

**F.20.1 Blue-green roof plan standards**

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the blue-green roof. Refer to Section 4.14.5 for guidance. [Section 2.3.1]
2. Verify that the plans include an appropriate cross-sectional detail for the blue-green roof. [Section 2.3.1]
3. Verify that a roof drainage plan is provided and that the roof drainage is consistent with the blue-green roof design. [Appendix E, Table E-7]

**F.20.2 Blue-green roof design standards**

1. Verify that structural loading is considered for the blue-green roof design, and that the blue-green roof design is coordinated with a licensed structural engineer for both new building construction and retrofits to existing structures. [Section 4.14.3, 1a]
2. Verify that the entirety of the blue-green roof is considered, and modeled as, DCIA, and that a curve number of 98 is used for the blue-green roof, where required for hydrologic calculations. [Section 4.14.3, 2]
3. Verify that vegetated green roof portions of the blue-green roof receive a DCIA reduction equal to the entire area of the vegetated footprint solely for the predevelopment to post-development impervious area reduction calculation during the determination of potential exemption from the Channel Protection and Flood Control requirements. [Section 4.14.3, 3]
4. Verify that the total impervious roof area within the designated boundary of a blue-green roof footprint does not exceed the total vegetated green roof area, which is equivalent to a maximum hydraulic impervious runoff loading ratio of 1:1. [Section 4.14.3, 4]
5. Verify that all stone/gravel margins or perimeters are considered roof DCIA, unless they are graded to allow flow over or through vegetated green roof area, in which case, they may be counted as tributary impervious area to the green roof portion of the blue-green roof. Stone margins adjacent to drain chambers, with an offset distance from the chamber edge of 12 inches or less, are exempt from being counted as tributary impervious area when installed on a blue-green roof, in addition to pervious pavers containing planted openings. [Section 4.14.3, 5]
6. Verify that the maximum ponding depth is one inch below the top of the foundation growing medium. For roof drain restrictor systems, this ponding depth maximum can be set at least five feet from the restrictor. [Section 4.14.3, 6]
7. Verify that the SMP drains within the acceptable 72-hour period after the 24-hour storm event. [Section 4.14.3, 7]
8. Verify that positive overflow is provided for large storm events, up to and including the 100-year, 24-hour storm event, or, if the project is exempt from Flood Control, the ten-year, 24-hour storm. [Section 4.14.3, 8]
9. Verify that the flooded storage area of the blue-green roof area is underlain by a waterproofing membrane. [Section 4.14.3, 9]

10. Verify that root barrier layers conform to the requirements of the waterproofing provider for each project. [Section 4.14.3, 10]
11. If runoff is conveyed via piping, verify that a distribution piping manifold embedded in a gravel strip, along with an appropriate detail, is provided on the plans to dissipate energy and promote uniform flow. [Section 4.14.3, 11]
12. For roof drain restrictor blue-green roofs that rely solely on growing medium to retain the Water Quality Volume (WQv), verify the following:
  - a. The minimum allowable thickness of the roof growing medium for a 1:1 loading ratio is six inches, including two inches of foundation growing medium, which serves as the drainage layer. [Section 4.14.3, 13a]
  - b. Any contributing impervious surface built atop a blue-green roof must either allow for sheet flow runoff onto the vegetated portion of the roof, like unit pavement, or be slotted, like decking. The minimum two-inch thickness of foundation growing medium required for the blue-green roof must extend under the entire extent of that surface area. [Section 4.14.3, 13b]
  - c. The top one-inch of the foundation growing medium must be maintained above the flooded elevation, starting five feet from the roof drain restrictor, to promote aerated conditions in the growing medium. [Section 4.14.3, 13c]
  - d. The roof drain restrictor must include an outfall device which limits the WQv discharge flow rate to comply with applicable Water Quality requirements. [Section 4.14.3, 13d]
  - e. In areas that will receive tributary discharge, the blue-green roof must not include a high-transmissivity drainage layer, defined as a layer with a transmissivity of greater than  $0.005 \text{ m}^2/\text{s}$  (ASTM D4716), where such products limit plant root access to tributary runoff. In general, this will exclude most synthetic sheet drains, including peg-style or egg carton style drains. High-transmissivity drainage layers will allow runoff to effectively flow under the blue-green roof, minimizing contact with growing medium and plant roots. Typical foundation growing medium (also called granular aggregate or coarse granular green roof medium), with a grain-size distribution complying with ASTM gradation No. 7 will satisfy the requirement, as will also a variety of mats and composite drainage layer assemblies. [Section 4.14.3, 13e]
13. Verify that the storage system provides adequate storage to control release rates to meet all applicable Stormwater Regulations. [Section 4.14.3, 14]
14. Verify that the plans indicate that the saturated permeability of the growing medium, in its compacted state [ASTM E2399], is not less than six inches per hour. [Section 4.14.3, 15]
15. Verify that a drainage layer is provided to promote aerated conditions in the growing medium and to convey excess runoff during large rainfall events. [Section 4.14.3, 17]
16. Verify that the contributing area of impervious rooftop to each disconnected discharge point is equal to, or less than, 500 square feet. [Section 4.14.3, 21]
17. Verify that roof drain restrictors are sized according to the desired release rate and ponding depth. [Section 4.14.3, 22]
18. Verify that details are provided on the plans that demonstrate that all drains and scuppers are covered and protected by an enclosure, typically a square or round chamber with a locking lid. These chambers are designed to prevent clogging of the drains by debris. [Section 4.14.3, 24]
19. Verify that the roof drainage system and the remainder of the site drainage system safely convey roof runoff to the storm sewer, combined sewer, or receiving water. [Section 4.14.3, 25]
20. Verify that the emergency outflow is set at an elevation above the height of the roof drain restrictor. [Section 4.14.3, 26]

21. Verify that the blue-green roof is designed to allow for safe access and working conditions for blue-green roof inspection and maintenance personnel. This access must be a permanent feature of the building, such as a pilot house, roof hatch, or exterior stairs to the blue-green roof. Retractable, unsecured ladders should not be required for routine maintenance and inspections due to safety concerns. The design may include other permanent personal safety measures. For blue-green roofs, designers must specifically assess applicability to Occupational Safety and Health Administration (OSHA) Fall Protection Safety Standards and the American National Standards Institute (ANSI) and American Society of Safety Engineers (ASSE) consensus-based fall protection standards. [Section 4.14.3, 28]
22. Verify that easy access is provided to each of the outlet controls, low flow discharge points, and overflow connections to permit removal of debris under saturated conditions. [Section 4.14.3, 29]
23. For accessible residential roof terraces, verify that a railing with a maintenance gate that separates the vegetated green roof from accessible areas is provided. The railing can be metal, wood, or glass. Bird-friendly glass with a Threat Factor Rating of 1–25 is highly recommended. [Section 4.14.3, 31]

### **F.20.3 Blue-green roof material standards**

1. Verify that the green roof growing medium is specified on the plans to be a lightweight mineral material with added organic material that meets the following specifications: [Section 4.14.4, 2]
  - a. Moisture content at maximum water holding capacity (ASTM E2399 or FLL): 40% to 60% (vol)
  - b. Porosity at maximum water holding capacity (ASTM E2399 or FLL): 10% to 15%
  - c. Density at maximum water holding capacity (ASTM E2399 or FLL):  $\leq 85$  lb/ft<sup>3</sup>
  - d. Total organic matter (MSA): 6% to 10% (dry weight)
  - e. pH (MSA): 6.5 to 7.8
  - f. Soluble salts (DPTA saturated media extraction):  $\leq 2$  mmhos/cm
  - g. Water permeability (ASTM E2399 or FLL): 0.25 in/min to 1.25 in/min
  - h. Grain-size distribution consisting of  $\leq 4.5\%$  passing for clay (0.002 mm) and 5% to 15% passing for silt (0.05 mm). Clay and silt together must not exceed 15%.
  - i. The nutrients must be initially incorporated in the formulation of a suitable mix for the support of the specified plant materials.
  - j. The medium must withstand freeze/thaw cycles.
2. Verify that the foundation growing medium (lightweight drainage aggregate) is specified on the plans to be composed of a blended medium that meets the following specifications: [Section 4.14.4, 3]
  - a. Density at maximum water capacity (ASTM E2399-05):  $\leq 65$  lbs/ft<sup>3</sup>
  - b. Maximum water holding capacity: 15% to 25%
  - c. Water permeability (ASTM E2396-05):  $\geq 25$  in/min
  - d. Total organic matter by loss on ignition (ASTM F1647):  $\leq 1\%$
  - e. Porosity (ASTM C29): 20% to 65%
  - f. Grain-size distribution (ASTM C136) consisting of the following gradations:
    - i. Pct. Passing US#18 sieve (1.0 mm):  $\leq 5\%$
    - ii. Pct. Passing 1/4-inch sieve:  $\leq 30\%$
    - iii. Pct. Passing 3/8-inch sieve (9.5 mm):  $\geq 75\%$
    - iv. Pct. Passing 1/2-inch sieve (12 mm): 100%

3. Verify that geotextile is specified on the plans to consist of polypropylene fibers and to meet the following specifications: [Section 4.14.4, 4]
  - a. Grab Tensile Strength (ASTM-D4632): 70 lbs to 120 lbs
  - b. CBR Puncture Strength (ASTM-D6241): 120 lbs to 340 lbs
  - c. Flow Rate (ASTM-D4491): 130 gal/min/ft<sup>2</sup> to 200 gal/min/ft<sup>2</sup>
  - d. UV Resistance after 500 hrs (ASTM-D4355): 70%
  - e. Tear Resistance (ASTM-D4533): 30 lbs to 50 lbs
  - f. Heat-set or heat-calendared fabrics are not permitted.
4. Verify that all waterproof membranes meet appropriate ASTM specifications. PVC membranes must meet ASTM D4434 requirements, EPDM membranes must meet ASTM D4637 requirements, and TPO membranes must meet ASTM D6878 requirements. [Section 4.14.4, 5b]
5. Verify that all waterproofing membranes are fully waterproof with properly sealed seams, corners, and protrusions to prevent any intrusion of standing water above the membrane. [Section 4.14.4, 5c]
6. Verify that roofing membranes meet all building code requirements and guidelines of the City of Philadelphia. [Section 4.14.4, 5d]
7. Verify that the proposed green roof plantings are indicated on the plans and that the proposed plantings are non-invasive. Refer to [Appendix I](https://water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists)  [water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists](https://water.phila.gov/development/stormwater-plan-review/manual/appendices/i-plant-lists) for plant lists. [Section 4.14.4, 6]
8. Verify that at least two genera of sedums (i.e., both Sedum and Phedimus) and six different species or cultivars of sedums are indicated on the plans. [Section 4.14.4, 7a]
9. Verify that native or adaptive grasses, if proposed, include at least two genera and three different species. [Section 4.14.4, 7b]
10. Verify that native or adaptive perennials, if proposed, include at least three genera and four different species. [Section 4.14.4, 7c]
11. Verify that seed, as a supplement to live plants, is included in the proposed plantings. Refer to Section 4.13.3, Landscape Design Considerations, for a list of species appropriate for overseeding on green roofs. [Section 4.14.4, 8b]
12. Verify that temporary erosion control measures are provided that are appropriate to the planting method during the plant establishment period. [Section 4.14.4, 8c]
13. Verify that Sedum sarmentosum, also known as star sedum, gold moss, stringy stonecrop, or graveyard moss, is not proposed. [Section 4.14.4, 11]