Green Area Ratio

GUIDEBOOK

FOOD CULTIVATION
SOILS
NATIVE PLANTS
energy
TREES
PERMEABLE PAVING
ENHANCED TREE GROWTH SYSTEM
GREEN ROOF
HARVESTED STORMWATER
VEGETATED WALL
BIORETENTION
TREE PRESERVATION
PLANTS
GROUND COVER

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Chapter 1 Introduction to the Green Area Ratio

INTRODUCTION

Site development in the District of Columbia (District) is typically characterized by large building footprints and surrounding impervious surfaces. Conventional urban site design too often favors use of impervious surface at the expense of vegetation and other green infrastructure alternatives. This approach may result in a number of environmental consequences.

Extensive hardscape surfaces in urban areas are known to raise ambient temperatures above those of the surrounding region through the urban heat island effect. Increased temperatures lead to greater ozone production and air quality health alerts. Air quality may also be impaired by particulate matter and combustion emissions. Water bodies can be degraded by pollutants and erosion associated with increased stormwater runoff.

The Green Area Ratio (GAR) is a zoning regulation that integrates sustainable landscape elements into parcel site design to address these environmental consequences. The GAR sets minimum lot-coverage standards for landscape and site design features to promote greater livability, ecological function, and climate adaptation in the urban environment.

The GAR assigns a weighted score to a building based on the types of landscape and site design features that are implemented and the amount of area they cover. The minimum required GAR score needed to reach compliance differs by zoning district. This score is based on an assessment of the square footage of landscape elements that can be incorporated with each type of land use (see Chapter 2, Table 2).

With limited exceptions, sites that require a Certificate of Occupancy must submit a GAR plan as part of the building permit application. These sites include new building construction as well as additions and interior renovations where the cost of work exceeds 100% of the assessed building value.

PURPOSE AND SCOPE

The purpose of the GAR Guidebook is to provide technical guidelines to aid building permit applicants, Certified Landscape Experts, and property owners in complying with the requirements of the GAR zoning regulation.

The GAR Guidebook provides direction in the following areas:

- Additional details on specific zoning language
- Plan submission guidelines
- Scoring requirements and worksheets
- Descriptions of landscape and building elements eligible for scoring credit
- Certified Landscape Expert's responsibilities for design, construction, and maintenance
- Property owner's responsibilities for maintenance of landscape elements

DEVELOPMENT OF THE GREEN AREA RATIO

The GAR is inspired by similar programs developed in cities such as Berlin, Germany; Malmo, Sweden; and Seattle, Washington. Through analysis of numerous research studies, the District has assigned a relative environmental value, or multiplier, to each landscape element. This multiplier gives landscape elements with greater environmental value a higher GAR score per square foot to account for benefits such as climate adaptation, urban heat island mitigation, air quality improvement, and stormwater mitigation.

The Office of Planning spearheaded the passage of GAR through the Zoning Commission, in collaboration with the District Department of the Environment (DDOE). The regulation, Chapter 34 of Title 11 of the District of Columbia Municipal Regulations, was published on July 12, 2013, and established requirements for new plan submittals as of October 1, 2013. DDOE carries out plan review and inspection on behalf of the Zoning Administrator, who assigns the Certificate of Occupancy to the building permit applicant upon completion of all GAR requirements.

HOW TO ACHIEVE COMPLIANCE

1. Determine the zoning district and required GAR score for the project.
2. Use the GAR Scoresheet (see Appendix B) to calculate the total area of landscape elements necessary to achieve that score. Chapter 5 describes a wide variety of acceptable landscape elements.
3. After developing a design that achieves the minimum required GAR score, submit the required GAR documentation as part of the building permit application.
4. Construct and maintain the project according to the approved plans.

REFERENCES

Keeley, Melissa, “The Green Area Ratio: an urban site sustainability metric,” Journal of Environmental Planning and Management, September 2011.

Nowak, David, “The Effects of Trees on Air Quality,” USDA Forest Service.

Chapter 2 When Regulations Apply

Effective October 1, 2013

NEW BUILDINGS

All new buildings that require a Certificate of Occupancy must meet the appropriate Green Area Ratio (GAR) based on the zoning district.

There is one exemption:

- The building is a municipal wastewater facility operated by the District of Columbia Water and Sewer Authority (DC Water).

EXISTING BUILDINGS

A new addition, interior renovation, or both to an existing building requires a GAR when the construction cost of these improvements exceeds 100%of the assessed value of the existing building within any 12-month period.

Addition includes the extension or increase in floor area or height of an existing building structure

Interior renovation includes the alteration, renovation, or repair to the interior of the existing structure.

Assessed value of the building is based on the value set forth in the records of the Office of Tax and Revenue as of the date of the building permit application.

Construction cost for an addition, alteration, or repair to an existing building is the amount indicated by the applicant in the building permit application (Contract Agreement Form).

There are two exemptions:

1. If the addition is an interior renovation of an existing building located in the Central Employment Area and all of the following criteria apply:
    - The building has an existing 100% lot occupancy prior to filing the building permit;
    - The building has an existing roof that cannot support a dead load of four inches of growth medium; and

- The work proposed by the building permit application will not result in a roof capable of supporting a dead load of four inches of growth medium.

2. The building is a **historic resource** and the "change of use" or "increase of intensity of use" does not result in an increase to the gross floor area by 50% or more.

Central Employment Area boundaries are identified in Appendix C.

Historic resource is a building or structure listed in the District of Columbia Inventory of Historic Sites or a building or structure certified in writing by the State Historic Preservation Officer as contributing to the character of the historic district in which it is located.

TRANSITION PERIOD EXEMPTIONS

The GAR regulation adopted provisions to grandfather projects that initiated key steps in the permitting process prior to the October 1, 2013, effective date.

The GAR will not apply to a building permit application for a new building, addition, or interior renovation to an existing building if the building permit plans are consistent with the following conditions:

a. Officially accepted by the Department of Consumer and Regulatory Affairs as being complete prior to October 1, 2013, if the building permit plans are consistent; or

b. Filed on or after October 1, 2013, if the building permit plans are consistent with:

   1. An unexpired approval of a first stage, second stage, or consolidated planned unit development, variance, special exception, design review under the Capitol Gateway (CG) or Southeast Federal Center (SEFC) overlay, or concept design by the Historic Preservation Review Board or Commission of Fine Arts; provided the vote to approve occurred prior to October 1, 2013;

   2. An unexpired approval of a variance, special exception, or design review under the CG or SEFC overlay granted on or after October 1, 2013, for which a public hearing was held prior thereto;

   3. An unexpired approval of a first stage, second stage, or consolidated planned unit development that was granted after October 1, 2013, but which was set down for a public hearing prior thereto;

   4. A Large Tract Review completed prior to July 1, 2012 subject to the following:

      (a) The application shall be filed no later than July 1, 2014;

      (b) The application shall be consistent with the conditions of the Large Tract Review;

      (c) The building shall achieve a GAR of no less than 0.1; and

      (d) This subparagraph shall expire on July 2, 2014.

TRANSITION PERIOD MODIFICATIONS

Transition period exemptions are subject to removal if a change or modification is made to a permit, project, or application for exempted properties in 11 DCMR §3401.3 or transition period exemptions in 11 DCMR §3401.4 that results in an increase in impervious surface or lot occupancy of 20% or more (11 DCMR §3401.5). In these cases, the full GAR requirement is applied to the portion of a project affected by the approved change or modification.

CAMPUS PLAN

A college or university applicant proposing a new building or addition to an existing building shall demonstrate the extent to which the building or addition meets the GAR standards. The Zoning Commission will determine if the proposal is compliant with the intent of the GAR regulations while processing approval for the construction under the campus plan.

ZONE DISTRICTS

A required level of GAR compliance is established by zones. Properties in zones listed in Table 1 are required to achieve the specified GAR. The required GAR standard is subject to change by the Zoning Commission and should always be confirmed by reviewing the zoning code regulations as posted on the DC Office of Zoning website.

Table 1 Green Area Ratio by Zone District

Zone District	Green Area Ratio
R-5-A and R-5-B	0.4
R-5-C, R-5-D and R-5-E C-1, C-2-A, C-2-B and C-2-C W-1, W-2, W-3 SP-1, SP-2	0.3
C-3-A, C-3-B	0.25
C-3-C, C-4, C-5, CR and any property within the DDD overlay	0.2
CM-1, CM-2, CM-3, and M • all structures except one story warehouses • one story warehouses	• 0.3 • 0.1

Zoning Definitions

The zoning definitions in Table 2 are reprinted from the Office of Zoning website and were last updated on April 1, 2013 (see http://dcoz.dc.gov/info/districts.shtm).

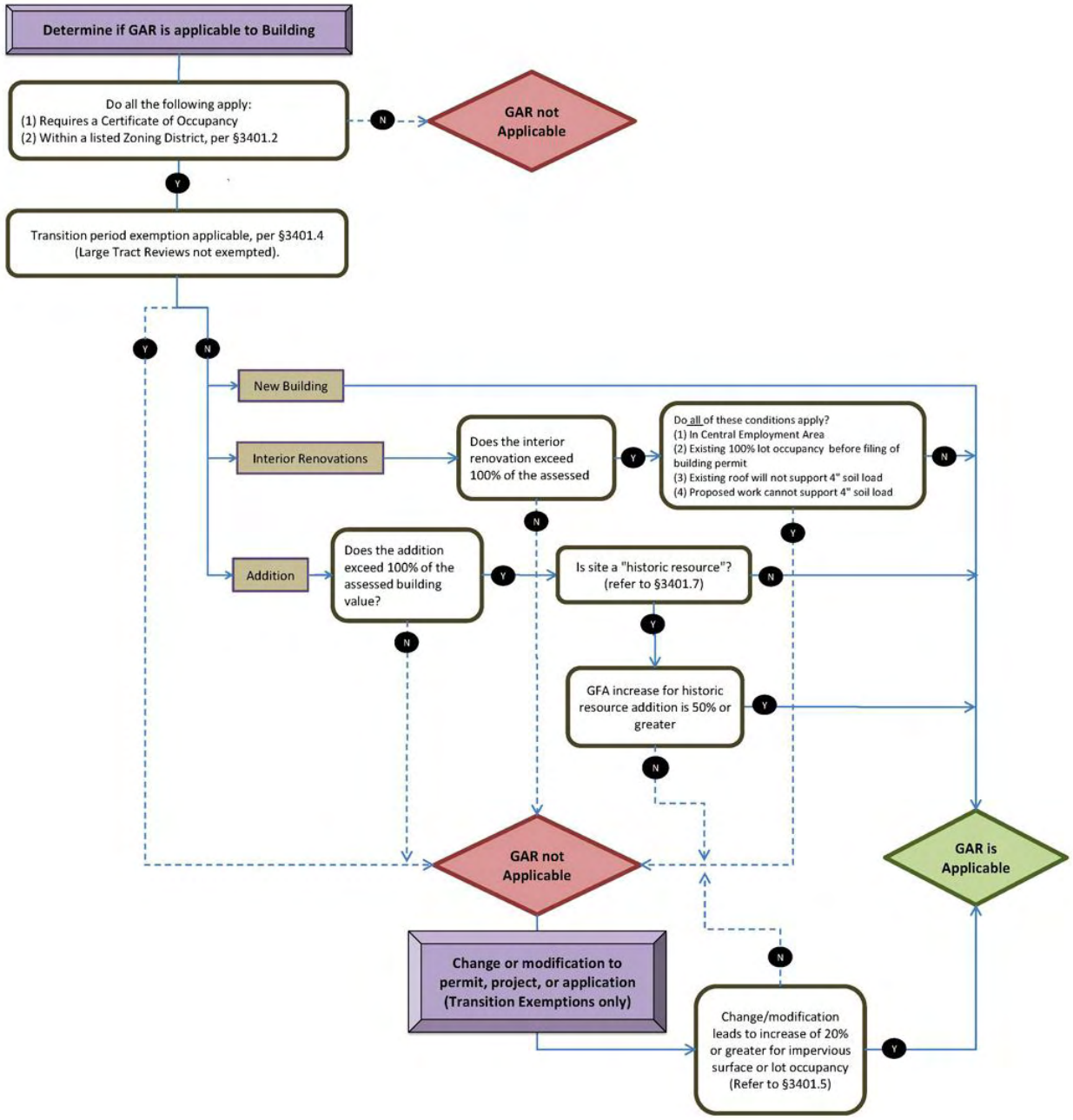
Table 2 Zoning Definitions

District	Summary
R-5-A	Permits matter-of-right development of single-family residential uses for detached and semi-detached dwellings and, with the approval of the Board of Zoning Adjustment, new residential development of low density residential uses including row houses, flats, and apartments to a maximum lot occupancy of 40%, 60% for churches and public schools, and 20% for public recreation and community centers; a maximum floor area ratio (FAR) of 0.9, and a maximum height of three (3) stories/forty (40) feet (90 feet for schools, 60 feet for churches, and 45 feet for public recreation and community centers). Rear yard requirements are twenty (20) feet. Side yard requirements are not less than eight (8) feet. If all other provisions of the zoning regulations are complied with, conversion of existing buildings to flat or apartment use is permitted as a matter-of-right.
R-5-B	Permits matter-of-right moderate development of general residential uses, including single-family dwellings, flats, and apartment buildings, to a maximum lot occupancy of 60% (20% for public recreation and community centers), a maximum FAR of 1.8, and a maximum height of fifty (50) feet (90 feet for schools and 45 feet for public recreation and community centers). Rear yard requirements are not less than fifteen (15) feet.
R-5-C	Permits matter-of-right medium density development of general residential uses, including single-family dwellings, flats, and apartment buildings, to a maximum lot occupancy of 75% (20% for public recreation and community centers), a maximum FAR of 3.0 and a maximum height of sixty (60) feet (90 feet for schools and 45 feet for public recreation and community centers). Rear yard requirements are not less than fifteen (15) feet.
R-5-D	Permits matter-of-right medium/high density development of general residential uses, including single-family dwellings, flats, and apartment buildings, to a maximum lot occupancy of 75% (20% for public recreation and community centers), a maximum FAR of 3.5 and a maximum height of ninety (90) feet (45 feet for public recreation and community centers). Rear yard requirements are not less than fifteen (15) feet.
R-5-E	Permits matter-of-right high density development of general residential uses, including single-family dwellings, flats, and apartment buildings, to a maximum lot occupancy of 75% (20% for public recreation and community centers), a maximum FAR of 6.0 for apartment houses and hotels, and 5.0 for other structures, and a maximum height of ninety (90) feet (45 feet for public recreation and community centers). Rear yard requirements are not less than twelve (12) feet.
C-1	Permits matter-of-right neighborhood retail and personal service establishments and certain youth residential care homes and community residence facilities to a maximum lot occupancy of 60% for residential use and 100% for all other uses, a maximum FAR of 1.0, and a maximum height of three (3) stories/forty (40) feet. Rear yard requirements are twenty (20) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.

District	Summary
C-2-A	Permits matter-of-right low density development, including office employment centers, shopping centers, medium-bulk mixed use centers, and housing to a maximum lot occupancy of 60% for residential use and 100% for all other uses, a maximum FAR of 2.5 for residential use and 1.5 FAR for other permitted uses, and a maximum height of fifty (50) feet. Rear yard requirements are fifteen (15) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-2-B	Permits matter-of-right medium density development, including office, retail, housing, and mixed uses to a maximum lot occupancy of 80% for residential use and 100% for all other uses, a maximum FAR of 3.5 for residential use and 1.5 FAR for other permitted uses, and a maximum height of sixty-five (65) feet. Rear yard requirements are fifteen (15) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-2-C	Permits matter-of-right higher density development, including office, retail, housing, and mixed uses to a maximum lot occupancy of 80% for residential use and 100% for all other uses, a maximum FAR of 6.0 for residential and 2.0 FAR for other permitted uses, and a maximum height of ninety (90) feet. Rear yard requirements are fifteen (15) feet; one family detached dwellings one family semi-detached dwellings side yard requirements are eight (8) feet.
SP-1	Permits matter-of-right medium density development including all kinds of residential uses, and limited offices for non-profit organizations, trade associations and professionals if approved as a special exception by the Board of Zoning Adjustment. Maximum lot occupancy is 80% for residential use except a hotel, 20% for public recreation and community centers and 40% with special exception approval from the BZA. Maximum FAR is 4.0 for residential and 2.5 for other permitted uses, and a maximum height of sixty-five (65) feet. Rear yard requirements are not less than twelve (12) feet, one-family detached dwellings and one-family semi-detached dwellings side yard requirements are eight (8) feet.
SP-2	Permits matter-of-right medium/high density development including all kinds of residential uses, and limited offices for non-profit organizations, trade associations and professionals if approved as a special exception by the Board of Zoning Adjustment. Maximum lot occupancy of 80% for residential use except a hotel, 20% for public recreation and community centers and 40% with special exception approved from the BZA. Maximum FAR is 6.0 for residential and 3.5 for other permitted uses, and a maximum height of ninety (90) feet. Rear yard requirements are not less than twelve (12) feet, one-family detached dwellings and one-family semi-detached dwellings side yard requirements are eight (8) feet.
W-1	Permits matter-of-right low density residential, commercial, and certain light industrial development in waterfront areas to a maximum lot occupancy of 80% for residential use, a maximum FAR of 2.5 for residential and 1.0 for other permitted uses and a maximum height of forty-five (45) feet. Rear yard requirements are not less than twelve (12) feet.

District	Summary
W-2	Permits matter-of-right medium density residential, commercial, and certain light industrial development in waterfront areas to a maximum lot occupancy of 75% for residential use and public recreation and community centers, a maximum FAR of 4.0 for residential and 2.0 for other permitted uses and a maximum height of sixty (60) feet. Rear yard requirements are not less than twelve (12) feet.
W-3	Permits matter-of-right high density residential, commercial, and certain light industrial development in waterfront areas to a maximum lot occupancy of 75% for residential use and public recreation and community centers, a maximum FAR of 6.0 for residential and 5.0 for other permitted uses and a maximum height of ninety (90) feet. Rear yard requirements are not less than twelve (12) feet.
C-3-A	Permits matter-of-right medium density development, with a density incentive for residential development within a general pattern of mixed-use development to a maximum lot occupancy of 75% for residential use and 100% for all other uses, a maximum FAR of 4.0 for residential and 2.5 FAR for other permitted uses and a maximum height of sixty-five (65) feet. Rear yard requirements are twelve (12) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-3-B	Permits matter-of-right medium density development, including office-retail, housing, and mixed uses. It is intended for uptown locations, where the largest component of development will be office-retail and other nonresidential uses to a maximum lot occupancy of 100%, a maximum FAR of 5.0 for residential and 4.0 FAR for other permitted uses, and a maximum height of six (6) stories/seventy (70) feet. Rear yard requirements are twelve (12) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-3-C	Permits matter-of-right development for major business and employment centers of medium/high density development, including office, retail, housing, and mixed uses to a maximum lot occupancy of 100%, a maximum FAR of 6.5 for residential and for other permitted uses, and a maximum height of ninety (90) feet. Rear yard requirements are twelve (12) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-4	The downtown core comprising the retail and office centers for the District of Columbia and the metropolitan area, and allows office, retail, housing and mixed uses to a maximum lot occupancy of 100%, a maximum FAR of 8.5 (or 10.0 if permitted height is in excess of one hundred ten (110) feet), a maximum height of 110 feet and 130 on 110-foot adjoining streets. (Maximum height and FAR depend on width of adjoining streets.) Rear yard requirements are not less than twelve (12) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.
C-5	Pennsylvania Avenue Development (PAD) permits retail and office, housing and mixed development in the area on the north side of Pennsylvania Avenue, NW between Tenth Street and 15th Street, NW to a maximum lot occupancy of 100%, a maximum FAR of 10.0 to 12.0, and a maximum height of 130 to 160 feet. (Maximum height and FAR depend upon approval of bonus incentives.) Rear yard requirements are not less than twelve (12) feet; one family detached dwellings and one family semi-detached dwellings side yard requirements are eight (8) feet.

District	Summary
CR	Permits matter-of-right residential, commercial, recreational and light industrial development to a maximum lot occupancy of 75% for residential use, 20% for public recreation and community center use (up to 40% with Board of Zoning Adjustment approval), and 100% for all other structures, a maximum FAR of 6.0 for all buildings and structures, of which not more than three (3.0) may be used for other than residential purposes, a maximum height of ninety (90) feet for all buildings and structures and forty-five (45) feet for public recreation and community centers. An area equivalent to 10% of the total lot area shall be required at ground level for all new development, and rear yards shall be provided for each residential building or structure.
CM-1	Permits development of low bulk commercial and light manufacturing uses to a maximum FAR of 3.0, and a maximum height of three (3) stories/forty (40) feet with standards of external effects and new residential prohibited. A rear yard of not less than twelve (12) feet shall be provided for each structure located in an Industrial District. No side yard shall be required on a lot in an Industrial District, except where a side lot line of the lot abuts a Residence District. Such side yard shall be no less than eight (8) feet
CM-2	Permits development of medium bulk commercial and light manufacturing uses to a maximum FAR of 4.0, and a maximum height of sixty (60) feet with standards of external effects and new residential prohibited. A rear yard of not less than twelve (12) feet shall be provided for each structure located in an Industrial District. No side yard shall be required on a lot in an Industrial District, except where a side lot line of the lot abuts a Residence District. Such side yard shall be no less than eight (8) feet.
CM-3	Permits development of high bulk commercial and light manufacturing uses to a maximum FAR of 6.0, and a maximum height of ninety (90) feet with standards of external effects and new residential prohibited. A rear yard of not less than twelve (12) feet shall be provided for each structure located in an Industrial District. No side yard shall be required on a lot in an Industrial District, except where a side lot line of the lot abuts a Residence District. Such side yard shall be no less than eight (8) feet.
M	Permits general industrial uses to a maximum FAR of 6.0 and a maximum height of ninety (90) feet with standards of external effects and new residential prohibited. A rear yard of not less than twelve (12) feet shall be provided for each structure located in an Industrial District. No side yard shall be required on a lot in an Industrial District, except where a side lot line of the lot abuts a Residence District. Such side yard shall be no less than eight (8) feet.



Decision Tree of GAR Triggers

Chapter 3 Calculating the Green Area Ratio Score

DESIGN CONSIDERATIONS

Once you have determined the site's zoning district and minimum required Green Area Ratio (GAR) score (see Table 1), you will need to design a plan of approved landscape elements that achieve that score. Table 3 indicates approved landscape elements and their multipliers.

Chapter 5 discusses each landscape element in detail. There are instructions for calculating square footages, which vary for each type of landscape element. And the "Integration" sections include charts that show which landscape elements can be layered in the same area of the site to increase the total GAR score. The end of Chapter 3 provides more information about maximizing GAR score.

In addition to the usual concerns for construction projects, it is also important to consider other regulations and standards that may impact GAR design, including the District Department of the Environment's (DDOE's) 2013 Rule on Stormwater Management and Soil Erosion and Sediment Control (21 DCMR Chapter 5), DDOE's 2013 Stormwater Management Guidebook, the District the District Department of Transportation's Low Impact Development Standards, and the District of Columbia's LEED certification criteria.

CALCULATING A PROJECT'S GAR SCORE

The following are the key steps to calculate a project's GAR score:

1. Determine the total lot area.
2. Calculate the area of each proposed landscape element. For certain types of plantings, identify the number of individual plants.
3. Multiply the area of each landscape element by its assigned multiplier to provide a weighted square footage.
4. Add the weighted square footages of all landscape elements.
5. Divide the sum by the total lot area of the site to provide the project's GAR score.
6. If needed, redesign the landscape elements to achieve the required GAR score.

GAR SCORESHEET

The GAR Scoresheet tool (see Appendix B) is a calculator that simplifies the process to calculate the project's GAR score. The formulas and multipliers are built in. The user simply enters the

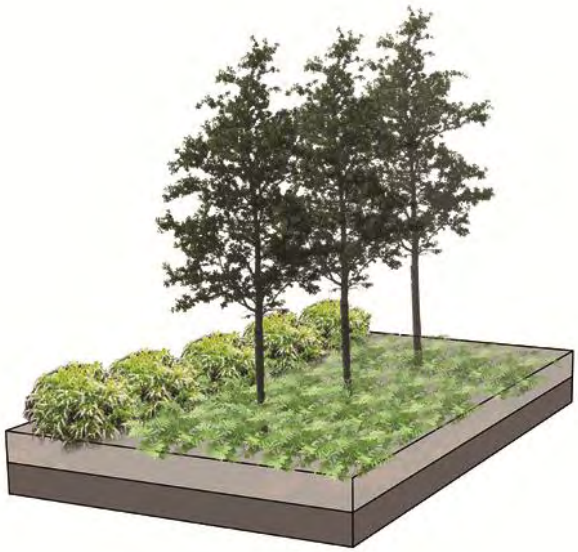
total lot area, the area of each landscape element (in square feet), and the numbers of individual plants (if applicable). The GAR Scoresheet is especially helpful for testing a variety of design options. The completed GAR Scoresheet must be submitted as part of the GAR plan.

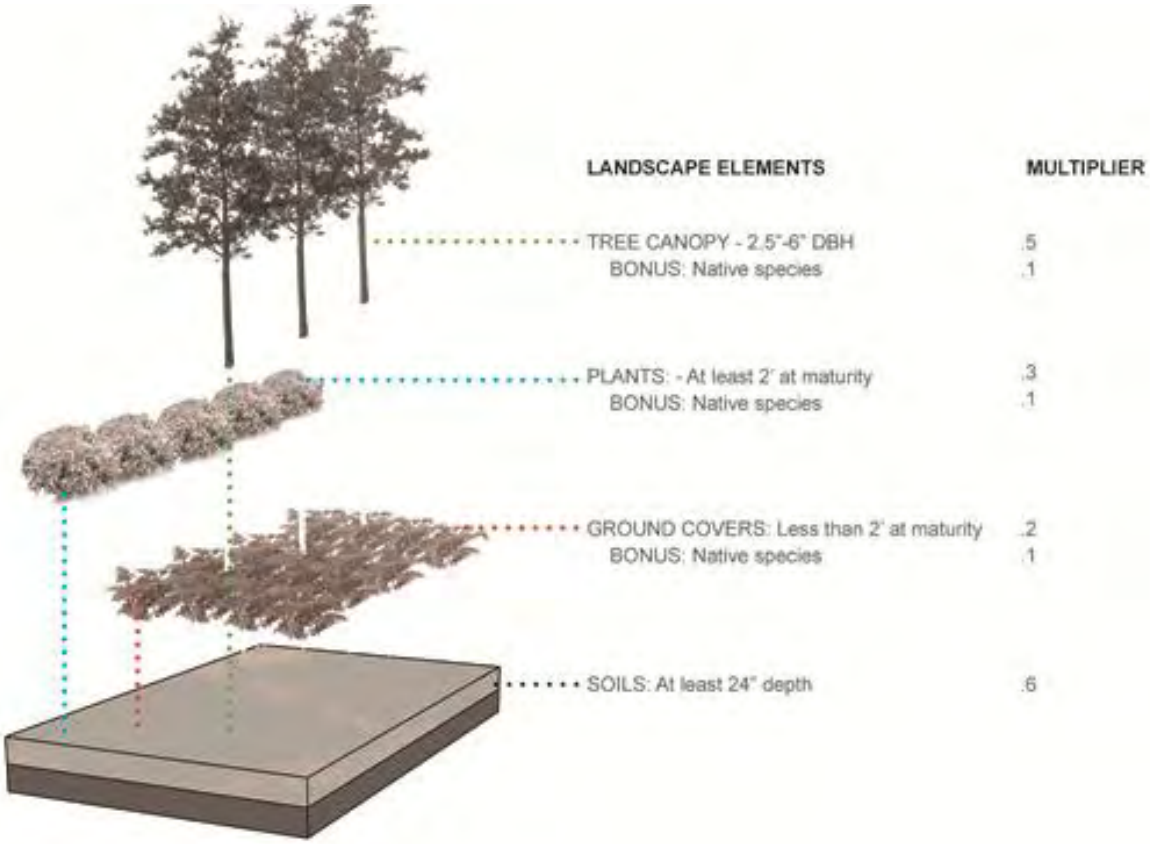
The GAR Scoresheet is available online at ddoe.dc.gov/GAR.

Table 3 Landscape Element Multipliers

GAR Landscape Elements	Multiplier
Landscaped areas with a soil depth of less than 24 inches	0.3
Landscaped areas with a soil depth of 24 inches or more	0.6
Bioretention facilities	0.4
Ground covers, or other plants less than 2 feet tall at maturity	0.2
Plants, not including grasses, at least 2 feet tall at maturity	0.3
Tree canopy for all trees, 2.5 inches to 6 inches in diameter	0.5
Tree canopy for new trees 6 inches in diameter or larger	0.6
Tree canopy for preservation of existing trees 6 inches to 24 inches in diameter	0.7
Tree canopy for preservation of existing trees 24 inches diameter or larger	0.8
Vegetated walls, plantings on a vertical element	0.6
Extensive vegetated roof over at least 2 inches but less than 8 inches of growth medium	0.6
Intensive vegetated roof over at least 8 inches of growth medium	0.8
Permeable paving over at least 6 inches and less than 2 feet of soil or gravel	0.4
Permeable paving over at least 2 feet of soil or gravel	0.5
Enhanced tree growth systems	0.4
Renewable energy generation (area of)	0.5
Water features (using at least 50% recycled water)	0.2
Bonuses	
Native plant species listed in §3403.9	0.1
Landscaping in food cultivation	0.1
Harvested stormwater irrigation	0.1

MAXIMIZING GAR SCORE



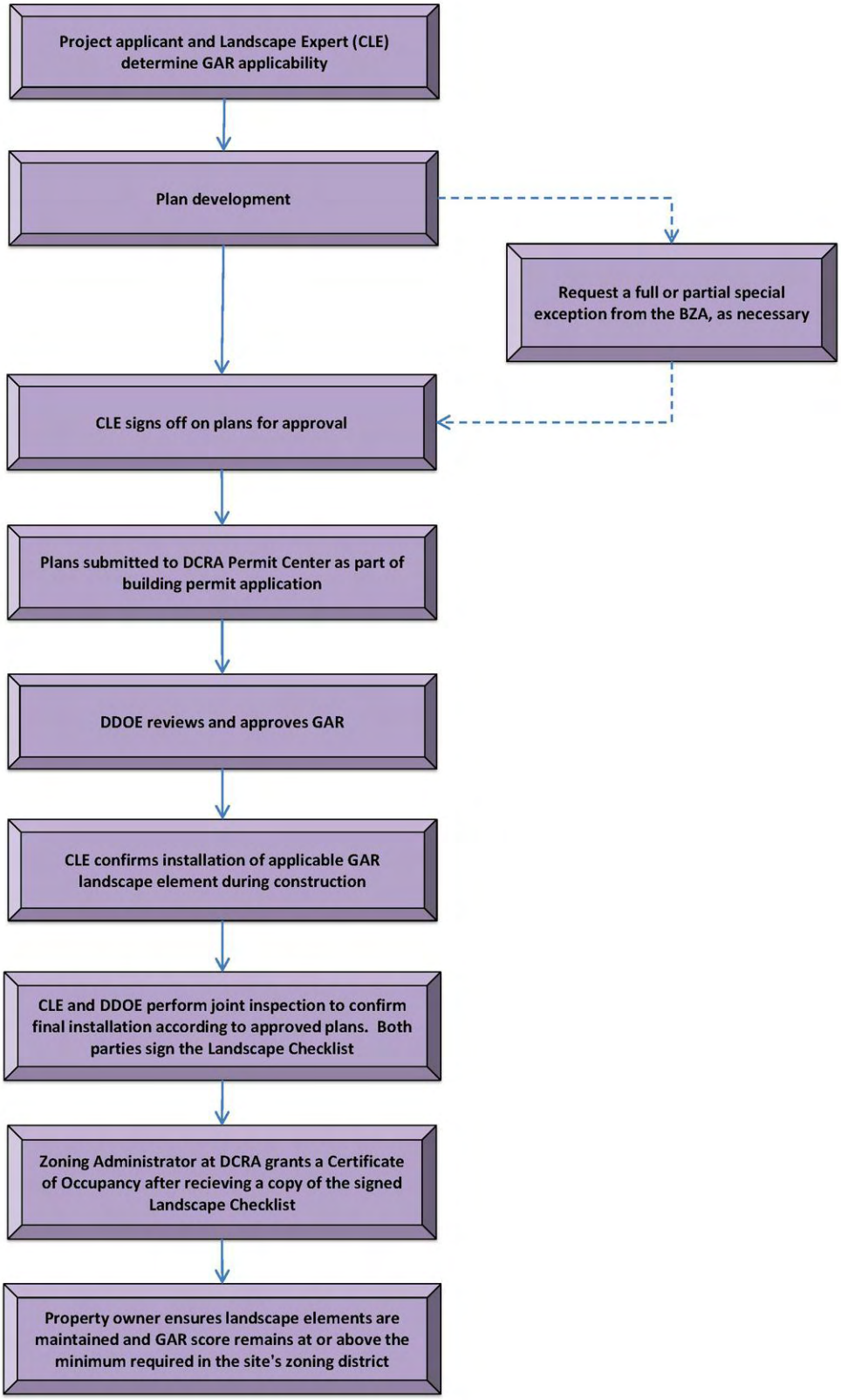


Example of Layering Landscape Elements

Chapter 4 Administration - Plan Development, Construction, and Maintenance

OVERVIEW

The Green Area Ratio (GAR) is a zoning regulation administered by the Department of Consumer and Regulatory Affairs (DCRA), District Department of the Environment (DDOE), and District of Columbia Office of Zoning. Plans are submitted to DCRA for zoning approval. If the GAR applies, DDOE reviews and approves GAR plans as part of the building permit application. The applicant's Certified Landscape Expert signs off on GAR plans and confirms appropriate installation or preservation of landscape elements during construction. After construction, the DDOE inspector and the Certified Landscape Expert jointly review the installation for conformance with the approved plans. After DDOE sign off, the Zoning Administrator can then grant the Certificate of Occupancy.



Green Area Ratio Administrative Process

Certified Landscape Expert
The project applicant shall secure a Certified Landscape Expert (Landscape Expert) for plan submittal and verification of installation to confirm GAR compliance. The Landscape Expert who signs the GAR plans may be different from the individual who signs the Landscape Checklist. The applicant should select a Landscape Expert with expertise and specialization appropriate to the type(s) of landscape elements used in the project.

The Landscape Expert is defined as any of the following:

- Maryland or Virginia Licensed Landscape Architect
- International Society of Arboriculture (ISA) Certified Arborist
- Maryland Professional Horticulturist
- Landscape Contractors Association, DC-MD-VA Landscape Industry Certified Technician

The Landscape Expert must do the following:

- Sign off on submitted GAR plans to indicate that they conform to the GAR regulations and GAR Guidebook
- Confirm that the landscape elements are installed according to the approved plan and then sign off on the Landscape Checklist
- Prepare and sign a landscape maintenance plan for the property owner

PLAN SUBMITTAL AND REVIEW

Sites that Qualify for a Reduced GAR Score
The applicant may request a special exception from the Board of Zoning Adjustment (BZA) if the application meets sustainability goals through means outside the scope of the GAR. The BZA may then choose to grant a full or partial reduction in GAR score requirements. If granted, the applicant will be issued a BZA Order stating the reduced GAR requirements. The BZA Order and a certified copy of the Exhibits (plans submitted to the BZA for their review) must be provided with the building permit application.

Submittal Requirements
GAR plan review is part of the building permit application process managed by DCRA. Building permit applications may be submitted in person at DCRA headquarters (1100 4th Street SW, 2nd Floor) or through the DCRA online intake form available at http://cpms.dcra.dc.gov/OCPI/PermitMenu.aspx. All project plans must have the signature of the Certified Landscape Expert to certify that the GAR landscape plan meets or exceeds the project's required minimum GAR score.

When the GAR applies to a project, GAR plans are submitted to DCRA in the building permit application as separate drawings from the stormwater management plans. Prepare and include two sets of signed GAR plans if submitting by paper.

GAR plan submittals must have the following elements to be considered for review and approval:

General Requirements

- GAR Scoresheet within the plan drawings (see Appendix A)
- GAR Worksheet, if plans are more than one page (see Appendix A)
- GAR elements called out by category and area
- Lot dimension and size
- Location and area of all landscape elements with associated dimensions
- Other drawings, including details, that enable interpretation of GAR plan documents
- Schematic irrigation and drainage plan for rooftop and container landscaping or areas requiring harvested rainwater irrigation
- Signed landscape maintenance plan within the submitted drawings or as separate document with notation in the plans that the landscape maintenance plan is a separate document within the submittal
- Landscape Expert's signature, printed name, name of certifying organization, and certification number. On this same page, identify all sheet numbers included in the GAR submittal package.

New and Existing Plantings

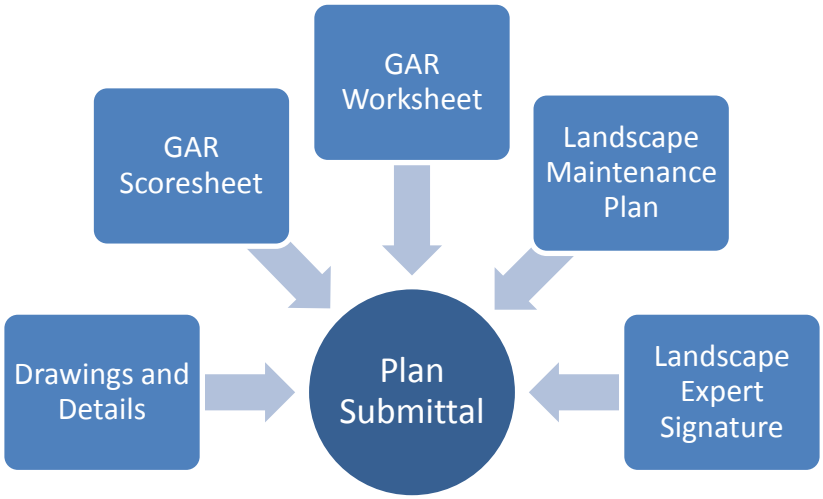
- Location, installed size, and species of all plants used to meet GAR requirements
- Common and botanical names of all plant materials

Existing Trees

- Location, trunk diameter at breast height, estimated canopy radius, and species of each preserved tree
- Tree preservation plans for the demolition and construction phases
- Location and dimensions of all measures used to protect landscape areas from vehicular traffic
- Location and size of all tree removals

Soils

- Soil and amendment specifications



Plan Review
Where sites require GAR documents but are exempt from stormwater plan submission, DDOE staff at DCRA will complete the GAR plan review. GAR plans for sites that additionally trigger stormwater plan development are forwarded to and reviewed by Watershed Protection Division Technical Services staff at DDOE headquarters.

Within 10 to 30 working days of the submission date of an accepted plan, DDOE will review and make a determination to approve or disapprove the GAR plans. If disapproved, DDOE will provide the reason for the denial in writing. Once the GAR plans are approved, a final submission package is required, including one Mylar and four paper copies of the GAR plan set signed by the Landscape Expert.

Revisions to Approved Plans
Revisions to an approved plan usually require supplemental review and reapproval by DDOE. Submit revised plans to DCRA for routing to DDOE.

<u>Supplemental review is required for any of the following changes to an approved GAR plan:</u>

- Reducing the number of trees, shrubs, or groundcovers
- Changing the location of required plantings or landscape elements
- Substituting species that results in a lesser GAR square footage, different installed canopy size, height, caliper, or different rootball/container size than the approved species
- Revising any features that could decrease the planting area or lower the GAR score

Fees
Prior to DDOE plan review, the applicant will pay an initial fee that includes an initial review and first resubmission. The applicant will pay a supplemental review fee for each review beyond the

first resubmission. Final fees are paid once DDOE approves the GAR plan and prior to the building permit being issued, as shown in Table 4 (also see 21 DCMR Chapter 5).

Table 4 Fees for Review of Green Area Ratio Plan (Source: 21 DCMR §501.10)

Payment Type	Payment Requirement	Fees by Land Disturbance Type	
		≤10,000 ft^2	≥10,000 ft^2
Initial	Due upon filing for building permit	$575.00	$850.00
Final	Due before building permit is issued	$125.00	$200.00
Supplemental	For reviews after first resubmission	$500.00	

CONSTRUCTION INSPECTION

The Landscape Expert must confirm that all GAR landscape elements are properly installed according to the approved GAR plan. Once the landscape elements are installed and fully established, the applicant must contacts the DDOE Watershed Protection Division, Inspection and Enforcement Branch to schedule an inspection. Please provide the Inspector at least 48 hours advanced notice before the anticipated inspection date. During the inspection, the Landscape Expert and DDOE inspector review the plans and site for compliance, and both parties sign the Landscape Checklist (Appendix A) upon confirming that the site is built according to the approved building permit. Chapter 5 describes the Landscape Expert's responsibilities for each landscape element.

Certificate of Occupancy
The Zoning Administrator may approve a Certificate of Occupancy application upon receiving the signed Landscape Checklist from the applicant. The Office of Zoning Administrator relies upon DDOE to confirm sites have met their GAR requirements.

To schedule a GAR inspection, contact the DDOE Watershed Protection Division, Inspection and Enforcement Branch at 202-535-2977.

Temporary Certificate of Occupancy
The applicant may request a temporary Certificate of Occupancy from the Zoning Administrator if installation of landscape elements is prevented due to:

- Weather
- Season
- Site construction

The temporary Certificate of Occupancy is valid for four months and is granted with the condition that the landscaping be installed prior to its expiration. The temporary Certificate of

Occupancy may be granted only twice, each for a four-month period, based on the conditions of 11 DCMR §3404.9.

MAINTENANCE OBLIGATION

A property owner is required to maintain the GAR score through appropriate stewardship and maintenance of landscape elements after the property is granted its Certificate of Occupancy. When the GAR score falls below the minimum required, a property owner may choose to meet that requirement with an equivalent but different landscape element of their choosing. After the Certificate of Occupancy has been granted by the Office of Zoning Administrator, property owners are not required to resubmit GAR plans to DCRA for reapproval.

Prior to signing the Landscape Checklist, the Certified Landscape Expert provides the landscape maintenance plan to the property owner. The landscape maintenance plan serves as guidance toward continued upkeep of the approved landscape elements. Regardless of subsequent property ownership and possession of the landscape maintenance plan, owners and their designated agents are required to ensure that GAR landscape elements are properly maintained and the minimum GAR score is upheld. See Chapter 5, “Landscape Maintenance Plan” for additional guidance.

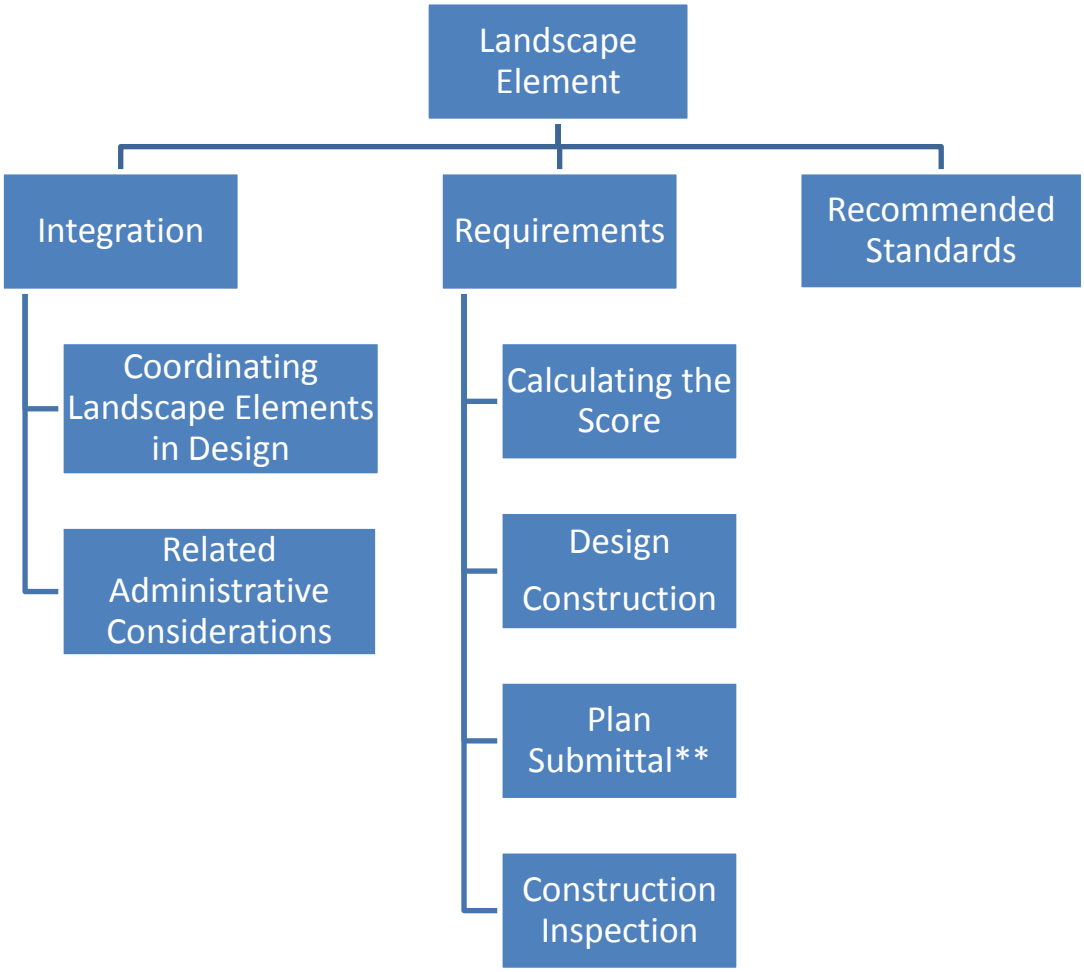
Note: Properties in the Anacostia Watershed Development Zone with a stormwater management obligation must also prepare an integrated pest management plan. Refer to Appendix R of the 2013 DDOE Stormwater Management Plan for additional guidance.

Chapter 5 Landscape Elements

OVERVIEW

This chapter describes the 13 approved categories of Green Area Ratio landscape elements: soils and amendments, bioretention, new and existing plantings, tree preservation, vegetated walls, vegetated roofs, permeable paving, enhanced tree soil systems, renewable energy, water features, native plants, food cultivation, and harvested stormwater irrigation. Several categories include multiple options.

For each landscape element, the following factors are discussed:



** Refer to Chapter 4, "Submittal Requirements" (pages 19–20) for general submittal requirements.

ENVIRONMENTAL BENEFITS OF LANDSCAPE ELEMENTS

The GAR is intended to increase the use of landscaping and renewable energy practices in urban development in the District of Columbia. These types of sustainable development yield many environmental and public health benefits:

- Stormwater management and retention
- Nutrient cycling
- Carbon sequestration
- Erosion control
- Heat island reduction
- Evaporative cooling
- Improved building energy efficiency
- Improved air quality
- Noise reduction
- Urban agriculture
- Habitat creation and increased biodiversity
- Pollutant sequestration

5.1 Soils and Amendments

Landscaped areas with topsoil receive points toward a site's total Green Area Ratio (GAR) score. To be eligible, existing topsoil must be protected during construction or amended with compost if it has been disturbed. Imported topsoil also qualifies if it meets standards indicating that it is capable of supporting plant growth.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Soils & Amendments													

REQUIREMENTS

CALCULATING THE SCORE

Measure the surface area and depth of uncompacted topsoil. Soil depth determines the GAR multiplier as noted in the following chart.

GAR Landscape Elements	Multiplier
Landscaped areas with a soil depth of less than 24 inches	0.3
Landscaped areas with a soil depth of 24 inches or more	0.6

DESIGN AND CONSTRUCTION

The soil improvement specification shall identify soil texture, organic matter percentage (by weight), pH, and soil installation or amendment incorporation practices. It applies to both existing and imported soil. Existing topsoil must have healthy vegetated cover, be protected during construction, and remain uncompacted. Soils marked for preservation that have been disturbed must be amended with compost to receive credit. Imported topsoil must meet minimum standards identified in the specifications.

Coordinate soil plans with the Erosion and Sediment Control regulations (21 DCMR Chapter 5) and, where applicable, the DDOE 2013 Stormwater Management Guidebook, Appendix N "Land Cover Designations" and Appendix J "Soil Compost Amendment Requirements."

The following are design guidelines for protecting, amending, or importing topsoil.

Protecting Existing Topsoil throughout Construction
Specify fencing or other measures used to protect topsoil from compaction, construction debris, and contamination during the construction process. Protected topsoil must have existing healthy vegetation and remain uncompacted. These soils are credited with a soil depth of greater than 24 inches.

Amending Existing Disturbed Topsoil
Alternatively, topsoil may be stripped, stored, and spread to avoid compaction and contamination. Stockpiled topsoil must be amended with compost when respread unless it meets minimum organic matter content. Protected soils that have been disturbed, or their vegetation removed, must be amended with compost.

A soil scientist can identify the deficiency of organic matter in existing soil and specify the required rate to meet the specific landscape use (e.g. lawn areas, planting beds). This approach is especially useful for larger sites. Where soil has been disturbed, provide a minimum of 5% organic matter (by weight) to a 12-inch or greater soil depth. See the recommended specifications below for a default compost application rate.

Importing New Topsoil
Topsoil recommendations are listed below. Alternative specifications, such as that administered by DDOT may be substituted with permission from DDOE. Topsoil for stormwater BMPs shall comply with the DDOE 2013 Stormwater Management Guidebook.

PLAN SUBMITTAL
In addition to complying with the design standards, submitted GAR plans shall include the following:

- Soil depth and area, with dimensions specified on plan
- Specify soil protection measures on plan for existing soils if claiming credit. Also specify location and species of existing vegetation on preserved soils.
- Provide a soil improvement specification for amending and installing existing disturbed soils or imported topsoil. Specifications should include the following parameters:
    - Texture class and particle size (for imported topsoil only)
    - Percentage organic matter
    - pH
    - Installation guidelines including: subgrade preparation, soil handling and storage, and installation procedures
    - Amendment incorporation method and rate for: compost, limestone, or acidulants

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for confirming the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Area and depth of topsoil are installed per plan, with soils decompacted to depth.
- Topsoil conforms to soil improvement specifications.
- Subgrade is scarified and decompacted. Also debris and contaminants are removed prior to installation of topsoil.
- Topsoil is permanently stabilized with vegetative cover or mulch.

Excavate test pits to indicate amendment incorporation. A rod penetrometer should be used to establish the depth of uncompacted soil (< 260 psi) at a minimum of one location per 10,000 square feet.

Soil depth (source: Univ. of Mich.)

Soil penetrometer (source: Cornell University)

RECOMMENDED STANDARDS

These are general guidelines and may be modified based on site conditions and the requirements of each landscape type if the applicant provides appropriate justification. Specifications administered by other agencies may be substituted as authorized by DDOE.

Bioretention facilities, vegetated roofs, and enhanced tree growth systems typically require soil media with specifications designed with special consideration for infiltration, weight, or load-bearing capacity.

In the design phase, send samples of existing soil to a reputable agronomic soil testing laboratory to test a full range of soil quality parameters. For imported topsoil, perform testing prior to delivery and again prior to planting.

Soil Depth and Volume
Soil depth is measured by the depth of uncompacted topsoil. Topsoil shall be placed over material of suitable drainage that is clear of contaminants and debris. Recommended topsoil depth varies by plant type:

- Turfgrass, 6–12 inches
- Perennials, groundcover, and ornamental grasses, 12–18 inches
- Shrubs, 18–24 inches
- Trees, 24–36 inches

Trees in containers require irrigation to account for limited soil volumes and canopy intercept of precipitation. Under ideal circumstances, ground surface soil volumes for canopy trees (35-foot mature canopy) will provide at least 1,500 cubic feet for individual specimens and 1,000 cubic feet per tree in shared soil pits; this standard is compatible with the DDOE 2013 Stormwater Management Guidebook and may allow trees to be credited for stormwater retention value.

SOIL IMPROVEMENT SPECIFICATION (TOPSOIL)

Table 5 Topsoil Physical and Chemical Parameters

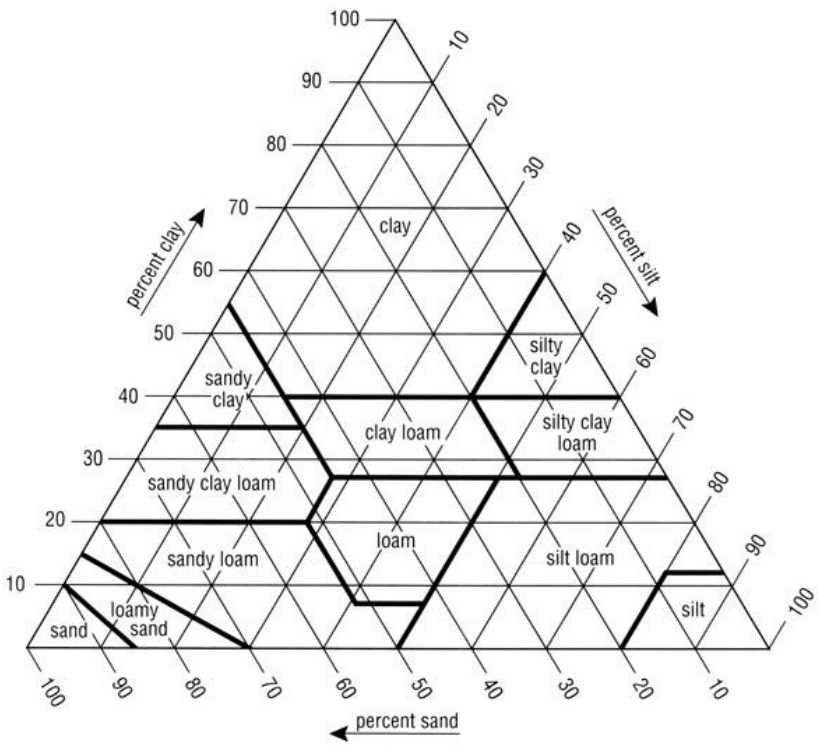
Topsoil characteristic	Test Method	Required Standard
Texture class		Loam, silt loam, sandy clay loam, sandy loam, clay loam
% Sand (0.05 mm–2.00 mm)	Hydrometer	< 70%
% Silt (0.002 mm–0.05 mm)	Hydrometer	< 70%
% Clay (< 0.002 mm)	Hydrometer	< 30%
% Organic matter (by weight)	Loss of Ignition	Lawn areas (4%–6%), Planting beds (5–7%)
pH		6.0–7.2, specific plantings may require alternate values
Macronutrients & micronutrients		Determined by professional soil scientist

Soil Source
The topsoil and subgrade may be from a naturally occurring soil or soil that has been mixed to achieve the requirements of the plant selections.

Debris Content
Particles and stone greater than 1 inch in the longest dimension should not be allowed. This includes fragments of brick, concrete, wood, glass, metal, stone, and plastic. The total volume less than 1 inch long should not be more than 5% of the soil volume. Stones ranging from 0.5 to 1 inch (1.25 to 2.5 cm) should not exceed 5% of the soil volume, and gravel ¼ to ½ inches (0.6 to 1.25 cm) should not exceed 5% of the soil volume.

Contaminants Prohibited
The soil shall have no herbicides, heavy metals, biological toxins, or hydrocarbons that will impact plant growth.

Texture
Topsoil texture can be variable and include: loam, silt loam, sandy clay loam, sandy loam, clay loam. The percent composition must fall within this range: sand (< 70 %), silt (< 70%), and clay (<30%). Particle size is determined according to USDA Classification: sand (< 0.002mm), silt 0.002mm–0.05 mm, sand (0.05 mm–2 mm).



Soil texture triange (source: USDA NRCS)

Organic Matter
Organic matter should be a minimum of 4% in lawn soils and 5% in planting beds. Percentage organic matter is measured by weight. Incorporate compost to raise organic matter content.

Soil pH
Soil pH determines the availability of nutrients in the soil. The exact pH range is dependent on the plant species to be planted and should be tested and adjusted based on species prior to installation. The ideal pH for most landscape plants falls in the range of 6.0–7.0, however other plants prefer a pH outside this range. A pH of 6.5–7.2 is beneficial to microbial activity that converts nitrogen, phosphorous, and sulfur into forms most available to plants.

Nutrient Recommendations
Have a soil scientist provide recommendations for macronutrients and micronutrients.

Subgrade Preparation
Using a backhoe or similar device, scarify and loosen the subgrade. Remove from the area all debris or stones that are one inch or greater.

Percolation
After preparing the subgrade, conduct a percolation test. Water should readily drain from the soil. Percolation rates of 1–2 inches per hour are preferred if irrigation will be installed. A drainage system should be installed if the native subsoil has a drainage rate less than 1 inch per hour.

Handling, Storage, and Spreading Topsoil
Material shall not be handled or hauled when it is wet, as after a heavy rainfall or if frozen. Soil shall be handled only when the moisture content is less than at field capacity. The Landscape Expert or a professional soil scientist shall be consulted to determine if the soil is too wet to handle. Stockpiles shall be covered during wet weather.

Spread topsoil in no greater than 12-inch lifts, using the lightest possible equipment. Compact the topsoil to the proper soil density so that it is suitable for root growth and plant stability.

Soil Density and Compaction
Soil density must be high enough to avoid settlement and low enough to encourage root growth. Using a rod penetrometer, soil and subsoil shall be less than 260 pounds per square inch (psi) throughout the depth of credited soil. Compaction completely inhibits root growth at 300 psi. A rod cone penetrometer should be used to measure compaction when soil moisture is at field capacity, after the soil is wetted but drained. The penetrometer shall be inserted at a rate of 72 inches per minute (1.2 inches/second), according to ASAE Soil Testing Specifications.

<u>SOIL IMPROVEMENT SPECIFICATION (AMENDMENTS)</u>

Compost
Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

Alternative specifications and/or certifications, such as those administered by the Maryland Department of Agriculture or other agencies, may be substituted, as authorized by DDOE. In all cases, compost material must meet standards for chemical contamination and pathogen limits pertaining to source materials, as well as reasonable limits on phosphorus and nitrogen content to avoid excessive leaching of nutrients.

The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council Seal of Testing Assurance Compost Technical Data Sheet provided by the vendor:

a. 100% of the material must pass through a 1/2-inch screen
b. The pH of the material shall be between 6 and 8
c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
d. The organic matter content shall be between 35% and 65%
e. Soluble salt content shall be less than 6.0 mmhos/cm
f. Maturity must be greater than 80%
g. Stability shall be 7 or less
h. Carbon/nitrogen ratio shall be less than 25:1
i. Trace metal test result = “pass”
j. The compost must have a dry bulk density ranging from 40 to 50 lb/ft^3

Compost Application Rate

To achieve a minimum 5% organic matter content, apply compost at the rate specified below.

Add 1.75 inches of compost per 8 inches of existing topsoil and incorporate by rototilling or mixing prior to respreading stockpiled topsoil. Scarify the subgrade down to a 4-inch depth. Using 35% to 60% organic matter in compost, this will provide a topsoil organic matter rate of 5%. The amended soil and subsoil together provide 12 inches of amended topsoil. For deeper soils, such as planting beds, mix compost and topsoil at the same rate.

The DDOE 2013 Stormwater Management Guidebook, Appendix J, describes compost application rates for impervious cover disconnections and grass swales.

Additional Amendments

Limestone – dolomitic limestone containing no less than 50% total carbonates and 25% total magnesium with a neutralizing value of at least 100%.

Acidulant – commercial grade sulfur, ferrous sulfate, and aluminum sulfate for horticultural use.

Fertilizer – granular or pelleted slow-release fertilizer consisting of 50% water-insoluble nitrogen, phosphorous, and potassium in a composition recommended by the soil testing laboratory.

REFERENCES

"Best Practices in Site Systems: Soils," High Performance Landscape Guidelines, Design Trust for Public Space and NYCDPR, pp. 122–159.

"Building Soil: Guidelines and resources for implementing soil quality and depth BMP T5.13," WDOE Stormwater Management Manual for Western Washington, 2012, http://buildingsoil.org/tools/Soil_BMP_Manual.pdf

"Diagnosing Soil Compaction Using a Penetrometer (soil compaction tester)," Penn State Extension, agronomy Facts 63, http://extension.psu.edu/plants/crops/soil-management/soil-compaction/diagnosing-soil-compaction-using-a-penetrometer

Hanks, D., Lewandowski, A., "Protecting Urban Soil Quality: Examples for Landscape Codes and Specifications," NRCS, Dec. 2003, http://soils.usda.gov/sqi/management/files/protect_urban_sq.pdf

Smiley, Dr. E. Thomas, "Bartlett Tree Research Laboratories Technical Report: Soil for Urban Tree Planting," http://www.bartlett.com/resources/SoilforUrbanTreePlanting.pdf

Urban, James, Up By Roots: healthy soils and trees in the built environment, 2008.

"Using Compost to Improve Turf Performance," Penn State Cooperative Extension, http://plantscience.psu.edu/research/centers/turf/extension

RESOURCES

"Selecting and Using a Soil Testing Laboratory," University of Maryland Cooperative Extension http://www.hgic.umd.edu/documents/HG110SelectingandUsingaSoilTestLabwithchart2_09.pdf

5.2 Bioretention

Bioretention facilities are practices that capture and store stormwater runoff and pass it through a filter bed of engineered soil media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to a storm sewer or allowed to infiltrate into the soil.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Bioretention													

RELATED ADMINISTRATIVE CONSIDERATIONS

DDOE 2013 Stormwater Management Guidebook, Section 3.6 “Bioretention” and Section 3.9 “Open Channel Systems.”

REQUIREMENTS

CALCULATING THE SCORE

Square footage is determined by measuring the extents of bioretention soil area, including the pretreatment area where applicable.

GAR Landscape Elements	Multiplier
Bioretention facilities	0.4

DESIGN

There are several bioretention design variants that are acceptable under GAR, as defined in the DDOE Stormwater Guidebook, which include:

- Traditional bioretention
- Stormwater planters
- Residential rain gardens
- Dry Swales/bioswales

- Grass Channels and Wet Swales, also defined in Section 3.9 of the DDOE Stormwater Guidebook, are not credited as bioretention under GAR.
- Structures made of concrete alone are not credited for bioretention.
- Bioretention systems shall be planted primarily with native herbaceous and woody species however ornamental species are suitable as long as they are not aggressive or invasive. A list of acceptable native species can be found in the DDOE 2013 Stormwater Management Guidebook (see the link for Chapter 3.6 above, pp.119–121). Native plant criteria are discussed in the Green Area Ratio regulations, 11 DCMR §3403.9.
- Bioretention soil media must be compatible with the bioretention soil specifications listed in the DDOE 2013 Stormwater Management Guidebook.

Small residential rain garden installed as part of the DDOE RiverSmart Homes program.

Example of traditional bioretention along Oxon run in SE DC.

Example of stormwater planter at Navy Yard in SE DC.

Dry Swale (source: Chesapeake Stormwater Network)

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Plans showing dimensions and area of bioretention
- Planting plan showing plant species, location, and size

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for confirming the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Confirm horticultural suitability of soil media prior to planting.
- Inspect plantings for quality control; ensure installation per plan and adjust as site conditions require.
- Plantings are maintained during the establishment phase.
- Confirm area of installed bioretention zone.

When constructing a bioretention system, please consult Chapter 3.6.6 (pp. 122–124) and Chapter 3.9.6 of the DDOE 2013 Stormwater Management Guidebook (see link above).

RECOMMENDED STANDARDS

Before designing a bioretention system, design standards developed by the District Department of the Environment (DDOE) and DC Water should be addressed. Web page links for the standards from each agency are included below:

- DDOE 2013 Stormwater Management Guidebook, Chapter 3.6 “Bioretention” and Chapter 3.9 “Open Channel Systems,” http://ddoe.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Section%203.6%20%20Bioretention.pdf
- DC Water Green Infrastructure Utility Protection Guidelines: http://www.dcwater.com/business/permits/utility_protection_guide_lines.pdf

In association with other required professionals, the Landscape Expert will review horticultural suitability of soil media and plant material during the design and construction phases.

Planting recommendations for bioretention facilities are as follows:

- The primary objective of the planting plan is to cover as much of the surface areas of the filter bed as quickly as possible. Herbaceous or ground cover layers are as or more important than more widely spaced trees and shrubs.
- Native plant species should be specified over non-native species.
- Plants should be selected based on a specified zone of hydric tolerance and must be capable of surviving both wet and dry conditions ("Wet footed" species should be planted near the center, whereas upland species do better planted near the edge).
- Woody vegetation should not be located at points of inflow; trees should not be planted directly above underdrains but should be located closer to the perimeter.
- Shrubs and herbaceous vegetation should generally be planted in clusters and at higher densities (i.e., 5 feet on center and 1–1.5 feet on center, respectively).
- If understory trees are part of the planting plan, a tree density of at minimum one tree per 250 square feet (i.e., 15 feet on center) is recommended. Canopy trees should have a spacing of 30–40 feet on center.
- Designers should also remember that planting holes for trees must be at least 3 feet deep to provide enough soil volume for the root structure of mature trees. This applies even if the remaining soil media layer is shallower than 3 feet.
- Tree species should be those that are known to survive well in the compacted soils and the polluted air and water of an urban landscape.
- If trees are used, plant shade-tolerant ground covers within the drip line.
- If the bioretention area is to be used for snow storage or is to accept snowmelt runoff, it should be planted with salt-tolerant, herbaceous perennials.

The contractor is required to ensure that proposed bioretention areas are protected from soil disturbance prior to and throughout the construction process to preserve soil infiltration rates. Stabilize surrounding areas prior to beginning bioretention construction. After the contractor installs all required engineered layers and filter soil media, the contractor can then install plantings, apply mulch or jute/coir matting, and finally open the bioretention facility to stormwater inflow after plantings have established.

REFERENCES

DDOE 2013 Stormwater Management Guidebook, Chapter 3.6 "Bioretention," pp. 99–128, 2013.

5.3 New and Existing Plantings

Plantings add greater environmental benefit with increased plant size. Multilayered plantings (e.g., canopy trees, understory, groundcover, perennial plantings, and turfgrass) together enable sites to achieve a higher GAR score than would otherwise be possible.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
New & Existing Planting													

RELATED ADMINISTRATIVE CONSIDERATIONS

DDOE 2013 Stormwater Management Guidebook, Section 3.14.1 "Tree Planting and Preservation."

REQUIREMENTS

SCORE DETERMINATION

The New and Existing Planting landscape elements are divided into seven categories, each with a defined square footage. For plants less than 2 feet high at maturity, square footage is measured as the expected coverage at maturity. For all plants of 2-foot height or greater, including trees, each individual plant contributes an equivalent square footage as listed below.

GAR Landscape Elements	Equivalent Square Footage (ft^2 per plant/tree)
Groundcovers, or other plants less than 2 feet tall at maturity	Square footage at maturity
Plants, not including grasses, at least 2 feet tall at maturity	9
Tree canopy for trees 2.5–6 inches in diameter	50
Tree canopy for trees 6–12 inches in diameter	250
Tree canopy for trees 12–18 inches in diameter	600
Tree canopy for trees 18–24 inches in diameter	1,300
Tree canopy for trees larger than 24 inches in diameter	2,000

The categories are also assigned a multiplier, increasing with size and associated environmental benefit.

GAR Landscape Elements	Multiplier
Ground covers, or other plants less than 2 feet tall at maturity	0.2
Plants , not including grasses, at least 2 feet tall at maturity	0.3
Tree canopy for all trees 2.5 inches to 6 inches in diameter	0.5
Tree canopy for new trees 6 inches in diameter or larger	0.6

Standards of measurement
Refer to American Standard for Nursery Stock (ANSI Z60.1-2004) for all standards of caliper size or height determination.

- For trees, caliper measurement of the trunk shall be taken 6 inches above the ground up to and including 4-inch caliper size. If the caliper at six inches above the ground exceeds four inches, the caliper should be measured at 12 inches above the ground.
- Clump-form and multi-stem trees, above a specified height, may be measured by caliper according to ANSI Z60.1-2004. The appropriate standard for measurement is one-half the total calipers for the three largest trunks. Shrub-form trees are measured by height only.
- Height measurement shall be taken from ground level for field grown stock and from the soil line for container grown stock, which should be at or near the top of the root flare.

Plant type and landscape element category

Groundcovers or other plants less than 2 feet tall at maturity:

- Perennials and ornamental grasses less than 2-foot height
- Woody plants less than 2-foot height
- Turfgrass

Plants, not including grasses, at least 2 feet tall at maturity:

- Perennials and ornamental grasses above 2-foot height
- Shrubs above 2-foot height
- Trees < 2.5-inch caliper

Tree canopy for all trees 2.5 inches to 6 inches in diameter, and new trees 6 inches in diameter or larger:

- Single stem, multi-stem, and clump-form trees > 2.5 inch caliper
- Existing trees transplanted to new locations within a site will receive a multiplier equivalent to that of new trees.

DESIGN

Plant Stock – Size and Quality Specifications
All plant material shall comply with the American Nursery and Landscape Association (ANLA) American Standard for Nursery Stock (ANSI Z60.1-2004). Considerations for plant material specifications include:

- Relationship between caliper, height, and branch number
- Size of the root ball or container
- Relation of root ball diameter and tree height
- Ball depth to diameter
- Container size to caliper height

Annuals, bulbs, or plantings otherwise requiring annual replanting do not count for GAR credit unless used for food cultivation purposes.

Location and Spacing
Plant spacing should be specified with consideration for a species mature spread as well as immediate visual impact.

- The minimum plant spacing is species-specific. Canopy trees should have a minimum 30–40 foot spacing. Understory trees should be planted at a 15-foot minimum spacing. Shrubs and perennials shall not be planted over the root ball of new trees.
- Shrubs and perennials shall be planted no closer than 18-inches on center unless otherwise justified. Shrubs greater than 2-foot mature height shall be planted no closer than 30-inches on center unless otherwise justified. Species with greater spread should have an accordingly greater spacing.

Plant Protection Measures
Planting areas shall be protected from vehicular traffic. Examples of design for landscape area protection include but are not limited to the following: wheel stops, curbs, bollards, or fencing.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Plant location and spacing
- Plant size - specified according to American Nursery and Landscape Association (ANLA) American Standards for Nursery Stock.
- Plant species - listed by common and scientific name
- Planting and other details illustrating soil depth, staking, planting hole, vehicular and pedestrian traffic protection
- For container plantings, illustrate the drainage, irrigation, soil depth, and container size

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for confirming the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Plant material installed at horticulturally appropriate times with consideration for: weather, season, and site conditions.
- Plants are installed after topsoil has been confirmed to meet specifications.
- Ensure new plant material meets standards listed in the approved plan and ANLA American Standard for Nursery Stock (ANSI Z60.1-2004).
- Plant installation is conducted according to industry standards and common horticultural practice. All plant material is in vigorous health at the time of planting and final inspection.
- Trees and shrubs must have a species identification tag from the nursery to remain on 2 of each planted species until the Landscape Checklist is signed. Afterwards, remove the nursery tags to prevent girdling to plantings.
- Post-installation watering and care.

RECOMMENDED STANDARDS

DESIGN

Plant Stock – Size and Quality Specifications

- Smaller caliper trees establish more quickly and have better survival rates than larger specimens, thus larger-caliper trees should only be specified if there is dedicated maintenance during plant establishment.
- Balled and Burlapped (B&B), containerized, and bare root plants are all acceptable for planting. Bare root material however has a restricted planting season in comparison to B&B and containers.

Species Selection
Select species compatible with the cultural and design constraints of the site. Factors to consider include:

- Suitability to proposed soils
- Drainage
- Soil volume
- Availability of sunlight
- Wind exposure
- Plant habit in relation to circulation patterns and existing buildings or structures

Invasive species should be avoided, especially if in proximity to natural areas. Native species receive a bonus credit if meeting the standards of Section 4.12 "Native Plants."

Tree Pit Opening
Tree pit openings should be large enough to prevent conflict between mature tree trunk flare and pavement, curb, tree grates or other barriers. The tree pit opening should be at least 3 times the mature tree's trunk diameter at breast height or greater.

CONSTRUCTION

Planting Season, Weather, and Site Conditions
Plant material and seeding should be installed within designated planting seasons. Weather and soil conditions may however affect planting dates. No planting, seeding, or sod installation shall be done in frozen or snow covered ground, wet soil, or when the soil is otherwise in an unsatisfactory condition for planting.

Recommended planting times are as follows:

- Deciduous plants – mid-October through May
- Evergreen plants – mid-March through May and September through November
- Turfgrass seeding – March through April and mid-August through October
- Sod – all months (with irrigation)

Preparing the Planting Hole
If planting in existing uncompacted soils, excavate the planting hole to a minimum 2-times the width of the rootball, then slope the sides outward to surrounding soils. In compacted soils, excavate the planting hole to a minimum 3 times the width of the rootball, then slope outward to surrounding soils. Trees with limited opportunity to spread to surrounding soils, due to compaction under pavement or if planted in containers, should be designed and installed with

an enlarged soil volume installed up to 36-inch depth. All newly planted B&B tree rootballs shall be placed directly over compacted subsoil.

Pruning
Prior to planting, inspect trees for dead, diseases, or crossing branches and prune accordingly. Remove co-dominant trunks and broken branches.

Plant Installation
All plant material shall be installed to the following standards:

Trees and Shrubs

- Confirm at least two structural roots, 4 inches from the trunk, are within the top 3 inches of the top of root ball. If excess soil is present, raise the root ball and expose the trunk flare, or otherwise reject the plant material if remaining root volume is too limited. Place the root ball directly over sub-grade to avoid settling.
- Remove the top 8–12 inches of the wire basket from B&B material to prevent future root girdling. Remove burlap from the top of the root ball. Synthetic burlap and rope are not allowed for planting.
- Inspect and remove girdling or circling roots prior to backfilling. Place tree irrigation bags or water wells over newly planted trees. Fill irrigation bags or otherwise irrigate new plantings to provide a minimum of 1-inch water per week. Spread 3 inches of mulch over the root ball but not in contact with the trunk.

Perennials and Groundcovers

- Plant all material at or slightly above final grade. Backfill the planting holes with topsoil, tamp down, and water thoroughly.
- Spread 2-inches of mulch between plantings.

Turfgrass

- Loosen, amend as necessary, and fine grade topsoil prior to seeding. If existing topsoil is compacted, rototill or use a similar method to de-compact the material.
- After topsoil is loosened and scarified, place the seed, lightly rake into the soil, and roll for good soil-seed contact.
- Establish a full stand of grass for acceptance.

Staking
The necessity for tree staking is specific to individual trees and locations. Trees should be staked under the following conditions:

- Windy locations
- Trees subject to vandalism or mowing damage
- Trees subject to settlement in soil
- Large crown volume

Transplanting and Large Tree Planting
Tree transplanting should be done by a qualified contractor. Larger trees require greater care during installation to successfully transplant. Experienced contractors and specialized equipment are necessary to perform this work. Refer to American Standard for Nursery Stock (ANSI Z60.1-2004) for all root ball size standards and handling.

REFERENCES

Harris, R., Clark, J., Matheny, N., Arboriculture: integrated management of landscape trees shrubs and vines, 4th ed., 2004.

"Technical Guide to Urban and Community Forestry," World Forestry Center, http://www.na.fs.fed.us/spfo/pubs/uf/techguide/toc.htm

Transplanting Guide - Cornell University Urban Horticulture Institute, http://www.hort.cornell.edu/uhi/outreach/recurbtree/pdfs/17transguide.pdf

Perennials: Culture, Maintenance, and Propagation Virginia Cooperative Extension, http://pubs.ext.vt.edu/426/426-203/426-203.html

ANSI A300 (Part 6), Tree, Shrub, and Other Woody Plant Management Standard Practices (Planting and Transplanting), 2012

ISA Best Management Practices: Tree Planting, 2005

RESOURCES

ANLA American Standards for Nursery Stock, 2004, http://www.anla.org/docs/About%20ANLA/Industry%20Resources/ANLAStandard2004.pdf

Plant Invaders of Mid-Atlantic Natural Areas, NPS USFWS, 2010, http://www.nps.gov/planTs/alien/pubs/midatlantic/toc.htm

5.4 Tree Preservation

The preferred method for increasing tree cover at a development site is to preserve existing trees, particularly where mature trees are present. Trees provide increasing environmental benefit as they mature. Established trees however may be impacted by careless site work during the construction process. Such impacts may result in tree death. Tree protection measures established during the design phase and followed throughout construction can provide a significant component of the GAR score.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Tree Preservation													

RELATED ADMINISTRATIVE CONSIDERATIONS
DDOE 2013 Stormwater Management Guidebook, Section 3.14.1.

Special Tree Removal Permit – Urban Forestry Administration requires property owners apply for a permit if removing a tree 55” circumference or greater, as per 24 DCMR Chapter 37, Public Space and Safety.

REQUIREMENTS

CALCULATING THE SCORE
The GAR score for tree preservation is based on the number and size of existing tree stock to be preserved. Each individual tree contributes an equivalent square footage as listed in Table 7.

GAR Landscape Elements	Equivalent Square Footage (ft^2 per tree)
Tree canopy for trees 2.5–6 inches in diameter	50
Tree canopy for trees 6–12 inches in diameter	250
Tree canopy for trees 12–18 inches in diameter	600
Tree canopy for trees 18–24 inches in diameter	1,300
Tree canopy for trees larger than 24 inches in diameter	2,000

The calculated equivalent square footage is then assigned a multiplier (listed below) based on tree size class. The multiplier times the equivalent square footage for a size class provides the calculated Green Area Ratio for preserved trees.

GAR Landscape Elements	Multiplier
Tree canopy for all trees 2.5 inches to 6 inches in diameter	0.5
Tree canopy for preservation of existing trees 6 inches to 24 inches in diameter	0.7
Tree canopy for preservation of existing trees 24 inches diameter or larger	0.8

Standards of measurement

- Preserved trees will be measured by trunk DBH, 4.5 feet above ground level.
- Existing trees transplanted to new locations within a site will receive a multiplier score equivalent to that of new trees, see Chapter 4.3 “New and Existing Plants.”

DESIGN AND CONSTRUCTION

Existing trees are preserved during construction through a three-step process:

Step 1: Inventory existing trees.

Step 2: Prepare a tree preservation plan

Step 3: Protect trees and soil during construction.

Inventory Existing Trees

The inventory must include a survey of existing trees and list their location, species, trunk diameter at breast height (DBH), and canopy radius. The canopy radius is measured by the dripline of the canopy. Alternatively, the Landscape Expert may list the critical root zone (CRZ) in place of the canopy radius. The canopy radius or critical root zone must be identified on plan. The CRZ shall be determined by an ISA certified arborist. The CRZ is measured as a circular area with a radius (in feet) from the trunk measuring up to 1.5 times the trunk diameter (in inches). The CRZ will differ according to species tolerance to construction impact and age class.

Prepare a tree preservation plan

From the tree inventory, individual trees shall be identified for preservation and protection during site development. Trees selected for preservation and protection must be clearly marked both on construction drawings and at the actual site.

The critical root zone or dripline shall be protected with durable and well-anchored fencing and shall remain throughout construction. The canopy radius or CRZ protection shall be marked on the site map. Specify in the notes that stockpiling of material, construction activity, and grading are not allowed within the dripline or CRZ. Also, specify that site disturbance only be permitted if done by hand tool, pneumatic excavation, or tunneling.

Within the dripline of the tree, root soil protection measures are required, including surface protection mats or 6-12 inch depth mulch. To preserve existing roots specify additional design approaches such as discontinuous footings or bridged curbs.

No grading operations are permitted within the CRZ. Raising or lowering the grade under the dripline shall be minimized.

Protect trees during construction

Physical barriers must be properly installed around the Critical Root Zone (CRZ) of trees to be preserved. Require that all protection measures be installed and maintained prior to and throughout the construction process. Trees with CRZ/dripline protected by existing pavement must have trunk protection in place, such as 6-foot height wooden tree guards.

- Discuss all tree protection measures at the pre-construction meeting.
- Tree protection barriers include highly visible, well-anchored temporary protection devices, such as 4-foot chain link, wire mesh, or wooden-slat snow fencing. Plastic mesh fencing is typically not appropriate for construction activity due to its limited durability.
- For excavation anywhere within the CRZ or dripline, conduct hand or pneumatic excavation or tunneling beneath roots to limit root disturbance. Preserve roots greater than 2-inches in diameter. Where excavation must occur beyond the dripline and CRZ, prune roots to the edge of the excavation with a trenching machine, vibratory knife or rock saw and to a depth of 18 inches to allow a clean cut.
- No stockpiling or storage of material is permitted within the CRZ/dripline.

<u>PLAN SUBMITTAL</u>

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Submit a tree survey for all trees to be preserved, including: location, species, trunk DBH, estimated canopy radius (or critical root zone). It is recommended this work be done by a certified arborist or MD or VA licensed landscape architect with related experience, to properly assess the condition of the tree and critical root zone
- Prepare a tree preservation plan for all phases of construction activity. The tree preservation plan should be prepared and signed by a certified arborist or qualified MD or VA licensed landscape architect.

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for confirming the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Inspect tree protection measures throughout construction for protection of the root zone within the canopy dripline or CRZ.
- Monitor construction activity to prevent damage to tree canopy.
- Monitor trees for signs of decline or damage; revise design plans accordingly to maintain GAR score at completion of work.
- Post-construction watering and care.

RECOMMENDED STANDARDS

Tree Inventory and Preservation Plan

A licensed forester or arborist should conduct an inventory of existing trees and forested areas at the development site before any site design, clearing, or construction takes place, as specified by the Urban Forestry Administration (UFA). An ISA Certified Arborist should determine tree condition and remove those deemed hazardous or in poor condition. The applicant is required to apply for a Special Tree Removal Permit from the Urban Forestry Administration if removing a tree 55” circumference or greater.

Existing and proposed site conditions should be considered when determining which trees are suitable for preservation. Additional selection criteria should include tree species, size, condition, and location (Table 6).

Table 6 Tree Preservation Criteria

Selection Criteria for Tree Preservation	Examples of Priority Tree and Forests to Conserve
Species	• Rare, threatened, or endangered species • Specimen trees • High quality tree species (e.g., trees that are structurally strong and live longer than other trees)
Size	• Trees over a specified diameter at breast height or other size measurement. • Trees designated as national, state, or local champions. • Contiguous forest stands of a specified minimum area.
Condition	• Healthy trees that are structurally sound. • High quality forest stands with high forest structural diversity
Location	• Trees located where they will provide direct benefits at the site (e.g., shading, privacy, windbreak, buffer from adjacent land use). • Forest stands that are connected to off-site forests that create wildlife habitat and corridors. • Trees located in protected natural areas such as floodplains, stream buffers, wetlands, erodible soils, critical habitat areas, and steep slopes. • Forest stands that are connected to off-site non-forested natural areas or protected land.

Critical Root Zone

Table 7 provides guidance for determining the critical root zone. In no case shall the CRZ be less than 6-foot diameter. To determine species tolerance to construction, refer to appropriate references (Matheny, Clark, 1994), (ISA BMP, 2008). If a tree species tolerance to construction impact is unknown, assume a tolerance of “poor” and therefore highest level of CRZ protection.

Table 7 Determining the Critical Root Zone (Matheny, Clark 1994)

Species Tolerance to Construction	Tree Age	Distance from Trunk (CRZ ft/in. DBH)
Good	Young (<20% life expectancy)	0.5
	Mature (20-80% life expectancy)	0.75
	Advanced (>80% life expectancy)	1.0
Moderate	Young	0.75
	Mature	1.0
	Advanced	1.25
Poor	Young	1.0
	Mature	1.25
	Advanced	1.5

Additional Considerations

Secure an ISA Certified Arborist or professional forester to address additional measures related to tree management on construction sites.

- Elevate low-hanging branches to protect against damage from construction equipment and prune dead, diseased, or otherwise hazardous branches from the tree canopy. Do not remove more than 20% of a tree canopy in any one year.
- Responsible parties should address tree damage incurred during construction. Consult with a qualified professional for advice. Appropriate remedial measures for tree damage include: irrigation, watering, vertical mulching, pneumatic decompaction and compost incorporation, or other appropriate measures depending on individual tree conditions.

REFERENCES

"Best Management Practices (BMP) - Managing Trees during Construction," International Society of Arboriculture, 2008.

ANSI A300 (Part 5), Tree, Shrub, and Other Woody Plant Management Standard Practices (Management of Trees and Shrubs During Site Planning, Site Development, and Construction), 2012.

Doherty, K, Bloniarz, D, 2003. Positively the pits: successful strategies for sustainable streetscapes, Tree Care Industry, 14(11), pp. 34–42.

Matheny, Nelda and Clark, James, Trees and Development: a technical guide to preservation of trees during land development, 1998, pp. 167–179.

Urban Forestry Watershed Manual: Part 2 Conserving and Planting Trees at Development Sites, http://www.na.fs.fed.us/pubs/uf/watershed2/urban_watershed_forestry_manual_part2.pdf.

Trowbridge, P.; Bassuk, N. 2004. Trees in the urban landscape: site assessment, design, and installation. Hoboken, NJ: John Wiley & Sons, Inc.

RESOURCES

Matheny, Nelda and Clark, James, Trees and Development: a technical guide to preservation of trees during land development, 1998.

5.5 Vegetated Walls

Vegetated walls are vertical growing systems; they reduce the Districts heat island effect and stormwater runoff among other benefits. Climbing vines with vertical structural support and living walls with built-in-place soil media, are design approaches to achieve credit under the "Vegetated walls" landscape element. Vegetated walls allow sites to gain credit using minimal site area.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Vegetated Walls													

REQUIREMENTS

CALCULATING THE SCORE

To determine the score for vegetated walls, calculate the square footage of climbing vegetation from ground level; this number is based upon the following assumptions.

Length - linear coverage along the vertical element ground plane

- Green facades – measured by the extent of soil at the vertical surface and specified plantings. For full wall coverage, maximum spacing between plantings is assumed to be 4-foot on center for green facades.
- Living walls – measured by full vegetated coverage along ground plane.

Width – coverage perpendicular to the vertical element.

- Green facades – one-foot standard width per exposed surface.
- Living walls – measure the standard one-foot width plus width of suspended soil perpendicular to wall.

Area – multiply length and width along the ground plane.

GAR Landscape Elements	Multiplier
Vegetated Wall	0.6

DESIGN

- Vegetated walls shall be at least five feet from a side or rear lot line.
- Where stormwater harvesting for irrigation is proposed, vegetated walls shall contain a connection to the proposed irrigation system.
- All plant specifications comply with ANLA American Standards for Nursery Stock and requirements listed in Chapter 4.3 “New and Existing Plantings.”
- Plantings must be designed to reach a minimum 12-foot height.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Specify plant species, location, spacing, and size.
- Specify support structure along vertical element for vegetated wall plantings.
- Specify setback dimensions from property line, as necessary
- Where stormwater harvesting for irrigation is proposed, vegetated walls shall contain a connection to the propose irrigation system.
- Specify irrigation system for living wall systems

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Area and spacing of plantings.
- Harvested stormwater irrigation system, where proposed, serves the vegetated wall.
- Approved irrigation system is present for living wall.
- Planting inspection and installation in accordance with the standards listed in Chapter 4.3 “New and Existing Plantings.”

RECOMMENDED STANDARDS AND BACKGROUND

- Vegetated walls should have a 5-foot clearance from all facing walls, to allow adequate light penetration.
- Plantings on green facades should be planted no greater than 4-feet on center to be credited for continuous wall coverage. See below for additional guidance on plant spacing.
- Green facades should have a minimum 1-foot planting bed width.
- Living walls require permanent irrigation.
- Plantings are suitable to selected vertical supporting structures.

There are three major categories of vegetated walls:

Green Facades

- Green facades or green screens are systems that grow vertically from a planter or soil beds at the base of the structure. Alternatively, green facades may cascade down a wall from a planting bed situated on the rooftop. Vines, other climbing plants, or cascading groundcovers comprise green facades. An underlying support structure, designed purposely for the location, provides support for the system. Such structures may include freestanding structures or cable or trellis systems attached to a wall. Espaliered trees also fall under this category.
- Green facades can take several seasons to reach maturity. This depends on the climate, plant choice, depth of soil bed, orientation (south facing facades are ideal), nutrition and irrigation system.
- Plant spacing should be done with consideration for individual species growth characteristics. Recommended spacing of plantings on green facades as follows: #1 container (18-24-inch on center), #3 container (24-36-inch) #5 container (36-48-inch), #7 container (48-inch). Plantings on cable systems should be planted with one plant per cable.
- Cable systems are appropriate for twining plants. Trellis systems are appropriate for vines that cling or climb with tendrils or suckers.

Living Walls

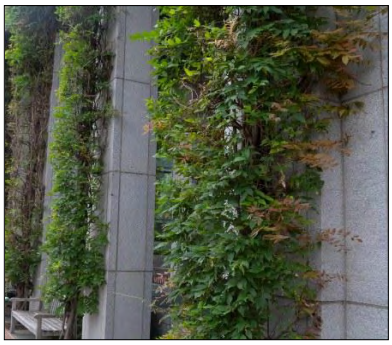
- Living walls are systems comprised of vegetated panels, modules, plugs, planted blankets or bags that are attached to an existing structural wall or freestanding structure. A living wall is essentially a green roof turned on its side.
- Living wall modules can be made of plastic, expanded polystyrene, synthetic fabric, clay, or concrete. Their design typically includes a dense and diverse mix of plants, such as ferns,

low shrubs, perennial flowers, and edible plants. The wide variety of plant options helps living walls thrive in full sun, shade, and interior applications.

- Living walls require supplemental irrigation to compensate for limited soil volume in the trays. The original irrigation specification should also include a recommended initial irrigation frequency and time, based upon the season and plant requirements.

Retaining Living Walls

- Retaining walls with built-in growing media do not qualify for credit under this item. Refer to Chapter 4.3 “New and Existing Plantings” for additional guidance.


Cable system, 2nd Street NE

Trellis system, H Street NW

Living wall by Tournesol Siteworks

REFERENCES

Green Roofs for Healthy Cities - http://www.greenroofs.org/index.php/about/aboutgreenwalls

Arsenault, Peter, “Green Walls: integrating nature into buildings,” Architectural Record Continuing Education Center, 2013.

“Considerations for Advanced Green Façade Design,” GreenScreen, September 2012 http://www.greenscreen.com/direct/Considerations/AdvancedGreenFacadeDesign_Fall12.pdf

5.6 Vegetated Roofs

Green roofs enable sites with significant building footprint coverage on a site to achieve GAR compliance. Green roofs over occupied buildings, parking decks, or other structures are all applicable under this item. Additionally, green roofs can be used for food cultivation.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Vegetated Roofs													

RELATED ADMINISTRATIVE CONSIDERATIONS

For additional guidance, refer to Chapter 3.2 “Green Roofs” of the DDOE 2013 Stormwater Management Guidebook.

REQUIREMENTS

CALCULATING THE SCORE

- Vegetated roofs are calculated by first determining the square footage of vegetated surface area. The vegetated roofs’ landscape features are divided into two categories, extensive and intensive.
- Each category, listed below, is assigned a multiplier. An intensive vegetated roof is assigned a larger value than an extensive roof due to the increased depth and associated environmental benefits (e.g., greater stormwater retention, greater plant diversity, higher rate of evapotranspiration).
- Groundcover plants less than 2-foot height on the green roof are ineligible for additional credit beyond the green roof landscape element. Plants greater than 2-foot height will provide additional credit if adequate soil media depth is provided to specified plantings.

GAR Landscape Elements	Multiplier
Extensive vegetated roof over at least 2 inches but less than 8 inches of growth medium	0.6
Intensive vegetated roof over at least 8 inches of growth medium	0.8

DESIGN

- Designs for vegetated roofs must include supplemental water
- Vegetated roofs shall contain a connection to the harvested stormwater when stormwater harvesting for irrigation is proposed

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Dimensions of soil media, showing area and depth
- Plant species, size, and location
- Source and location of supplemental water to vegetated roof

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Area of green roof vegetation and depth of soil media.
- Quality of vegetative stock during installation and establishment.
- Irrigation and drainage features have been installed for green roof

RECOMMENDED STANDARDS

DESIGN GUIDELINES

Design of the green roof include: deck layer, leak detection system, waterproofing layer, insulation layer, root barrier, drainage layer, filter fabric, soil growth media, and plant materials. In association with other required professionals, the Landscape Expert will review: drainage layer, soil growth media, and plant materials. See Table 8 for additional guidance.

Table 8 Extensive Green Roof Materials Specifications

Green Roof Layer	Recommended Standard
Drainage Layer	Depth of the drainage layer is generally 0.25 to 1.5 inches thick for extensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., gravel, high density polyethylene (HDPE), etc.) that are capable of retaining water and providing efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. Designers should consult the material specifications as outlined in ASTM E2396 and E2398. Roof drains and emergency overflow must be designed in accordance with the District's construction code (12 DCMR).
Growth Media	70% to 80% lightweight inorganic materials and a maximum of 30% organic matter (e.g., well-aged compost). Media typically has a maximum water retention of approximately 30%. Material makeup and proof of maximum water retention of the growing media must be provided. Media must provide sufficient nutrients and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396-05.
Plant Materials	*Sedum*, herbaceous plants, and perennial grasses that are shallow-rooted, low maintenance, and tolerant of direct sunlight, drought, wind, and frost. See ASTM E2400-06, *Guide for Selection, Installation and Maintenance of Plants for Green (Vegetated) Roof Systems*.

TYPICAL CONSTRUCTION SEQUENCE

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct a flood test to ensure the system is watertight by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system. Alternately, electric field vector mapping (EFVM) can be done to test for the presence of leaks.
- Add additional system components (e.g., insulation, root barrier, drainage layer and interior drainage system, filter fabric) per the manufacturer's specifications, taking care not to damage the waterproofing. Any damage occurring must be reported immediately.
- Drain collars and protective flashing should be installed to ensure free flow of excess stormwater [inspection by Landscape Expert].
- The growing media should be mixed prior to delivery to the site. Media must be spread evenly over the filter fabric surface as required by the manufacturer. If a delay between the

installation of the growing media and the plants is required, adequate efforts must be taken to secure the growing media from erosion and the seeding of weeds. The growing media must be covered and anchored in place until planting. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction beyond manufacturer's recommendations [inspection by Landscape Expert].

- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan or in accordance with ASTM E2400. Plants should be watered immediately after installation and routinely during establishment [inspection by Landscape Expert].
- It generally takes 2 to 3 growing seasons to fully establish the vegetated roof. The growing medium should contain enough organic matter to support plants for the first growing season, so initial fertilization is not required. Extensive vegetated roofs may require supplemental irrigation during the first few months of establishment. Hand weeding is also critical in the first two years.
- Most construction contracts should contain a Care and Replacement Warranty that specifies at least 50% coverage after one year and 80% coverage after two years for plugs and cuttings, and 90% coverage after one year for Sedum carpet/tile.

REFERENCES

DDOE 2013 Stormwater Management Guidebook, Chapter 3.2 "Green Roofs," pp. 29–41, 2013.

Extensive green roof at Canal Park, 200 M Street SE

5.7 Permeable Paving

Permeable paving is a system that captures and temporarily stores stormwater by filtering the runoff through voids in the pavement surface and underlying stone reservoir layer or sub-grade. Permeable paving systems may also provide additional soil-water to plants. GAR divides permeable paving into two categories based on depth of soil or gravel media.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Permeable Paving													

RELATED ADMINISTRATIVE CONSIDERATIONS

For additional guidance, refer to Chapter 3.5 “Permeable Pavement” of the DDOE 2013 Stormwater Management Guidebook.

REQUIREMENTS

CALCULATING THE SCORE

- These areas are credited by square feet (length ×width).
- Permeable paving and enhanced tree growth, may not count for more than one third (1/3) of the total GAR score for the lot.

GAR Landscape Elements	Multiplier
Permeable paving over at least 6-inches and less than 2-feet of soil or gravel	0.4
Permeable paving over at least 2-feet of soil or gravel	0.5

DESIGN

- Examples of acceptable practices include: porous asphalt, porous concrete, porous pavers, vegetated permeable pavement, or other proprietary practices.
- Vegetated permeable paving should only be used in low-traffic situation, such as temporary overflow parking. Do not specify vegetated permeable paving for areas with high traffic, as turfgrass will perform poorly.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Plan and details, with dimensions, showing depth, area, and type of permeable paving

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Total square footage of permeable paving systems.
- Depth of reservoir (gravel/soil) layer as per plan.
- Full establishment of grass for vegetated permeable pavement areas.

RECOMMENDED STANDARDS

DESIGN

Permeable pavers may be designed to meet the requirements of the DDOE 2013 Stormwater Management Guidebook. Design of the permeable pavement system includes: geotextile, base material components, stone media, reservoir media, bedding layer, paving material, and in some cases vegetated cover. Perform a percolation test to determine whether underdrains are necessary. Specify permeable pavement within an impervious contributing drainage area for minimal maintenance requirements. In association with other required professionals, the Landscape Expert will review the reservoir layer depth (aggregate or soil) for permeable pavement as well as soil quality and turf establishment for vegetated pavers.

Standard Design- Practices with a standard underdrain design and no infiltration sump or water quality filter (see DDOE 2013 Stormwater Management Guidebook, figure 3.13).

Enhanced Design with underdrain - Practices that contain a water quality filter layer and an infiltration sump beneath the underdrain sized to drain the system within 48 hours (see DDOE 2013 Stormwater Management Guidebook, figure 3.13).

Enhanced Design without an underdrain- Practices that infiltrate the design storm volume in 48 hours (see DDOE 2013 Stormwater Management Guidebook, figure 3.15).

Permeable Pavement systems are not typically designed to provide stormwater detention for larger storms (e.g., 2-year, 15-year) and are generally combined with other best practices where detention is required. These BMPs are subject to the same feasibility constraints as most infiltration practices as described in Section 3.5.1 of the DDOE 2013 Stormwater Management Guidebook.

CONSTRUCTION

Proper installation is critical to the success and operation of all permeable pavement systems. Care should be taken to ensure that all permeable pavement areas are fully defined on construction documents and protected from sediment intrusion and compaction. These locations may not be used as a temporary sediment trap or stockpile locations. Where feasible it is recommended that permeable pavement sites be located outside of the limit of disturbance (LOD) and excavation areas for Green Area Ratio landscape sites.

Sequence of Construction

1. Stabilize drainage area (all site utility work should be complete).
2. Install Erosion and Sediment Control best practices (as described in the ESC Plan).
3. Promote Infiltration Rate (protect pavers excavation areas from heavy equipment and scarify or till the bottom of the pavers excavation three to four inches).
4. Install Geotextile Fabric and Base Material Components (install aggregate and underdrain).
5. Stone Media (clean double washed stone at least four inches above the underdrain, do not compact with rollers).
6. Reservoir Media (to the desired depth depending on the type of pavement) [inspection by Landscape Expert].
7. Bedding Layer and Paving Media (installed in accordance with the manufacture or industry specifications for the type pavement used).
8. Vegetated pavers require coordination for soil quality and grass seed establishment. Pavers with Enhanced Tree Growth below require additional horticultural oversight [inspection by Landscape Expert].

Practices and Standards

Supervision before, during and after construction by a qualified professional is recommended for Permeable Pavement Systems to ensure that the facilitates are constructed in accordance with the specifications of the manufactures and the storm water regulations of the District of Columbia (see Permeable Pavement Construction checklist in Appendix K of the DDOE 2013 Stormwater Management Guidebook).

REFERENCES

DDOE 2013 Stormwater Management Guidebook, Chapter 3.5 “Permeable Pavement Systems,” pp. 79–98, 2013.

National Menu of Stormwater Best Management Practices. 2009-09-10. “Porous Asphalt Pavement” EPA. Retrieved 18 September 2012.

5.8 Enhanced Tree Soil Systems

The landscape element "Enhanced Tree Growth" consists of soil techniques designed to transfer the load from pavement directly to the subsoil rather than the topsoil media. These systems promote additional soil volume for trees than is otherwise available under conventional pavement systems.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Enhanced Tree Growth													

RELATED ADMINISTRATIVE CONSIDERATIONS

Under the DDOE 2013 Stormwater Management Guidebook, Chapter 3 "Bioretention," engineered tree boxes meet the same design strategy as Enhanced Tree Growth.

REQUIREMENTS

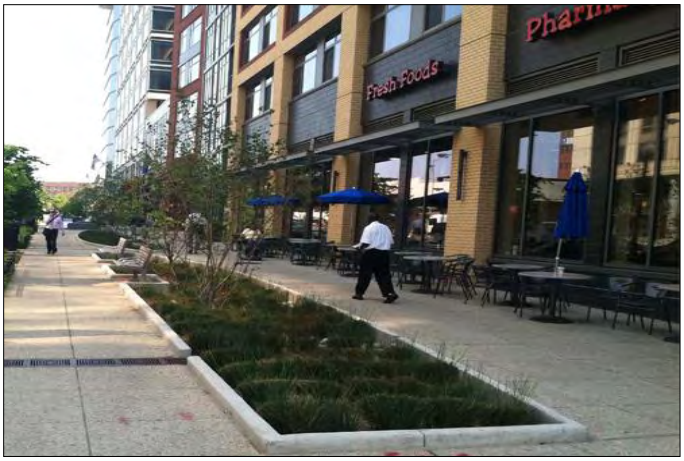
CALCULATING THE SCORE

- These areas are credited by square feet (length x width)
- Enhanced Tree Growth and Permeable Paving may not count for more than one third (1/3) or the total GAR score for the lot

GAR Landscape Elements	Multiplier
Enhanced Tree Growth	0.4

DESIGN

- Provide a minimum 24" depth of soil media. Use in locations underneath pavement and connected to adjacent planting areas.
- The materials used for these systems should be neither contaminated nor compacted according to the Comprehensive Environmental Response, compensation, and Liability Act of 1980.



Enhanced tree growth and bioretention in NoMa, NE DC.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Provide plan and details, with associated dimensions and area.
- Identify irrigation (if any) associated with enhanced tree growth system.

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Total square footage of enhanced tree growth system.
- Installation of soil media to the specified depth.
- Installation of proposed irrigation and drainage if necessary.
- Review delivered topsoil or structural soil for compatibility with the standard or proprietary specification.

Supervision before, during, and after construction should be done by a qualified professional.

RECOMMENDED STANDARDS AND DEFINITIONS

First consider enlarging at-grade soil volumes for trees where feasible before selecting an enhanced tree growth system. This practice however is especially appropriate where pedestrian or vehicular activity would otherwise compact the soil in tree pits.

A number of approaches can be followed to enhance tree root growth through modification of the structural supports underneath pavement. Of these approaches, several systems are most common: suspended pavements, sand-based structural soil, and aggregate structural soil.

DESIGN

All enhanced tree growth systems should be designed to provide minimum tree openings 2–3 times the mature tree's trunk DBH. Consider placing permeable paving or drain inlets with perforated pipe irrigation under pavement.

Suspended pavements - support pavement through columns or walls, allowing soil placed within the suspended pavements to remain at a compaction level suitable to root growth. Both proprietary and non-proprietary devices are available.

Sand-based structural soil systems - includes pavement over open-graded crushed stone and Sand-Based Structural Soil. Due to the poor water retention capacity of sand, an additional water source is necessary, provided by drainage channels or permeable pavers. Such systems should be designed with passive irrigation only. Additional guidance can be found in the DDOT LID Specifications.

Aggregate structural soils - consist of angular gravels that directly support pavement but through which roots may grow. These systems are constructed from load-bearing materials such as: aggregate and clay-loam mix or expanded slate with clay-loam mix. Aggregate Structural Soils shall be used as a pathway for roots to reach additional soil volumes across pavement subsurface and not as the only available tree soil volume.

INSTALLATION

Suspended pavements – Topsoil in suspended pavement structures do not support the pavement above. These soils are compacted at a lower rate than that of structural fill thus allowing for root growth while still providing a stable soil substrate for trees.

Sand-based structural soil – The sand-based soil is compacted to support overlaying pavement. Inspect the proposed irrigation system as well. Additional guidance can be found in the DDOT LID Specifications.

Aggregate structural soils – A number of proprietary devices are available and as such, it is necessary to follow the manufacturer's guidelines. Materials from such systems should be purchased from licensed suppliers and the recommended installation procedures followed.

REFERENCES

Urban, James, Up By Roots: healthy soils and trees in the built environment, 2008.

The Great Soil Debate: Understanding Competing Approaches to Soil Design, ASLA Annual Meeting Handout, September 20, 2009.

The Great Soil Debate Part II: Structural Soils Under Pavement, ASLA Annual Meeting Handout, September 11, 2010.

5.9 Renewable Energy

Because of limited wind potential in the District of Columbia, the primary renewable energy technologies with widespread applicability for GAR are rooftop- and ground-mounted solar photovoltaic (PV) and solar thermal systems. These systems are designed as an alternative energy source that provides long-term financial and environmental benefits and reduces the use of conventional fuels.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Renewable Energy													

RELATED ADMINISTRATIVE CONSIDERATIONS

Solar project plan designs must be submitted to the Department of Consumer and Regulatory Affairs (DCRA) Planning and Zoning officials for review and approval to ensure compliance with building codes and zoning regulations. Projects in historic districts will require additional review by the Historic Preservation Review Board. Upon approval, permits for building and electrical or plumbing are provided for each project. These approvals are required before installation.

REQUIREMENTS

SCORE DETERMINATION

The Solar PV and thermal system score is calculated by multiplying the square footage of the array by the element multiplier assigned below.

GAR Landscape Elements	Multiplier
Renewable energy	0.5

DESIGN

- Only solar PV and solar thermal systems are credited under the renewable energy landscape element.

PLAN SUBMITTAL

In addition to complying with the design standards submitted GAR plans shall include the following:

a. Reference note on GAR plan sheet listing all electrical, plumbing, mechanical, or other relevant plan sheet details and specifications that are part of the total building permit approval.
b. A copy of plan documents for project electrical, plumbing and building permitting must be provided, including site plan with drawings showing solar array, number of collectors or panels, system size, array dimensions, and location of array and mounting.
c. Schematic diagram showing balance of system components (system wiring, disconnects, inverter(s), valves, pipes, tanks, and pumps) It is helpful for review to have the Solar PV panel specification sheet and Solar Thermal OG 100 collector rating specification sheet or OG 300 system rating specification sheet.

Shading analysis (is used to determine the most efficient and economical array position. Request from solar professional if more than 20% shading exists on the array location.) More information: http://www.builditsolar.com/References/SunChartRS.htm.

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign-off of the Landscape Checklist:

a. Visually verify system size and components are present as per GAR plan (verify with contractor).

Supervision before, during, and after construction should be done by qualified professionals. Certified Solar Energy Professionals have training and experience with the required safety, electrical, plumbing and building codes and standards required by the authority having jurisdiction to install or inspect systems. Visit http://www.nabcep.org/ for more information about certification requirements for solar professionals. A certified, licensed, bonded and experienced solar installer should be consulted for commercial systems. Electrical wiring for pumps and monitoring systems is typically more complicated for commercial-scale systems.

Qualified professionals for solar systems include, but are not limited to the following:

- Master Plumbers
- Master Electricians
- Licensed Carpenters/Roofers
- Professional Engineers
- Certified Solar Energy Professionals

RECOMMENDED STANDARDS

Solar Photovoltaics

The Solar America Board for Codes and Standards is the national best practices organization for solar photovoltaic codes and standards. This organization tracks, evaluates and provides industry collaboration on improving and standardizing solar codes and standards for industry professionals. Visit http://www.solarabcs.org/codes-standards/IAPMO/index.html.

Solar Thermal Systems

Solar heaters or solar thermal systems provide clean heat energy for water or space heating. The systems collect the sun's energy to heat air or a fluid. The Solar Rating and Certification Corporation (SRCC) and the Florida Solar Energy Center (FSEC) certify and rate solar thermal systems and equipment. SRCC has a directory of certified systems along with system performance ratings on their web site for use in comparing both individual collectors and complete systems. http://www.solar-rating.org/ratings/index.html.

DESIGN AND CONSTRUCTION PROCESS

Prior to plan submittal, the Landscape Expert will coordinate with the solar professional to collect all necessary plan submittals. At the completion of construction, the Landscape Expert will visually confirm the installation of the renewable energy system.

The design of a PV or solar thermal system is generally based on unshaded access to the sun's radiant energy, site orientation relative to the sun, and structural capacity of the site hosting the solar collection modules or panels. The following steps are required to complete design and installation of solar systems in the District of Columbia.

For solar photovoltaic systems, the electrical professional (design engineer, contractor, or installer) is responsible for the following:

1. Site evaluation: To determine available daily solar resource and how much energy can be produced from a given site.
2. System design: Engineer/system designer determines system size (number of modules), array's geographic orientation, inverter type, balance of system components, the tilt/azimuth of solar panels to maximize performance, integration with vegetated roofing systems, etc.
3. Installation: Design approval through DCRA zoning, building and electrical permits, and historic preservation office (if required). Designs must be approved before installation. Utility grid interconnection application (complete with system capacity and approved DCRA plans) submitted to Pepco for request to interconnect.

For solar thermal systems, the heating professional (design engineer, contractor or installer) is responsible for the following:

1. Site evaluation: The type of system, including the type of thermal collector and whether it is active or passive, depends on several factors. These include proposed site, local climate, installation considerations (distance of pipe runs, building height, pressure, flow rates, existing building construction, etc.), cost, and the use of the solar heating system (domestic water or space heating).
2. System design: Engineer/system designer determines system size (number of collectors); location; and number and type of piping, control valves, storage tanks, circulating pumps (active systems), controls (active systems), and British thermal unit (Btu) meters.
3. Installation: Design approval through DCRA zoning, building and plumbing. Electrical permitting may be required for larger active systems. Plan reviewers of the authority having jurisdiction (DCRA) make the determination and notify the installer submitting the plan. Upon plan approval, a master plumber/engineer finalizes system installation and interconnection to building plumbing.

RESOURCES

District of Columbia Interconnection Application and Agreement Form
http://www.pepco.com/_res/documents/dc_level1_interconnection_application_agreement_pepco.pdf.

REFERENCES

"Installing and Maintaining a Home Solar Electric System"
http://energy.gov/energysaver/articles/installing-and-maintaining-home-solar-electric-system.

"Solar Water Heating System Maintenance and Repair"
http://energy.gov/energysaver/articles/solar-water-heating-system-maintenance-and-repair.

"Solar Water Heaters" consumer guide, how they work
http://energy.gov/energysaver/articles/solar-water-heaters.

District Department of the Environment, Renewable Energy Programs "Green Energy DC"
http://green.dc.gov/service/green-energy-dc.

5.10 Water Features

The landscape element "Water Features" consists of amenities such as fountains, pools, or other constructed elements.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Water Features													

RELATED ADMINISTRATIVE CONSIDERATIONS
Refer to the DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting" for additional guidance.

Also refer to the DDOE 2013 Stormwater Management Guidebook, Appendix M "Tiered Risk Assessment Management: Water Quality End Use Standards".

The DC Plumbing Construction Code provides additional guidance on the uses of potable and non-potable water sources for the design and construction of water features.

REQUIREMENTS

CALCULATING THE SCORE
Measure water features by the area of the site covered with water at least six months of the year.

GAR Landscape Elements	Multiplier
Water features	0.2

DESIGN
- The credited area of the landscape element must be covered with water a minimum six months of the year.
- Harvested rainwater must provide at minimum 50% of the annual flow.
- Water must re-circulate in the system to conserve water and inhibit mosquito breeding.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Plumbing and drainage plan – the drawings must demonstrate that harvested stormwater provides at least 50% of annual water flow. Provide a water budget indicating the percentage of water demand met by rainwater, calculated on a monthly and annual basis.
- Plans and details with associated dimensions - the drawings must demonstrate the area of the landscape element covered with water a minimum six months of the year.

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Confirm the credited water coverage area upon completion of construction.
- Review records that confirm fountain system is functional and connected to a harvested stormwater system. Test the system during the Final Inspection if feasible.

RECOMMENDED STANDARDS

District of Columbia Construction Code – comply with all relevant sections of the Plumbing, Mechanical, and Green Construction Code for water feature design and construction. Refer to appropriate standards for: potable water connections, installation, insect and vermin control, drainage, freeze protection, trenching requirements, rainwater catchment and collection systems, tests and inspections, operations and maintenance manuals, discharge system, metering, and other necessary features.

Harvested rainwater storage devices– cisterns must be designed by a qualified professional with consideration for: the size, location, filtration, pump type, construction material, and contributing drainage area. Refer to Chapter 3.3 of the DDOE 2013 Stormwater Management Guidebook for additional guidance. **Water quality and Risk Assessment** - the DDOE 2013 Stormwater Management Guidebook, Appendix M, details the process for the designer and owner to evaluate health risks and treatment standards for harvested stormwater based on collection surfaces, proposed uses, and exposure pathways. Oversight of the Tiered Risk Assessment process and water treatment measures fall outside the scope of the Green Area Ratio. Any proposed GAR water features also outside the scope of the Stormwater Management regulations must be independently assessed by the project applicant for associated health risk.

REFERENCES

DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 “Rainwater Harvesting”

DDOE 2013 Stormwater Management Guidebook, Appendix M “Tiered Risk Assessment Management: Water Quality End Use Standards”

5.11 Native Plants

Native plant species provide an additional environmental benefit beyond that of non-native plants. Likewise, the landscape element "Native Plants" provides additional GAR credit above that of already-credited planting landscape elements.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Native Plants													

REQUIREMENTS

CALCULATING THE SCORE

Native Plants are a bonus feature; as such, determine the cumulative square footage of all native plantings already credited under the below-listed landscape elements.

Green Area Ratio Landscape Elements	Equivalent Square Footage (ft^2 per plant/tree)
Groundcovers, or other plants less than 2 feet tall at maturity	Square footage at maturity
Plants, not including grasses, at least 2 feet tall at maturity	9
Tree canopy for trees 2.5–6 inches in diameter	50
Tree canopy for trees 6–12 inches in diameter	250
Tree canopy for trees 12–18 inches in diameter	600
Tree canopy for trees 18–24 inches in diameter	1,300
Tree canopy for trees larger than 24 inches in diameter	2,000

The cumulative square footage is then computed against the 0.1 multiplier.

GAR Landscape Elements	Multiplier
Native plant species listed in §3403.9 (Bonus credit)	0.1

DESIGN

- The plant species must be listed in the U.S. Fish and Wildlife Service's Native Plants for Wildlife Conservation Landscaping: Chesapeake Bay Watershed Guide. For more information on plant selection visit: http://nativeplantcenter.net/, or http://www.nps.gov/plants/pubs/chesapeake/.
- Alternatively, the applicant will provide two (2) references in current publications showing that the plant is native to the region.
- The plant is not listed on the U.S. Fish and Wildlife Service's list of Plant Invaders of Mid-Atlantic Natural Areas.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Identify the species, quantity and square footage for each native species being credited.

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Confirm that all credited plant species are natives as per the approved plan.

RESOURCES

For more information on plant selection visit: http://nativeplantcenter.net/.

U.S. Fish and Wildlife Service's Native Plants for Wildlife Conservation Landscaping: Chesapeake Bay Watershed Guide, http://www.nps.gov/plants/pubs/chesapeake.

5.12 Food Cultivation

Locally grown food enables individuals to reduce travel required for food purchases as well as provides a healthy and fresh alternative to other food sources. The landscape element "Landscaping in Food Cultivation" provides additional GAR credit above that of credited soil, vegetated wall, and vegetated roof landscape elements.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Food Cultivation													

REQUIREMENTS

CALCULATING THE SCORE

"Landscaping for food cultivation" is a bonus feature; as such, the square footage is measured equivalent to cultivated areas under the items "Landscaped areas with soil depth (of less than 24 inches/of 24 inches or more), Vegetated walls, and Vegetated roofs."

In addition to the above-listed landscape elements, bonus credit is also given to perennial and woody planting square footage. To determine the cumulative square footage of all related plantings already credited under the below-listed landscape elements, apply the chart below.

Green Area Ratio Landscape Elements	Equivalent Square Footage (ft^2 per plant/tree)
Groundcovers, or other plants less than 2 feet tall at maturity	Square footage at maturity
Plants, not including grasses, at least 2 feet tall at maturity	9
Tree canopy for trees 2.5–6 inches in diameter	50
Tree canopy for trees 6–12 inches in diameter	250
Tree canopy for trees 12–18 inches in diameter	600
Tree canopy for trees 18–24 inches in diameter	1,300
Tree canopy for trees larger than 24 inches in diameter	2,000

The cumulative square footage is then computed against the 0.1 multiplier.

GAR Landscape Elements	Multiplier
Food cultivation (Bonus credit)	0.1

DESIGN

- Access to food cultivation area by at least one building occupant.
- A water source must be available to all food cultivation plantings.
- Annual, perennial, and woody crops are all suitable for credit.
- Animal cultivation is not creditable.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- Location, species, and areas designated for food cultivation
- Identify building access
- Type and location of water source

CONSTRUCTION INSPECTION

The Certified Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Confirm the area designated for food cultivation is suitable to crop growth.
- Confirm planting of crops. If work is completed at a time inappropriate for crop growth, stabilize the soil with a cover crop, straw, or similar erosion control method.

5.13 Harvested Stormwater Irrigation

Stormwater collected from rooftops or other contributing drainage areas can be directed to storage devices, such as cisterns or rain barrels, and used for landscape irrigation. The landscape element "Harvested Stormwater Irrigation" provides additional GAR credit for the landscape element Landscape areas with soils receiving irrigation from collected stormwater.

INTEGRATION

Suggested Coordination of Design Across Landscape Elements	Soils & Amendments	Bioretention	New & Existing Planting	Tree Preservation	Vegetated Walls	Vegetated Roofs	Permeable Paving	Enhanced Tree Growth	Renewable Energy	Water Features	Native Plants	Food Cultivation	Harvested Stormwater Irrigation
Harvested Stormwater Irrigation													

RELATED ADMINISTRATIVE CONSIDERATIONS

Refer to the DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting" for additional guidance.

Refer to the DC Green and Plumbing Construction Codes for additional guidance on designing the water feature landscape element.

REQUIREMENTS

CALCULATING THE SCORE

The Harvested Stormwater Irrigation landscape element is a bonus feature; as such it is measured as additional credit through the square footage of landscape irrigation coverage area. To calculate multiply the coverage area by the 0.1 multiplier.

GAR Landscape Elements	Multiplier
Harvested stormwater irrigation (Bonus credit)	0.1

DESIGN

- If the irrigation type is spray, applicants shall follow treatment standards set forth in the DDOE 2013 Stormwater Management Guidebook.
- If irrigation type is drip, no additional treatment of stormwater is required.
- Irrigation may be supplied by a combination of harvested rainwater and the public water supply. The percentage of irrigation water demand met by harvested rainwater must be greater than 50% of annual usage. The default water demand for irrigation is 1.0 inch per week over the area to be irrigated. Justification must be provided if larger volumes are to be used.

PLAN SUBMITTAL

In addition to complying with the design standards, submitted GAR plans shall include the following:

- If using spray irrigation, identify treatment standards consistent with the DDOE 2013 Stormwater Management Guidebook.
- Submit a schematic irrigation and drainage plan showing:
    - Areas to receive irrigation
    - Delivery system (spray, drip)
    - Anticipated water demand from plantings that require irrigation
    - Water budget indicating percentage of water demand met by rainwater, calculated on a monthly and annual basis
    - Drainage plan for all irrigated areas

CONSTRUCTION INSPECTION

The Landscape Expert is responsible for reviewing the following construction items for accuracy prior to sign off of the Landscape Checklist:

- Confirm the effective planting area receiving irrigation from harvested stormwater system.
- Review records that confirm irrigation system is functional and connected to a harvested stormwater system. Test the system during the Final Inspection if feasible.

Additional measures that must be reviewed by a qualified professional:

- Cistern or rain barrel appropriately sized for contributing drainage area
- Overflow is sufficiently sized and directed away from building foundation
- Pretreatment system is installed
- Pump appropriately sized for irrigation tubing diameter and length

- Cistern or rain barrel is accessible for maintenance
- Cistern or rain barrel footing is sufficient to handle load
- Treatment of spray irrigation measures

Refer to the DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting" for additional guidance.

RECOMMENDED STANDARDS

The Landscape Expert will coordinate with qualified professionals in the design and construction of harvested stormwater irrigation systems.

IRRIGATION

General Recommendations

- The irrigation specification should include a recommended initial irrigation frequency and time, based upon the season and plant requirements.
- Selection and placement of sprinkler and drip/micro-irrigation components should be guided by the larger plants expected size. Irrigation zones shall be based on plant water needs with plants of similar need grouped together.
- Place and direct the irrigation heads for minimal overspray or spray onto non-landscape areas.

Delivery of harvested stormwater is accomplished through two primary approaches:

Drip Irrigation
Drip irrigation is an appropriate approach for planting beds, living walls, and green roofs. When irrigation lines are subject to photo-degradation, protect from exposure to sunlight.

Spray Irrigation
Spray irrigation requires water quality treatment in accordance with the 2013 DDOE Stormwater Management Handbook.

CISTERN
Cisterns and rain barrels are cost effective and environmentally friendly measures one can use to supply water to vegetated areas. Harvesting stormwater for irrigation helps to reduce the peak hydrograph, restore natural hydrology, and save money on water bills. Harvested stormwater can be applied to vegetated areas via drip or spray, and can be gravity-fed or pumped. Choosing the right cistern or rain barrel and pump will depend on a variety of factors.

Cistern size and location, contributing drainage area, placement, footing, filters, associated plumbing and pumps must comply with the DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting," and be designed by a qualified professional. The

Landscape Expert will work in coordination with qualified professionals to determine planting areas requiring harvested stormwater irrigation and associated irrigation water demand.

Cistern Size
The volume of the water captured will depend on the size of the impervious contributing drainage area and the size of the cistern, which should be balanced against the water demand of the irrigated lands. The quantity of water captured should reflect the water demand of the irrigated areas. Calculate the watering rate (output) needed based on the plant species present.

Cistern or Rain Barrel Location
The cistern or rain barrel should be located in close proximity to the vegetated areas where the water will be applied. Above ground cisterns are less expensive to install as they do not require excavation. Aboveground cisterns need to be taken offline in the winter months to avoid freeze/thaw. Cisterns larger than 5,000 gallons will need a structural design to account for wind and load. Below ground system save valuable land space, but require excavation, thus increasing installation costs. Most commercial projects utilize below ground systems.

Pump Type and Placement
If the irrigated areas are not at a 10% negative slope from the cistern or rain barrel, a pump is recommended. Pumps can be submersible or in-line, suction pumps. Submersible pumps are placed directly in the cistern. Pump must be hard wired with power into cistern. Suction or in-line pumps are placed aboveground, but are limited by depth and pressure. A low-pressure transfer suction pump can be connected to the cistern with an additional pressure booster pump.

Filters or Sediment Traps
A fine-mesh filter or sediment trap must be used to capture fine particulate matter such as debris from asphalt shingles, leaf litter, or twigs.

Cistern or Rain Barrel Material
Cisterns or rain barrels can be made of materials such as polyethylene, plastic, concrete, steel-reinforced polyethylene, and fiberglass.

Water Demand for Landscaping - [Landscape Expert coordinates with qualified professionals.] The design plan elements must include the proposed delineation of planting areas to be irrigated, the planting plan, and quantification of the expected water demand. The default water demand for irrigation is 1.0 inch per week over the area to be irrigated. Justification must be provided if alternative volumes are to be used. Irrigation may be supplied by a combination of harvested rainwater and the public water supply. The percentage of irrigation water demand met by harvested rainwater must be greater than 50% of annual usage. In collaboration with the design engineer, refer to the 2013 Rainwater Harvesting Retention Calculator, http://ddoe.dc.gov/node/610622, for guidance in identifying the percent demand met by harvested rainwater.

REFERENCES

"Best Practices: Turf and Landscape Best Management Practices," Irrigation Association, http://www.irrigation.org/uploadedFiles/Resources/BMP_Revised_12-2010.pdf.

DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting," pp. 43–65, 2013.

RESOURCES

2013 Rainwater Harvesting Retention Calculator, http://ddoe.dc.gov/node/610622.

Chapter 6 Landscape Maintenance Plan

The landscape maintenance plan serves as guidance for the property owner to properly maintain the landscape elements installed under the Green Area Ratio. When suitable, coordinate submission of Green Area Ratio (GAR) landscape maintenance plans with those required under the DDOE stormwater management regulations.

SUBMITTAL REQUIREMENTS

The landscape maintenance plan must be prepared and signed by the Certified Landscape Expert. The plan is submitted within the plan set, as part of the building permit application. The plan describes how to properly maintain all components of the approved GAR landscape elements.

A GAR landscape management plan should address maintenance activities and schedules for each landscape element. The plan should address but not be limited to the following subject areas:

- Soil preparation
- Use of compost
- Plant replacement
- Irrigation
- Weed and pest control
- Control of noxious or invasive species
- Water features
- Hardscape features

PROPERTY OWNER RESPONSIBILITY

The landscape maintenance plan must be issued to the property owner prior to the Certified Landscape Expert completing the Landscape Checklist. This plan serves as guidance for the property owner to ensure all GAR-related features are maintained. The property owner and all subsequent owners are obliged to maintain the GAR score at or above the minimum level set in the regulations. Should the GAR score fall below the minimum required, other GAR environmental performance features can be substituted to achieve an appropriate score; this process does not require plan resubmittal.

ANACOSTIA WATERSHED DEVELOPMENT ZONE

Where GAR sites within the AWDZ fall under its requirements, landscape management plans must be consistent with the Integrated Pest Management Plan. Refer to Appendix R, "Integrated Pest Management" in the DDOE 2013 Stormwater Management Guidebook for additional guidance.

LANDSCAPE MAINTENANCE PLAN GUIDELINES

Recommended maintenance activities are listed for each landscape element. Maintenance activities should be done by a qualified individual. The maintenance professional should exercise proper judgment in regards to personal safety.

SOILS AND AMENDMENTS

Soil maintenance plans should provide guidance for: soil amendment application rate, schedule of work, and material source.

Decompaction

- Decompact topsoil by tilling or subsoiling and incorporating compost throughout the depth of compacted soil. Do not till soils underneath existing trees; instead consider practices such as mulching under the canopy or air tilling to ameliorate compaction.

Rate and application schedule

- Mulch – Apply yearly or as necessary to replace decomposed mulch.
- Compost – Apply compost yearly at a depth of 1–2 inches. Coarse textured sand and clay soils require greater compost addition than loamy soils. The organic matter content of the chosen compost will influence the depth applied.
- Fertilizer – Apply fertilizer only after incorporating compost into topsoil and conducting a soil test. This will avoid over-application of nutrients, as compost itself will increase the nutrient content.

Material source

- Compost should be well-decomposed material, stable, free of weeds, contaminants and foul odors. Compost may be derived from yard waste (decomposed leaves, grass clippings, branches) or food waste.
- Mulch can be derived from organic sources such as shredded bark, or leaf mulch.

BIORETENTION

Maintenance criteria for bioretention can be found in Chapter 3.6.7 (pp.124–126) of the DDOE 2013 Stormwater Management Guidebook.

Table 9 Bioretention Maintenance Tasks (Source: 2013 SWMG, Table 3.25)

Frequency	Maintenance Tasks
Upon establishment	• For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 1/2 inch of rainfall. Conduct any needed repairs or stabilization. • Inspectors should look for bare or eroding areas in the contributing drainage area or around the bioretention area, and make sure they are immediately stabilized with grass cover. • One-time, spot fertilization may be needed for initial plantings. • Watering is needed once a week during the first 2 months, and then as needed during first growing season (April-October), depending on rainfall. • Remove and replace dead plants. Up to 10% of the plant stock may die off in the first year, so construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.
At least 4 times per year	• Mow grass filter strips and bioretention with turf cover • Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow
Twice during growing season	• Spot weed, remove trash, and rake the mulch
Annually	• Conduct a maintenance inspection • Supplement mulch in devoid areas to maintain a 3 inch layer • Prune trees and shrubs • Remove sediment in pretreatment cells and inflow points
Once every 2–3 years	• Remove sediment in pretreatment cells and inflow points • Remove and replace the mulch layer
As needed	• Add reinforcement planting to maintain desired vegetation density • Remove invasive plants using recommended control methods • Remove any dead or diseased plants • Stabilize the contributing drainage area to prevent erosion

NEW AND EXISTING PLANTINGS

All Plantings

- Provide supplemental watering if rainfall is less than 1 inch per week during the first two growing seasons.
- Conduct weeding as necessary to reduce competition between weeds and plantings for nutrients, soil moisture, and sunlight.
- Replace mulch every 2–3 years, or as necessary to recommended depth (see below).
- Monitor the plantings for disease or stress and modify cultural practice as necessary. Employ an integrated pest management (IPM) approach if possible.
- Remove dead plant material and replant in the next appropriate growing season.

Trees and Shrubs

- For trees, install slow leak watering bags or tree buckets during the first two growing seasons. Water as necessary to supplement precipitation if less than 1 inch per week. Remove watering bags or tree buckets after plants have established.
- Inspect trees for signs of dead, diseased, or crossing branches and prune accordingly. Remove hazard limbs from established trees. Never remove more than 20% of the tree canopy during pruning activities in any year.
- Spread mulch at a maximum 3-inch depth and ensure mulch is not against the trunk of the tree.
- Maintain tree health by limiting all grade changes and other soil disturbance underneath the tree's Critical Root Zone.

Perennials and Groundcovers

- In the early spring, deadhead top-growth from perennials and warm-season grasses.
- Periodically divide perennials as necessary to encourage rejuvenated growth.
- Spread mulch at a maximum 2-inch depth.

Turfgrass

- Apply lime and fertilizer only as soil test results indicate.
- To reduce weed germination, maintain turfgrass at an increased height. Never mow more than one third of the grass height. Maintaining grass clippings in-place after mowing reduces fertilizer requirements.
- Regularly monitor and over-seed bare spots to prevent weed establishment.
- In late fall, core aerate and top-dress with organic matter.

TREE PRESERVATION

- The property owner must replace dead trees with an equivalent landscape element to meet the minimum-required GAR score for the site.
- Where appropriate, spread 3 inches of organic mulch over the soil surface out to the drip line of preserved tree. If preserved trees are clustered, mulch the entire planting area. Mulch should never be more than 4 inches deep or applied to the tree trunk.
- Apply slow-decomposing organic mulches, such as shredded bark, compost, leaf mulch, or wood chips. Grass clippings and sawdust are not recommended as mulches because they decompose rapidly.
- As needed, prune dead, diseased, broken or crossing branches. Elevate lower branches to provide clearance for pedestrian and vehicular below. Never prune more than 20% of a tree canopy per year.
- Existing trees whose roots have been pruned during construction should be watered at least once a week during the first growing season after construction.
- Water trees deeply and slowly to encourage deeper root growth. Soaker hoses and drip irrigation work best for deep watering of trees.
- Consult with a qualified professional for tree pruning, fertilization, and hazard condition management.

VEGETATED WALLS

Many vegetated walls are proprietary systems constructed and maintained by a company, for a contractually defined duration. Below are general guidelines for maintaining vegetated walls:

Living Facades

- Periodically inspect roof gutters and drains for clogging with vegetation or debris.
- Cable systems may require re-tensioning or inspection of the integrity of wall tie-ins.
- Schedule regular plant maintenance during establishment and ongoing growth. Inspect the plants for signs of disease, weed competition, training along the support structure, and pruning needs.

Living Walls

- Individual vegetated panels from living walls should be removed to inspect the wall and support structures for drainage and anchorage issues. Clean all drains and gutters yearly.
- When using harvested stormwater irrigation, valves and fertilizer injectors should be checked for function, and the irrigation pipes checked for leaks. Schedule frequent irrigation inspections. Drip irrigation emitters should be checked during operation to ensure water is being delivered to all panels. Winterize irrigation systems as per the irrigation specification.

- Schedule regular plant maintenance during establishment and ongoing growth. Inspect the vegetated wall for signs of disease, inadequate irrigation, and erosion.

VEGETATED ROOFS

A vegetated roof should be inspected by a qualified professional twice a year during the growing season to assess vegetative cover and to look for leaks, drainage problems, and any rooftop structural concerns (see Table 1).

Drainage and Waterproofing Systems

- If a roof leak is suspected, it is advisable to perform an electric leak survey (e.g., EVFM), if applicable, to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.
- Inspect drainage structures for blockage or signs of loss of soil media.

Soil and Vegetation

- The vegetated roof should be hand weeded to remove invasive or volunteer plants, and plants and/or media should be added to repair bare areas.
- The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of some waterproofing membranes. Check with the membrane manufacturer for approval and warranty information.
- Irrigation of intensive roofs is recommended. Extensive roofs do not require permanent irrigation but should have access to irrigation as needed, through hose bibs.
- Also, power washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the vegetated roof plant communities.
- Fertilization is generally not recommended due to the potential for leaching of nutrients from the vegetated roof. Supplemental fertilization may be required following the first growing season, but only if plants show signs of nutrient deficiencies and a media test indicates a specific deficiency. Addressing this issue with the holder of the vegetation warranty is recommended. If fertilizer is to be applied, it must be a slow-release type, rather than liquid or gaseous form.

Forms for DDOE's "Green Roof Maintenance Inspection Report" for vegetated roofs and the "Maintenance Service Completion Inspection Report" can be found in Appendix L of the DDOE 2013 Stormwater Management Guidebook.

Table 10 Typical Maintenance Activities Associated with Vegetated Roofs

Schedule Following Construction	Activity
As needed or as required by manufacturer	• Water to promote plant growth and survival. • Inspect the vegetated roof and replace any dead or dying vegetation.
Semi-annually	• Inspect the waterproof membrane for leaks and cracks. • Weed to remove invasive plants (do not dig or use pointed tools where there is potential to harm the root barrier or waterproof membrane). • Inspect roof drains, scuppers, and gutters to ensure they are not overgrown and have not accumulated organic matter deposits. Remove any accumulated organic matter or debris. • Inspect the vegetated roof for dead, dying, or invasive vegetation. Plant replacement vegetation as needed.

PERMEABLE PAVING

Maintenance is critical to the performance and longevity of permeable paving systems. Clogging of paver systems with sediment and organic material is the most frequently cited maintenance item. Regular street sweeping and inspection of the paver system is required to remove accumulated sediment and to provide maintenance repairs as needed to help prevent clogging. It is critical that surrounding areas remain stabilized and do not introduce sediment on to the permeable pavement.

Table 11 Typical Maintenance Tasks for Permeable Paving Practices

Frequency	Maintenance Task
After installation	For the first 6 months following Construction, the practice and Contributing Drainage Area (CDA) should be inspected at least twice a week after storm events that exceed ½ inch or rainfall. Stabilized any failing areas that may be depositing sediment on to the pavement areas
Once every 1-2 months during the growing season	Mow the grass in a vegetated permeable pavement application.
As Needed	Stabilize the CDA to prevent erosion Remove any soil or sediment deposit on Pavement Replace or repair any pavement surfaces that are degenerating or spalling
2–4 times a year	Mechanically sweep pavement with standard street sweeper
Annually	Conduct a maintenance inspection Spot weed for grass applications
Once every 2–3 Years	Remove any accumulated sediment in pretreatment areas and inflow areas
If clogged	Conduct maintenance using a regenerative street sweeper or vacuum sweeper. Replace any joint materials

ENHANCED TREE GROWTH

Periodically perform the following maintenance activities:

- Inspect pavement for settling or heaving and correct as necessary.
- Inspect and clear irrigation and drainage components, if present.

RENEWABLE ENERGY

Solar photovoltaic and solar thermal systems require periodic inspections and routine maintenance to keep them operating efficiently. Also, from time to time, components may need repair or replacement. System owners should also take steps to prevent scaling, corrosion, and freezing with solar thermal systems.

Property owners might be able to handle some of the inspections and maintenance tasks on their own, but more complicated systems and equipment may require a qualified technician. Ask for a cost estimate in writing before having any work done. For some systems, it may be more cost effective to replace, shut off, or remove the solar system than to have it repaired. Refer to manufacturer-provided owner's manual for additional guidance.

Periodic Inspection List
The following are suggested inspections of solar photovoltaic and solar thermal components:

- Collector shading
- Collector soiling
- Collector glazing and seals
- Plumbing, ductwork, and wiring connections
- Piping, duct, and wiring insulation
- Roof penetrations
- Support structures
- Pressure relief valves (on liquid solar heating collectors)
- Dampers (in solar air heating systems)
- Pumps or blowers
- Heat transfer fluids
- Storage systems
- Review of Emergency and Safety components

WATER FEATURES

Water feature devices should be maintained by a qualified professional. Refer to product manufacturer guidance material for maintenance instruction. Comply with all DC Codes for water quality treatment.

- Comply with DC codes and refer to materials supplied by product manufacturer for maintenance guidance.
- Take measures to protect all piping and storage tanks from freezing.
- Periodically clean and maintain all filtration devices.
- Repair all erosion or other sources of contamination in the harvested stormwater contributing drainage area.

NATIVE PLANTS

By selecting species appropriate to the site, native plants will require minimal maintenance, including reduced fertilizer, herbicide, and pesticide applications.

FOOD CULTIVATION

The property owner is required to maintain areas credited under "Landscaping for Food Cultivation" yearly, in accordance with seasonal restrictions. Should a property owner not wish to continue growing food crops, they must ensure that the minimum GAR scored is achieved otherwise.

Recommended maintenance schedule for food cultivation crops include the following:

Spring

- Till the cover crop or remove straw mulch to prepare for planting of crops.
- Incorporate organic matter and fertilize as soil tests deem necessary.
- Plant cool-weather crops.
- Apply mulch to non-planted areas to retain moisture and reduce weed pressure.

Summer

- Harvest cool season crops
- Plant warm season crops early in season
- Employ an integrated pest management strategy to control garden pests and diseases
- Periodic weeding and irrigation as needed

Fall

- Place a winter cover crop or mulch over the exposed soil.

HARVESTED STORMWATER IRRIGATION

Harvested stormwater irrigation devices should be maintained by a qualified professional. Refer to product manufacturer guidance material for maintenance instruction.

Cistern

- The cistern must be cleaned yearly. To clean, use a submersible pump to remove the water. Brush walls with a hard bristle brush or use a high pressure cleaner.
- Purpose of the maintenance is to remove the sediment that inevitably deposits on the cistern's floor and which may give rise to parasitic fermentation and odor. The rate at which the sediment accumulates depends on the region's atmospheric pollution (for dust), the roof type, and the quality of the set-up upstream from the cistern storage compartment.
- A fine mesh filter placed between the roof gutter's main downspout and the sedimentation basin will substantially delay the accumulation of sediment in the barrel or cistern. Additionally, a sedimentation basin equipped with an appropriate trapped overflow that prevents the passage of floating impurities can work. Filters need to be cleaned monthly.

- Cisterns and rain barrels should be dewatered often to ensure available volume on the onset of rain events.

Irrigation

- Conduct frequent inspections to verify integrity of irrigation system.
- Periodically review the pressure regulators, filters, controller, sensors, valves, sprinkler heads and other system components to verify they meet original design criteria for efficient operation and uniform water distribution.
- Ensure that replacement hardware used for system repairs matches the existing hardware, and is in accordance with the design. Ensure that system modifications are in keeping with design specifications and do not cause water demand to exceed the system's hydraulic capacity.
- Winterize irrigation systems and re-establish operation in the spring.

Refer to the DDOE 2013 Stormwater Management Guidebook, Chapter 3.3 "Rainwater Harvesting" for additional guidance.

Appendix A Forms

This appendix includes figures of the following forms:

- Green Area Ratio Worksheet
- Green Area Ratio Scoresheet
- Green Area Ratio Landscape Checklist
- Application for Exemption Status
- Application for Transition Exemption Status

These forms are available electronically at ddoe.dc.gov/GAR.

GREEN AREA RATIO Worksheet*

GOVERNMENT OF THE DISTRICT OF COLUMBIA
Vincent C. Gray, Mayor

		Quantity of GAR Features per Submitted Sheet						
		Sheet #__	Sheet #__	Sheet #__	*keep adding columns as needed*			TOTAL**
A1	*square feet*							0
A2	*square feet*							0
A3	*square feet*							0
B1	*square feet*							0
B2	*# of plants*							0
B3	*# of trees*							0
B4	*# of trees*							0
B5	*# of trees*							0
B6	*# of trees*							0
B7	*# of trees*							0
B8	*# of trees*							0
B9	*square feet*							0
C1	*square feet*							0
C2	*square feet*							0
D1	*square feet*							0
D2	*square feet*							0
E1	*square feet*							0
E2	*square feet*							0
E3	*square feet*							0
H1	*square feet*							0
H2	*square feet*							0
H3	*square feet*							0

*** See Green Area Ratio Scoresheet for category definitions**
**** Enter totals on the Green Area Ratio Scoresheet**

Green Area Ratio Scoresheet

Address

Other / BZA Order

Ward	Lot	Square	Zoning District

Lot size *(enter this value first)* *

enter sq ft of lot	multiplier	
0	SCORE	#DIV/0!

	Landscape Elements		Square Feet	Factor	Total
A	**Landscaped areas (select one of the following for each area)**				
1	Landscaped areas with a soil depth of less than 24"		enter sq ft 0	0.3	-
2	Landscaped areas with a soil depth of 24" or greater		enter sq ft 0	0.6	-
3	Bioretention facilities		enter sq ft 0	0.4	-
B	**Plantings (credit for plants in landscaped areas from Section A)**				
1	Groundcovers, or other plants less than 2' tall at maturity		enter sq ft 0	0.2	-
2	Plants, not including grasses, 2' or taller at maturity - calculated at 9 sq ft per plant (typically planted no closer than 18" on center)	enter number of plants 0	0	0.3	-
3	Tree canopy for all new trees 2.5" to 6" diameter or equivalent - calculated at 50 sq ft per tree	enter number of trees 0	0	0.5	-
4	Tree canopy for new trees 6" diameter or larger or equivalent - calculated at 250 sq ft per tree	enter number of trees 0	0	0.6	-
5	Tree canopy for preservation of existing tree 6" to 12" diameter or larger or equivalent - calculated at 250 sq ft per tree	enter number of trees 0	0	0.7	-
6	Tree canopy for preservation of existing tree 12" to 18" diameter or larger or equivalent - calculated at 600 sq ft per tree	enter number of trees 0	0	0.7	-
7	Tree canopy for preservation of all existing trees 18" to 24" diameter or equivalent - calculated at 1300 sq ft per tree	enter number of trees 0	0	0.7	-
8	Tree canopy for preservation of all existing trees 24" diameter or larger or equivalent - calculated at 2000 sq ft per tree	enter number of trees 0	0	0.8	-
9	Vegetated wall, plantings on a vertical surface		enter sq ft 0	0.6	-
C	**Vegetated or "green" roofs**				
1	Over at least 2" and less than 8" of growth medium		enter sq ft 0	0.6	-
2	Over at least 8" of growth medium		enter sq ft 0	0.8	-
D	**Permeable Paving*** **				
1	Permeable paving over at least 6" and less than 24" of soil or gravel		enter sq ft 0	0.4	-
2	Permeable paving over at least 24" of soil or gravel		enter sq ft 0	0.5	-
E	**Other**				
1	Enhanced tree growth systems***		enter sq ft 0	0.4	-
2	Renewable energy generation		enter sq ft 0	0.5	-
3	Approved water features		enter sq ft 0	0.2	-
		sub-total of sq ft =	0		
H	**Bonuses**				
1	Native plant species		enter sq ft 0	0.1	-
2	Landscaping in food cultivation		enter sq ft 0	0.1	-
3	Harvested stormwater irrigation		enter sq ft 0	0.1	-
				Green Area Ratio numerator =	-

*** *Permeable paving and structural soil together may not qualify for more than one third of the Green Area Ratio score.*

Total square footage of all permeable paving and enhanced tree growth -

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DISTRICT DEPARTMENT OF ENVIRONMENT
WATERSHED PROTECTION DIVISION/INSPECTION & ENFORCEMENT BRANCH

Green Area Ratio - Landscape Checklist

I, _____, declare as follows:
Full Name of Certified Landscape Expert (Printed)

☐ I am a Certified Landscape Expert, as defined in DCMR Title 11, Chapter 34, responsible for confirming installation of the approved landscape plan for development located at:

_____, Washington, DC, and developed pursuant to:
Street Address (Printed)

_____ _____
Building Permit Number DDOE Plan Number

_____ _____ _____
Ward Lot Square

☐ The landscape elements shown on the DDOE-approved landscape plan or DDOE-approved modification for this property have been installed as approved and in a manner consistent with the standards of 11 DCMR Chapter 34. This includes the number size, and approximate location of plantings and other approved landscape elements.

☐ Any changes or species substitutions (if applicable) have been approved by DDOE.

☐ A completed Landscape Maintenance Plan has been submitted to the property owner.

I declare under penalty of perjury under the laws of the District of Columbia that the following is true and correct.

_____ _____ _____
Signature of Certified Landscape Expert Certification/Registration Number Date

NOTE: If any landscape elements have been changed during installation, DO NOT SIGN OR SUBMIT this checklist until a revised landscape plan has been approved by the District Department of Environment. If you provide false information in this document, you may be subject to criminal or civil liability.

[TO BE COMPLETED BY DDOE INSPECTOR]

_____ _____ _____
Document received by: Inspector Signature Printed Name Date

DDOE (WHITE) OWNER/AGENT (YELLOW) LANDSCAPE EXPERT (GOLDENROD) INSPECTOR (PINK)

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF CONSUMER REGULATORY AFFAIRS

★ ★ ★

APPLICATION FOR EXEMPTION STATUS FROM D.C. ZONING REGULATION GREEN AREA RATIO

I hereby request evidence of exemption from the Green Area Ratio (GAR) Chapter 34 of DCMR Title 11 for the proposed construction on the property identified below.

Address: _____

Square: _____ Lot: _____

Allowable Exemptions (CHECK ONE):

	Single Family House or CBRF with fewer than six handicapped persons.
	R1 through R4 Zone Districts.
	Municipal wastewater treatment facilities operated by DC Water and Sewer Authority.
	Building(s) or structure(s) certified by the DC Inventory of Historic Sites, or State Historic Preservation Officer, as "historic resource(s)"; additions increase the gross floor area by less than 50 percent.
	Additions, interior renovations, or both are less than 100 percent of the assessed building value as set forth in the records of the Office of Tax and Revenue as of the date of the building permit application.
	Interior Renovations: (a) Central Employment Area, (b)100 percent lot occupancy, (c) existing roof not capable of supporting vegetated system, **and** (d) proposed work does not result in a roof capable of supporting vegetated roof. (*Note: all four conditions are required for this exemption*)

_____ _____
Applicant Telephone

_____
Address

_____ _____
Signature Date

DCRA, 1100 4th Street, SW, Suite E650 Washington, DC 20024 phone 202-442-4400 fax 202-442-9445

STRUCTURAL OFFICE USE ONLY

☐ I find there is sufficient evidence the existing roof for the property is NOT capable of supporting a vegetated system.

☐ I find there is sufficient evidence the proposed work will NOT result in a roof capable of supporting a vegetated system.

This review does not constitute an interpretation of zoning or building codes and does not entitle the applicant to any relief not authorized by zoning or building code officials pursuant to the applicable codes.

DCRA--STRUCTURAL Date

HISTORIC PRESERVATION OFFICE USE ONLY

I hereby certify that this property is either a historic landmark or a building or structure contributing to the character of a historic district listed in the D.C. Inventory of Historic Sites. *This certification does not constitute an interpretation of zoning or building codes and does not entitle the applicant to any relief not authorized by zoning or building code officials pursuant to the applicable codes.*

State Historic Preservation Officer Date

ZONING OFFICE USE ONLY [Exemption Categories—Section 3401]

☐ Single Family house
☐ R1 – R4 zoning district
☐ Municipal wastewater treatment facilities operated by DC Water and Sewer Authority
☐ Central Employment Area zoning district
☐ Additions will NOT result in an increase to the gross floor area by more than 50 percent (Historic Site)
☐ Additions, and/or interior renovations will NOT exceed 100 percent of the assessed building value

Office of Zoning Administrator Date

DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY OFFICE USE ONLY

I hereby certify that this property is a municipal wastewater treatment facility operated by DC Water & Sewer Authority. *This certification does not constitute an interpretation of zoning or building codes and does not entitle the applicant to any relief not authorized by zoning or building code officials pursuant to the applicable codes.*

DC Water and Sewer Authority Officer Date

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF CONSUMER REGULATORY AFFAIRS

APPLICATION FOR EXEMPTION STATUS FROM D.C. ZONING REGULATION GREEN AREA RATIO BASED ON TRANSITION PERIOD FILING STATUS

I hereby request evidence of a transition period exemption from the Green Area Ratio (GAR) Chapter 34 of DCMR Title 11 for the proposed construction on the property identified below.

Address: _____

Square: _____ Lot: _____

Allowable Transition Period Exemptions (CHECK ONE):

	Building Permit filed prior to October 1st, 2013.
	Unexpired approval of a first stage, second stage, or consolidated planned unit development (PUD) when vote to approve occurred before October 1st, 2013.
	Unexpired approval of a variance, special exception, design review under the CG or SEFC overlay when vote to approve occurred before October 1st, 2013.
	Unexpired approval of a concept design by the Historic Preservation Review Board or Commission of Fine Arts when vote to approve occurred before October 1st, 2013.
	Unexpired approval of a variance, special exception, design review under the CG or SEFC overlay when a public hearing occurred before October 1st, 2013.
	Unexpired approval of a first stage, second stage, or consolidated planned unit development (PUD) when public hearing occurred before October 1st, 2013.

NOTE: When impervious surface or lot occupancy is increased by 20 percent or more, that increase is not covered under this exemption. The GAR is applied to the modification.

_____ _____
Applicant Telephone

_____
Address

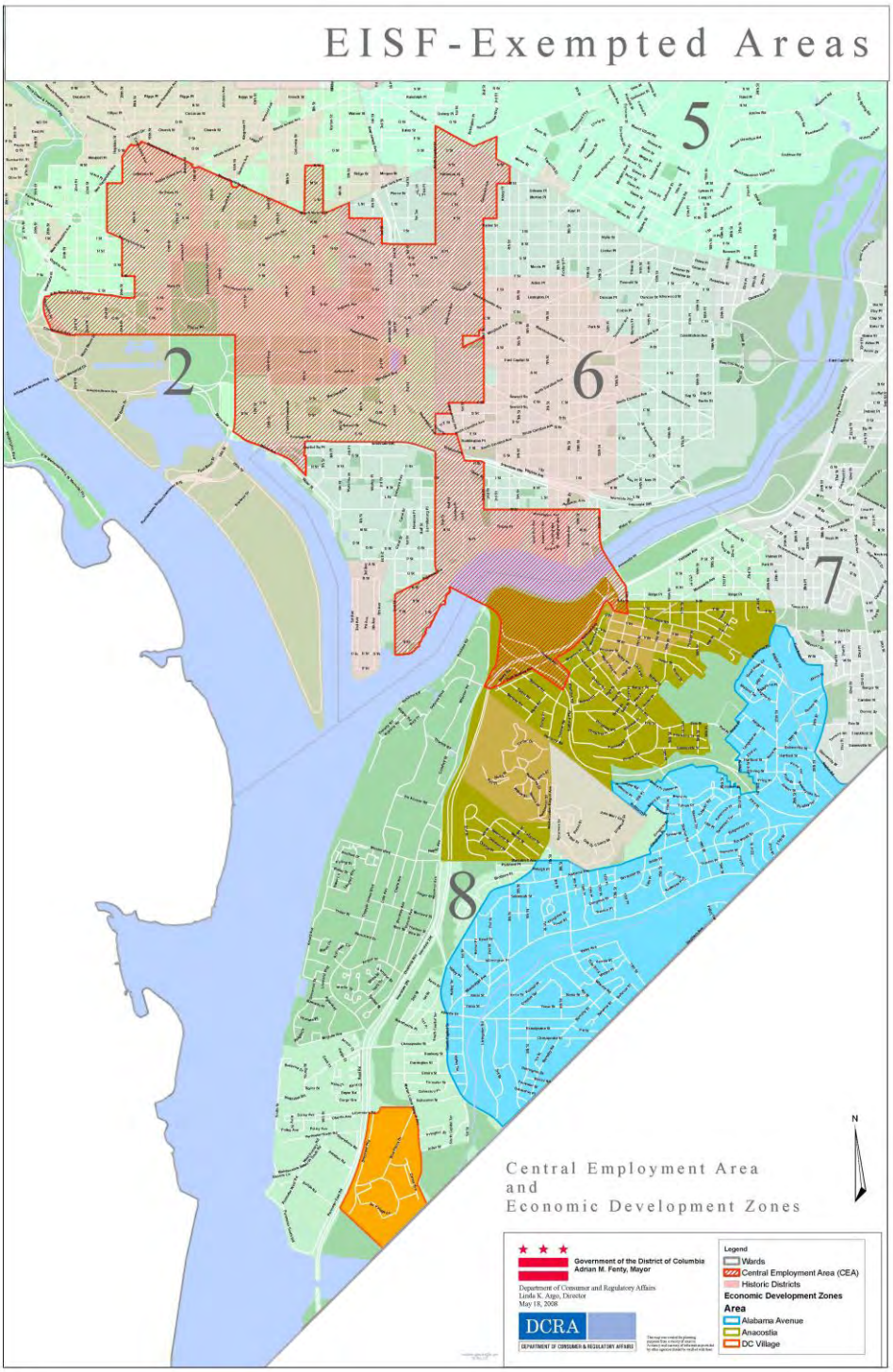
_____ _____
Signature Date

ZONING OFFICE USE ONLY

- ☐ Building Permit submitted prior 10/01/2013.
- ☐ PUD vote prior 10/01/2013.
- ☐ PUD with public hearing prior 10/01/2013.
- ☐ Variance, special exception, or design review under the CG or SEFC overlay vote prior 10/01/2013.
- ☐ Variance, special exception, or design review under the CG or SEFC public hearing prior 10/01/2013.
- ☐ Historic Preservation Review Board or Commission of Fine Arts vote prior 10/01/2013.

_____ _____
Office of Zoning Administrator Date

Appendix B Map of Central Employment Area



Appendix C Glossary

Applicant – the person or their agent who applies for the building permit and certificate of occupancy.

Building permit – Authorization for construction activity issued by the District of Columbia Department of Consumer and Regulatory Affairs.

Caliper – measurement standard for new trees according to ANLA American Standards for Nursery Stock.

Canopy radius – distance from the tree trunk to its dripline.

Central Employment Area – refer to Appendix C or the link below for defined area: http://dc.gov/DCRA/Permits/EISFExemptedAreas_Map.pdf

Certificate of Occupancy – granted by the Office of Zoning Administrator at DCRA after ensuring that the use of building, structure, or land in the District of Columbia conforms to the Zoning Regulations (11 DCMR) , and to the provisions of the DC Building Code (12 DCMR).

Certified Landscape Expert – professionals (defined under 11 DCMR §3404.2) qualified to review and sign GAR plans and Landscape Checklist for conformance with GAR requirements.

Compaction – compression and loss of pore space in soil resulting in conditions unsuitable to root growth. This is measured by increased soil resistance to a penetrometer or increased bulk density.

Critical Root Zone (CRZ) – the minimum protection area required to preserve the health and stability of a tree during construction. It is measured as a circular area with a radius (in feet) equal to 0.5-1.5 times the trunk diameter (in inches).

Diameter at Breast Height (DBH) – measurement standard for existing trees at 4-feet 6-inches above grade.

Dripline – extent of the tree canopy.

Downtown Development District (DDD) – refer to link of overlay districts: http://dcoz.dc.gov/info/overlay.shtm.

Gross floor area (GFA) – the sum of the gross horizontal areas of the several floors of all buildings on the lot, measured from the exterior faces of exterior walls and from the center line of walls separating two (2) buildings.

Historic resource – a building or structure listed in the District of Columbia Inventory of Historic Sites or a building or structure certified in writing by the State Historic Preservation Officer as contributing to the character of the historic district in which it is located.

Impervious surface – a surface area which has been compacted or covered with a layer of material that impedes or prevents the infiltration of water into the ground. See definition of "Impervious cover" in the 2013 Stormwater Management Regulations.

Landscape Checklist – document to be signed by the Landscape Expert and DDOE Inspector, certifying that GAR landscape elements have been installed as per plan (see Appendix A).

Landscape element – features designated in the regulation (11 DCMR §3402.9) that provide credit towards the GAR score.

Landscape Expert – see "Certified Landscape Expert."

Lot – the land bounded by definite lines that, when occupied or to be occupied by a building or structure and accessory buildings, includes the open spaces required under this title. A lot may or may not be the land so recorded on the records of the Surveyor of the District of Columbia.

Lot occupancy – that portion of a lot which is covered with buildings or structures; usually expressed as a maximum percentage; e.g., a maximum lot coverage of 40% means that no more than 40% of the lot area may be built over with buildings or structures.

Scoresheet – document submitted within the submitted drawings that calculates the total GAR score for the site (see Appendix A).

Soil depth – combined depth of uncompacted topsoil and subgrade.

Soil improvement specification – specification for importing topsoil or amending disturbed topsoil, including: texture, percent organic matter, pH, installation method, and incorporation method and rate.

Subgrade – existing soil beneath the installed topsoil.

Temporary certificate of occupancy – may be granted by the Zoning Administrator when installation of the required landscaping is not currently possible due to weather, season, or site construction subject the condition that the required landscaping must be installed within four (4) months after the date the temporary certificate is issued.

Topsoil – mineral and organic layer suitable to root growth, typically defined as the A horizon.

Worksheet – document submitted within the drawings that tabulate the landscape element square footages on each submitted page (see Appendix A).

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