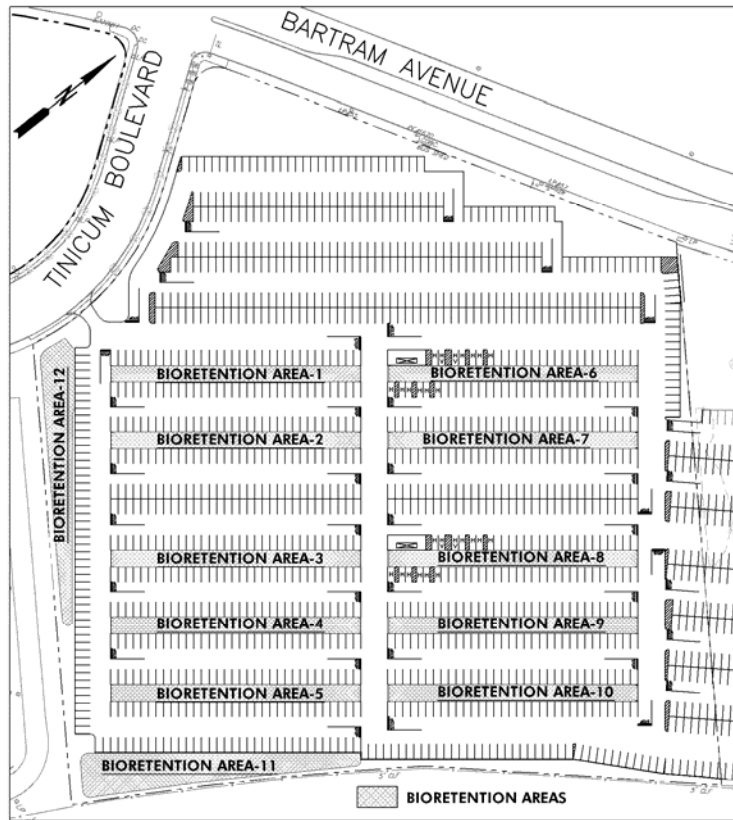


Figure 2. Location of Bioretention Areas In Between Parking Rows

A total of ten bioretention areas are located in between parking areas and two are located along the south and west property lines. Following the standard details found in the PaDEP Pennsylvania Stormwater Best Management Practices Manual and the City of Philadelphia Stormwater Management Guidance Manual, the bioretention areas contain a two-foot layer of highly permeable planting soil above an optional gravel infiltration bed to meet stormwater runoff volume and rate requirements (see Figure 3).

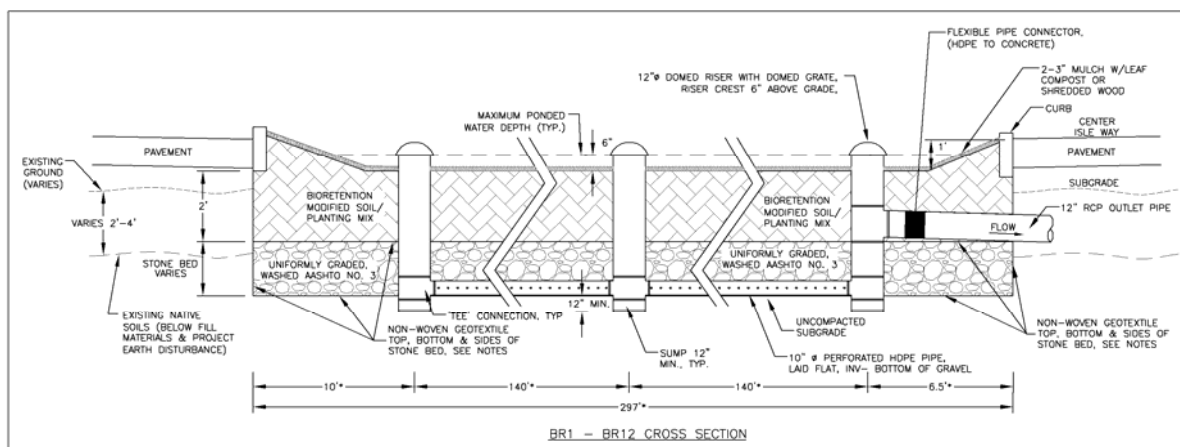


Figure 3. Cross Section of Bioretention Area with Optional Infiltration Bed Below

Although the twelve bioretention areas described above satisfied the PaDEP volume infiltration requirements and PWD runoff rate requirements, they did not entirely satisfy the PWD water quality requirements because the direct runoff from all newly proposed impervious area had not been treated. In order to satisfy this requirement for the northern property line, a thirteenth bioretention area was located in the northwest corner of the property in an area that was not found to be suitable for infiltration. A swale was incorporated along Bartram Avenue to direct runoff from the uncontrolled impervious area into this additional bioretention area (see Figure 4). This bioretention area will be constructed with two feet of planting soil and incorporate underdrains that will provide positive outflow without the optional infiltration trench. A six inch maximum ponding depth above the planting soil will capture the first one inch of runoff from the contributing impervious areas to provide the required water quality considerations prior to entering the City stormwater system.

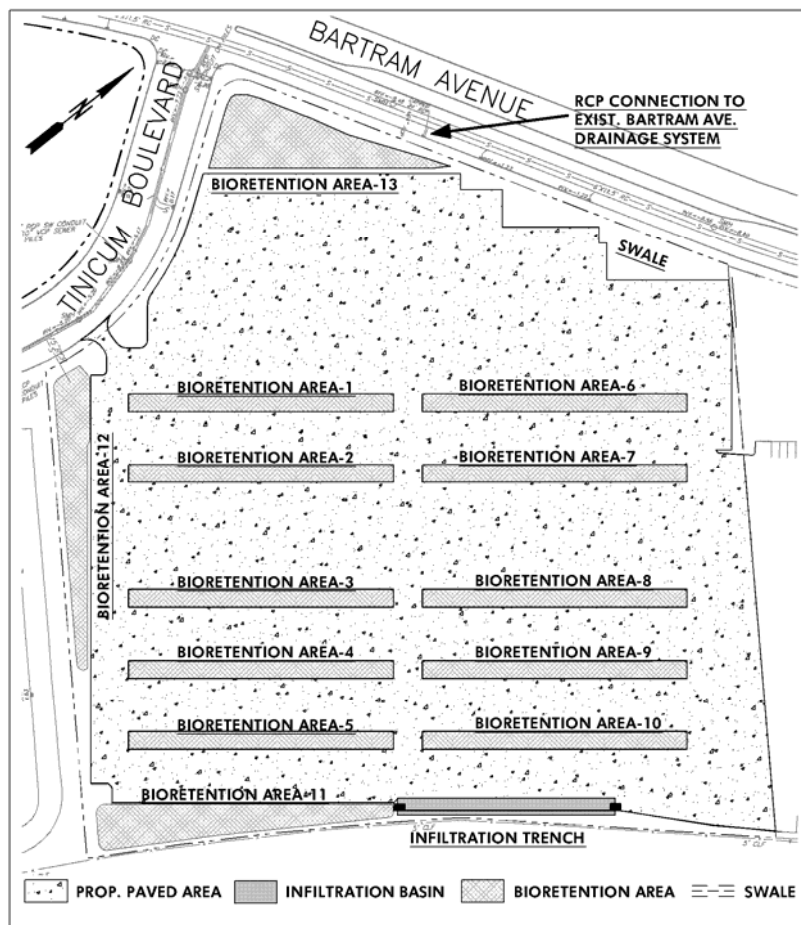


Figure 4. Stormwater BMP's Throughout Site

Due to the lot configuration, there was inadequate space along the southeast property line to construct a bioretention area to satisfy the Philadelphia City required water quality criteria. The adjacent bioretention area in the southwest property corner did not have enough depth above the seasonal high water table to be enlarged to accommodate the additional runoff from this adjacent area. For this reason, a subsurface infiltration trench

was located under the proposed paving (see Figure 4, above). Runoff from the surface will enter the infiltration trench through two inlets and be distributed throughout the trench via a ten-inch perforated pipe.

Landscaping

The bioretention areas are planted with native, non-invasive shrubs, grasses and wildflower seed mix with known aesthetic qualities which are suited to wet/dry cycles that will occur seasonally. Planting materials were selected from recommended planting lists in the Philadelphia Stormwater Management Guidance Manual based on knowledge of the surrounding area habitats. Shrub species include American Elder, Arrowwood Viburnum, Black Chokeberry, Highbrush Blueberry, and Sweet Pepperbush. In keeping with native species plantings in the bioretention areas, the remaining site landscape requirements are also satisfied using native species and, where practical, wild flower seed mix will be used in lieu of mowed grass areas to further decrease surface runoff. Some key tree species include Red Maple, White Ash, Honeylocust and Eastern Redbud. Where suitable conditions exist, shrub species contained in the bioretention areas are incorporated in other areas of the site along with other appropriate native species such as Serviceberry and Silky Dogwood.

Conclusion

The proposed parking lot layout maximizes the use of decentralized stormwater BMP's throughout the site to address stormwater management requirements. By using bioretention areas combined with subsurface infiltration, stormwater runoff volume, rate and quality issues were satisfied. The parking lot expansion project provides much needed additional employee parking spaces for the Philadelphia International Airport. Construction started in late Summer 2007 and is anticipated to be completed by Spring 2008.