8.1 Sustainable Roof Systems

8.1.1 Sustainable Roofing Zone Determination

Description/Design Approach:

A. Local Law 94-2019 requires new buildings, new roofs resulting from enlargement of existing buildings, and existing buildings replacing an entire existing roof deck or roof assembly to be provided with a "sustainable roofing zone", 100 percent of which must be a solar photovoltaic electricity generating system, a green roof system, or a combination thereof.

B. Beginning in the Pre-Schematic phase, project teams shall assess the potential of renewable energy **and green roof** as part of the Integrative Design Process (IDP) outlined in the 2019 NYC Green Schools Guide to evaluate synergistic opportunities with building systems and for compliance with Section BC 1512 of the 2022 NYC Building Code (Local Law 94 of 2019). Project teams will evaluate various roof uses to comprise the mandated sustainable roofing zone. While PV systems remain the SCA's preferred sustainable roof zone option, the requirements for green infrastructure or other feasibility considerations will determine the selected roof use. During the Schematic Design Phase, the project team shall further investigate the feasibility of renewable energy production per Green Schools Guide E6.1P criteria and Local Law 51/23 feasibility study requirements. If a PV roof system is selected, this preliminary analysis will serve as the basis of design to be used in subsequent design phases in order to comply with regulatory requirements. If a PV roof system is selected, this preliminary analysis will serve as the basis of design to be used in subsequent design phases in order to comply with regulatory requirements.

C. Pursuant to the DEP's USWR, the project team shall evaluate during the SWPPP process whether a green roof is required for stormwater retention.

D. **Refer to DOB Buildings Bulletin 2019-010 for further information and exemptions.**

8.1 Sustainable Roof Systems

8.1.2 Sustainable Roofing Zone System Selection

Description/Design Approach:

A. To meet the DEP's USWR water retention and water quality requirements, the preferred approach is to place green infrastructure at grade. If the requirements cannot be met at grade, a Green Roof will be required and will meet the Local Law 94/19 sustainable roof zone requirements. The site civil engineer shall determine as early in the design process as possible if a green roof will be required to meet the requirements.

1. If all quality and quantity of stormwater retention requirements of the DEP's USWR can be met on grade, which is the SCA's preferred approach, a green roof can be omitted, and a solar PV system shall be provided. Refer to DR 8.2.1.1 and DR 8.2.1.2.

    a. Ballasted PV systems are the preferred path of compliance for Section BC 1512, but depending on seismic requirements may need an anchored system.

2. If all stormwater mitigation requirements cannot be met on grade, a green roof will be required by DEP to meet its USWR requirements. Refer to DR 8.3.1. As part of the IDP process, the designer shall provide a rough estimate of what the cost of providing a PV system in addition to the green roof will be so the Authority can investigate additional funding sources to provide the solar-PV hybrid system.

8.2 Renewable Energy Systems

8.2.1 Rooftop Solar Photovoltaic Systems

8.2.1.1 General Rooftop PV Requirements

Description/Design Approach:

A. Shading Analysis

1. The intent of the shading analysis is to provide an estimated PV system production capacity to inform the design.

2. The shading analysis will provide the following information: monthly and annual production, solar irradiance, percentage/areas of roof that are shaded, sources of system loss, solar access by month, and minimum PV system generation based on the Southeastern and Southwestern shading analyses.

3. The shading analysis will initially be conducted by the design team during the 60% phase and updated at the 100% phase when the roof layout has been updated. A shading analysis shall also be performed by the PV contractor/installer for filing and prior to system installation. Shop drawings including the shading analysis will be submitted to the designer for review of conformance with the construction documents set.

4. The designer shall take into account shading from all roof layout infrastructure, such as mechanical/electrical/plumbing equipment, bulkheads, rooftop obstructions, etc. Existing site conditions including trees shall be counted in the shading analysis as a shading structure/obstruction. The designer shall analyze if any existing trees or adjacent tall structures will obstruct solar access to the roof. Exceptions for tree trimming, where trees from an adjoining property affect project adversely or create shading on the roof, may be taken at the discretion of the project team.

5. The shading analysis shall be conducted using HelioScope. The designer shall perform the shading analysis yielding an assessment at the Southwest and Southeast orientations and at the Winter equinox (December 21st), in order to receive the worst-case scenario, or minimum PV system generation output estimate. The designer will need to input the roof and PV system area, all roof layout obstructions (equipment, bulkheads, etc.), project address, system tilt angle, and specifications for the solar panel and inverter components.

B. General PV Design Parameters

1. PV panels shall be shown with landscape orientation only.

2. Panels shall face south when possible to optimize PV system output.

3. The panel efficiency used to determine the potential capacity of a solar photovoltaic system shall not be less than 19.4%.

4. Panels shall be selected from the Tier 1 list updated and published quarterly by BNEF (Bloomberg New Energy Finance)

5. When suitable, PV systems shall be designed to meet between a five to ten degree tilt angle to optimize PV system output.

C. PV Systems on Bulkheads

1. Rooftop solar installations on bulkheads shall be designed in accordance with DR 1.3.1.14, including Sections FC 504.4.4 and FC 504.4.6 of the 2022 NYC Fire Code, for access and clearance requirements.

2, The bulkhead will not be subject to rooftop solar applications if fewer than ten panels can be accommodated on the bulkhead roof area.

D. Structural Analysis

1. Structural Analysis Requirements: Refer to Section BC 1607.13.5 of the 2022 NYC Building Code for provisions regarding design loads on rooftop mounted PV systems and structures supporting them.

2. Strength and Stability Requirements: PV systems and structures supporting them shall be designed to resist the design loads and combinations required per Chapter 16, with considerations for array-level, panel-level, and fastener-level strength and stability. The PV system, including its racking/railing and any attachments to the roof base structure, shall be designed for all applicable design loads determined using ASCE 7-16 as modified by the 2022 NYC Building Code. The PV contractor will be responsible to hire a NY state registered PE to prepare signed and sealed calculations and shop drawings for the PV system and to submit for approval (Article 1.07 of Specification Section 13602 has the Contractor's design requirements for a ballasted system and similar requirements would need to be included in a specification for a racking system). The AEOR will be responsible to design the direct-mounted assembly attached to the structure to support the Contractor's PV racking system.

3. PV Mounting Systems: Three relevant categories of building PV mounting systems are considered: ballasted, direct-mounted and building-integrated PV (BIPV) systems.

   a. Ballasted systems are fastened securely together and are supported by frequent bearing points (not penetrating the roof surface). Ballasted systems are, in rare cases, directly attached to supporting structures, but unattached ballasted systems are preferred due to their simplicity of construction, flexibility of layout, and low cost. For stability, unattached ballasted systems use the weight of the panels, racking system, and ballast blocks (typically CMU) to resist sliding or uplift failure. The use of unattached ballasted PV systems is limited to roofs with a maximum slope of 1 to 12 (per NYCBC 1613.6). Rooftop ballast is prohibited for PV installations 100 feet or higher above grade (per 1 RCNY 105-02 (e)(ii)(f)).

   b. Direct-mounted systems are fastened securely together and use the strength of mechanical attachments (bolting, welding, clamping, or anchoring) to the building structure to provide support for the PV system. Direct-mounted PV systems can be

supported by light-gage steel framing, minor steel framing, or minor reinforced concrete elements, ultimately transferring loads to the structural system. Building structural designers should note that structural standard details for mechanical equipment dunnage will typically be inefficient and overdesigned for mounting PV arrays.

c. BIPV systems are defined by the building code as "a building product that incorporates photovoltaic modules and functions as a component of the building envelope." Structural design of BIPV systems is implicitly governed by the requirements imposed on the kind of envelope component the BIPV product serves as. Only BIPV roofing would contribute to a building's sustainable roofing zone compliance, but BIPV façade cladding products are available. These systems are not being used on SCA projects as of yet as research will be ongoing for potential future use.

4. Assumed Dead Load: For design of the building roof structure, the superimposed dead load from a ballasted PV system including the weight of the panels, racking and ballast blocks may be assumed to be 20 psf. Where ballasted PV systems are used, cementitious-topped roof insulation board shall be used as the top layer of insulation in place of full pavers to reduce overall weight and reduce the structural impact to the base building design.

5. Wind Load Determination for PV Systems: Chapter 29, 'Wind Loads on Building Appurtenances and Other Structures…', of ASCE 7-16 provides two cases where design wind load determination for PV systems follows special methods rather than those pertaining to building components and cladding.

   a. Section 29.4.3 of ASCE 7-16 applies to low-profile arrays, which may be angled relative to the supporting flat (maximum 7-degree slope) roof.

   b. Section 29.4.4 of ASCE 7-16 applies to flush-mounted arrays parallel to a supporting roof of any slope.

   Ballasted PV systems shall be designed for wind load determination according to Section 29.4.3 of ASCE 7-16, and flush-mounted direct-attached arrays shall be designed for wind load determination according to Section 29.4.4, where possible. These provisions allow for determination of relatively low design wind loads on PV systems that also satisfy the live load removal provision of Section BC 1607.13.5.1 (Refer to DR 3.1.2). When utilizing these wind load determination methods, the roof shall be designed for the greater load effects from either the installed PV case, or the case where PV systems are not installed.

6. Seismic Design Category: All types of PV systems are permitted, without any pertinent seismic requirements, on buildings assigned to Seismic Design Categories A (per Section 11.7 of ASCE 7-16) and B (per Section 13.1.4 of ASCE 7-16). Schools are assigned to Risk Category III and will typically be assigned to Seismic Design Category B, but may be assigned to Seismic Design Category C. See SCA DR 3.1.3 for further details.

7. Seismic Design Requirements: PV systems are considered "nonstructural components" for the purpose of seismic design. PV systems are not considered critical equipment during an emergency and thus seismic component importance factor 'Ip' of the PV system is equal to 1.0, unless depended upon for powering critical equipment.

a. Ballasted PV systems can be used on buildings designated as Seismic Design Category C, but they are subject to the requirements of Section BC 1613.6 and Section 13.6.12 of ASCE 7-16. These provisions allow for the sliding displacement of the ballasted PV systems during the design seismic event but, among other requirements, the provisions require either shake-table testing or nonlinear response history analysis (BC 1613.6). Due to these requirements, which are not likely practical to perform, a direct-mounted system shall be used.

b. Direct-mounted PV systems used on buildings designated Seismic Design Category C may be exempted from seismic design requirements per Section 13.1.4, item 5, of ASCE 7-16.

c. BIPV components used on buildings designated in Seismic Design Category C with a component importance factor Ip = 1.0 and positive attachment to the building structure, may be exempted from seismic design requirements per Section 13.1.4, item 5, of ASCE 7-16. In the case of a BIPV component with Ip = 1.5, the same exemption may apply based on the component weight. If seismic design requirements for nonstructural components apply for a BIPV product, the Contract Documents shall indicate that the PV contractor's engineer must indicate on their shop drawings the parameters considered in determining the seismic design horizontal force Fp for PV design engineer's approval.

E. Power Distribution

1. Electric Service

a. This photovoltaic system's utility interconnection point shall meet the specific requirements of article 690 of the New York City Electric Code, local code requirements and the requirements of the interconnection agreement.

b. During the Pre-schematic Design Phase, the design engineer shall submit a load letter to ConEdison indicating the required service load and proposed Solar Load anticipated.

c. The building shall be provided with a utility disconnect switch to disconnect PV system and associated equipment, such as inverters, batteries, and charge controllers, from all ungrounded conductors.

d. For detailed interconnection requirements, refer to the *New York State Standardized Interconnection Requirements, Section II. Interconnection Requirements.* Interconnection requirements must conform with the most current version of IEEE Std 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems as well as any local requirements.

e. This requirement covers the following sections that may be applicable: Voltage Response, Frequency Response, Reconnection to the Utility System post disconnection, Synchronous Generators, Induction Generators, Inverters, Minimum Protective Function Requirements, Metering, Operating Requirements, Dedicated Transformer, Disconnect Switch, Power Quality, Power Factor, Islanding, Equipment Certification, Verification Testing and Interconnection Inventory.

f. ConEdison makes the determination on affected transformer vaults. If PV installation affects transformer, there is an additional cost to upgrade ConEdison's equipment.

2. Component Requirements

   a. All exterior components shall have a NEMA rated enclosure. The EOR shall review the final submission for compliance with Article 690 of the 2011 New York City Electrical Code.

   b. A PV system disconnecting means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.

   c. The PV system disconnecting means shall be installed at a readily accessible location. Isolating devices or equipment disconnecting means shall be installed in circuits connected to equipment at a location within the equipment, or within sight and within 3 m (10 ft) of the equipment. An equipment disconnecting means shall be permitted to be remote from the equipment where the equipment disconnecting means can be remotely operated from within 3 m (10 ft) of the equipment.

   d. An equipment disconnecting means shall be one of the following devices:
      1) A manually operable switch or circuit breaker
      2) A connector meeting the requirements of 690.33 (E) (1)
      3) A load break fused pull out switch
      4) A remote-controlled circuit breaker that is operable locally and opens automatically when control power is interrupted

   e. An initiation device shall be provided on the rooftop as close as possible to the PV system to initiate the rapid shutdown function of the PV system during emergency circumstances. Rapid shutdown will disconnect the entire system.

   f. PV system circuits installed on or in buildings shall include a rapid shutdown function to reduce shock hazard for emergency responders in accordance with 690.12(A) through (D).

   g. The initiation device(s) shall initiate the rapid shutdown function of the PV system. The device "off' position shall indicate that the rapid shutdown function has been initiated for all PV systems connected to that device. The rapid shutdown initiation device(s) shall consist of at least one of the following:
      1) Service disconnecting means
      2) PV system disconnecting means
      3) Readily accessible switch that plainly indicates whether it is in the "off" or "on" position

   h. Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection

   i. A PV arc-fault circuit shall be provided to detect an interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module or other system component in the PV system dc circuits. Photovoltaic Systems operating at 80 volts dc or greater between any two conductors shall be protected by a listed PV arc-fault circuit interrupter or other system components listed to provide equivalent protection. The

system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the PV system de circuits.

j. A PV combiner box shall be provided as needed to combine two or more DC circuit inputs and provide one DC circuit output.

k. A DC-to-DC converter/power optimizer- A device installed in the PV source circuit or PV output circuit that can provide an output dc voltage and current at a higher or lower value than the input dc voltage and current (one optimizer per panel).

l. Overcurrent Protection shall be provided to protect the PV system against overcurrent.

m. Inverters shall be provided to convert DC input to an AC output.

n. The preferred location for an inverter will be an exterior allocated space and as close to the PV system as feasible. Additional interior space shall not be provided for the sole purpose of accommodating inverters. Additionally, inverters shall be weather rated for exterior siting.

o. The Designer shall indicate location of inverters in the drawings.

3. Power Distribution Drawing Requirements

a. One Line Diagram- The designer shall indicate the location of the meter, demonstrate grounding and indicate AC and DC disconnects and inverter.

b. PV System Electrical Notes
This drawing shall indicate general requirements, manner of installation, and criteria for conductors and conductors' installation, phase relationship, conduits and raceways, grounding and tests.

c. Typical Details: Solar System Typical Grounding Detail, Inverter Area Elevation, Racking System Details Landscape Layout, Solar Monitoring System, Solar System Flat Screen Display Wiring Diagram, Solar System String Wiring Details, Ground Lug to Solar Panel Detail, Bonding Bushing Grounding Detail, Racking Systems Details Landscape Layout

1) The designer shall select typical standard details as listed above and modify them for each specific project. The vendor/installer will typically utilize these details and modify slightly per their discretion and submit as part of the shop drawings.

2) All of these details shall be included in the shop drawings submission, with the exception of the Solar System Flat Screen Display Wiring detail, which shall be provided by the designer.

3) The following details will likely require major modifications by the installer for inclusion in the shop drawing submission:

a) Inverter Area Elevation

b) Solar System String Wiring- dependent upon inverter and array size

4. PV Grounding

   a. General
   Grounding of the solar panel is required as per Article 690 of NFPA 70.

   b. Solar System Grounding Detail

5. Lightning Protection

   a. For New Construction projects, the PV system will be covered by/tied into the general lightning protection system.

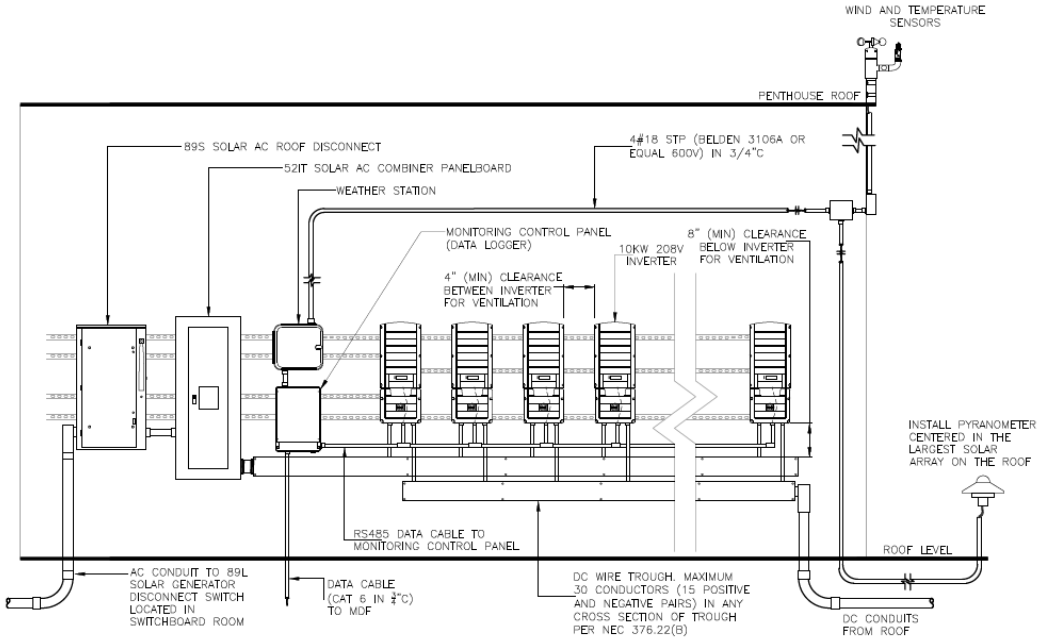
   b. Solar PV system installations shall be connected to the building lightning protection system. The designer shall refer to Design Requirements, Electrical and Communication Services- 7.0 for general lighting protection requirements. Lightning protection for solar PV arrays shall comply with the requirements of UL96A and NFPA 780.

6. Contractor's Responsibilities

   The Contractor's engineer is required to submit an application package to the utility company, consisting of all items detailed in Appendix F (Application Package Checklist) of the *New York State Standardized Interconnection Requirements.* The utility has ten days to determine if the application is complete and meets all interconnection requirements. The Contractor may proceed once a formal letter of acceptance and the New York State Standardized Interconnection Contract for interconnection has been received from the utility company. Projects with PV systems below 50 kW will receive a determination from the utility indicating whether the project is eligible for the expedited process and whether it is approved for interconnection if eligible. The utility has ten days upon receipt of the application submittal to make such determination. Projects with PV systems measuring 50 kW or above may be required to go through a Coordinated Electric System Interconnection Review (CESIR) as required by the utility company.

F. Relevant Conceptual Sketches

1. Inverter elevation



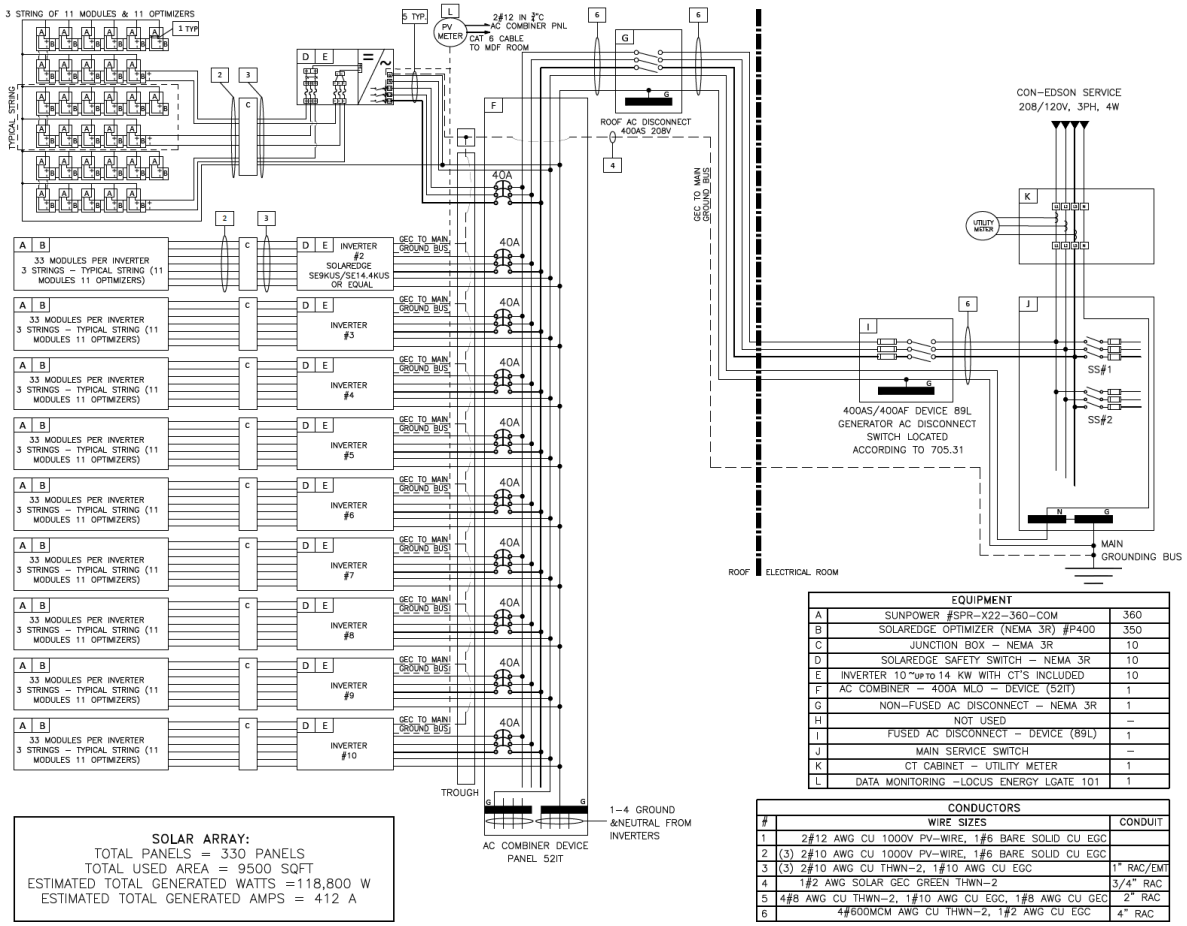
1 INVERTER AREA ELEVATION
N.T.S.

THE TOTAL CABLE LENGTH OF THE STRING FROM THE EXTENDED POWER THREE PHASE INVERTER TO THE FARTHEST POWER OPTIMIZER IS 1,150FT (2,300FT FROM DC+ TO DC− OF THE INVERTER).

2. The designer shall indicate inverter size and string configuration in the drawings.

   The below sample is a basis of design for a typical PV installation to ensure a balanced system. For example:

   Typical single inverter - 3 strings
   Typical single string - 10-14 panels
   Each Inverter is typically tied to 30-35 panels



EQUIPMENT		
A	SUNPOWER #SPR-X22-360-COM	360
B	SOLAREDGE OPTIMIZER (NEMA 3R) #P400	350
C	JUNCTION BOX – NEMA 3R	10
D	SOLAREDGE SAFETY SWITCH – NEMA 3R	10
E	INVERTER 10 ~UP TO 14 KW WITH CT'S INCLUDED	10
F	AC COMBINER – 400A MLO – DEVICE (52IT)	1
G	NON-FUSED AC DISCONNECT – NEMA 3R	1
H	NOT USED	–
I	FUSED AC DISCONNECT – DEVICE (89L)	1
J	MAIN SERVICE SWITCH	–
K	CT CABINET – UTILITY METER	1
L	DATA MONITORING –LOCUS ENERGY LGATE 101	1

CONDUCTORS		
#	WIRE SIZES	CONDUIT
1	2#12 AWG CU 1000V PV-WIRE, 1#6 BARE SOLID CU EGC	
2	(3) 2#10 AWG CU 1000V PV-WIRE, 1#6 BARE SOLID CU EGC	
3	(3) 2#10 AWG CU THWN-2, 1#10 AWG CU EGC	1" RAC/EMT
4	1#2 AWG SOLAR GEC GREEN THWN-2	3/4" RAC
5	4#8 AWG CU THWN-2, 1#10 AWG CU EGC, 1#8 AWG CU GEC	2" RAC
6	4#600MCM AWG CU THWN-2, 1#2 AWG CU EGC	4" RAC

SOLAR ARRAY:
TOTAL PANELS = 330 PANELS
TOTAL USED AREA = 9500 SQFT
ESTIMATED TOTAL GENERATED WATTS =118,800 W
ESTIMATED TOTAL GENERATED AMPS = 412 A

Requirement Applies to: ✔ **New Construction** ✔ **Major Modernizations** ✔ **Capital Improvement Projects**

8.1 Renewable Energy Systems

8.2.1 Rooftop Solar Photovoltaic Systems

8.2.1.2 Rooftop PV Regulatory Requirements

Description/Design Approach:

A. Applicable Local Laws and Regulations

1. Sustainable Roofing Zone Requirements per Section BC 1512 of the 2022 NYC Building Code (Local Law 94 of 2019)

   Section BC 1512 requires new buildings and new roofs resulting from enlargement of existing buildings to have a "sustainable roofing zone", which mandates 100 percent of the zone to be provided with a solar photovoltaic electricity generating system, a green roof system, or a combination thereof. Where PV installation has been selected, the layout of the PV system in relation to other rooftop structures and equipment is to minimize small sections of green roof that would not be maintainable.

   a. Low Slope Roofs (roof slope <2:12):
   Where a contiguous sustainable roofing zone on a roof is greater or equal to 200 square feet, either a solar photovoltaic system or a green roof system, or a combination thereof, must be installed. If a solar photovoltaic system cannot meet or exceed a capacity of 4kW due to site conditions such as shading, a green roof system shall be provided

   b. High Slope Roofs (roof slope >2:12):
   On a high-slope roof, a solar photovoltaic system shall be provided. Where the solar photovoltaic system cannot meet or exceed a capacity of 4kW, the roof is exempt.

   c. Excluded Areas

      1) Areas required to be set aside for setbacks or access pursuant to the New York City Fire Code, New York City Construction Codes or the Zoning Resolution of the City of New York. For example, rooftop access areas required by Sections FC 504.4 and FC 512.3.1 of the 2022 NYC Fire Code that must be kept clear are excluded from the sustainable roofing zone.

      2) Areas occupied by rooftop structures, water towers, greenhouses, mechanical equipment, towers, antennas, parapets, guardrails, solar thermal systems, equipment access pathways and appurtenances.

      3) Areas occupied by obstructions related to stormwater management practices including, but not limited to, cisterns, or reuse systems that are installed to comply with site connection or stormwater construction permits issued by the Department of Environmental Protection.

      4) Recreational spaces that are integral to the principal use of the building on which the rooftop is located, including but not limited to playgrounds and participant sport areas for sports facilities and schools, roof terraces and passive recreation areas that are

documented on the certificate of occupancy or Department of Buildings approved filing as outlined in Building Bulletin 2018-002.

5) Pitched roofs (roof slopes greater than 17 percent) that would accommodate less than 4kW of solar photovoltaic electricity generating capacity. Supporting documents, including calculations and shading report by a qualified contractor or NYS registered design professional, shall be submitted.

6) Areas where site conditions are determined by the BCC/DOB to be unfavorable to either a solar photovoltaic electricity generating system or a green roof system. For example, in cases where the entire roof assembly including roof deck is replaced, but the building structure cannot support the added weight of a sustainable roofing zone, a statement by a NYS registered design professional shall be submitted to the BCC/DOB to substantiate the practical difficulty due to structural limitation.

2. Fire Code Requirements for Rooftop Solar Installations

a. The designer shall meet the requirements of DR 1.3.14 for Rooftop Access and shall refer to **Section** FC 512 for additional provisions:

b. As per Fire Code Section **FC** 512:

FC 512.2 Flat-roofed buildings and structures 100 feet or less in height.
Solar panel installations shall not obstruct any rooftop area access to which is required pursuant to **Section** FC 504.4, except that solar panel installations may obstruct the clear path required by **Section** FC 504.4.4 as follows:

1) if the installation is provided with a hinged mechanism or other device for which a certificate of approval has been issued that enables the installation to be safely swung, slid, lifted, collapsed or otherwise moved out of the clear path, and that is designed to allow for operation by one person, without the use of a tool; or

2) on any building with a rooftop width or depth of 25 feet or less, where the design of a solar panel installation necessitates coverage of all or substantially all of the rooftop across the full width or length thereof, the commissioner may authorize permanent obstructions that encroach upon and thereby reduce the clear path width within such area when necessary to accommodate the presence of hatches; scuttles and skylights; bulkheads; attic ventilators; chimneys and plumbing vents; and heating, ventilation and air conditioning equipment or other rooftop building service equipment.

FC 512.3 Pitched-roofed buildings and structures 100 feet or less in height.
Solar panel installations shall be designed, installed, operated and maintained in accordance with this section on rooftops of buildings and structures 100 feet or less in height with a slope exceeding 20 degrees, except detached Group U buildings and structures.

FC 512.3.1 Hip roofs.
Solar panel installations shall provide a 3-foot wide clear access area along the ridge on each roof slope upon which solar panels are installed.

FC 512.3.2 Ventilation. Solar panels shall not be installed closer than 3 feet (914 mm) to the ridge line.

3. Energy Code Commissioning and Building Code Progress Inspection Requirements for Rooftop Solar Installations

   a. Energy Code

      1) Renewable energy and energy storage systems with a generating capacity of 25 kW or greater shall indicate provisions for commissioning and completion requirements in accordance with Section C408.2 of the 2020 NYC Energy Conservation Code (NYCECC) and GSG Credit E1.1P - Fundamental Commissioning & Verification. A Commissioning Plan shall be developed in accordance with these requirements.

      2) If system capacity is less than 25kW, Quality Control commissioning is to be performed by the Authority to meet GSG Credit E1.1P credit requirements.

   b. Building Code

      Rooftop solar installations are subject toTR8 Progress Inspections per the Building Code and Department of Building requirements.

4. Zoning Requirements for Rooftop Solar Installations

   Solar energy systems are permitted obstructions on roofs/bulkheads/walls of buildings and accessory structures within required open space, yards, courts, and height and setbacks subject to regulations of the Zoning Resolution.

   a. All portions of the solar panels that project more than 4 feet above the maximum height limit are limited to a cumulative total of twenty-five percent (25%) of roof coverage, must be set back at least six feet from the street wall (to limit visibility), and depending on the zoning district are also limited to: (i) in R1 through R5 (including C-overlays), C3, & C4-1 Districts, a height of six feet above the building height limit or finished level of the roof, whichever is higher; (ii) in R6 through R10, C & M Districts, a height of 15 feet; (However, sky exposure planes are in effect in the vast majority of M Districts, creating great potential for rooftop solar installations above relatively low buildings. This would permit an exposure plane to be exceeded by 15 feet. Please consult full Zoning Text.) (iii) when located on a bulkhead or other obstruction, a height of six feet.

   b. Zone Green Text Amendment: Allows solar panels on flat roofs anywhere below the parapet, regardless of building height. Portions of taller solar installations that are higher than 4 feet would be subject to limits on roof coverage and height. On sloping roofs, panels would be allowed to be flat-mounted (less than 18” high).

   c. Solar Installed on Pitched Roofs- If solar panels are installed on a pitched roof with a slope greater than 20 degrees, the PV panels are limited to 18 inches in height as measured perpendicular to the roof surface.

5. Historic Building Requirements for Additions/Annex Rooftop Solar Installations

   Rooftop solar installations for buildings designated by SHPO as meeting the criteria for listing on the National Register of Historic Places and buildings classified as New York City Landmarks should refer to the below guidelines. For roof applications not including PV ballasted systems on flat roofs, provide the following supporting documentation:

   a. Sight line studies for flat roof buildings showing that the panels are not visible from the ground in a variety of locations, close to the building and down the street.

   b. Drawings showing that the panels will be on the slope not facing the street on sloped roofs.

B. Permitting & Approval Procedures

1. BCC/DOB Filing Procedures

   For capacity project (NB) filings, two items shall be required for submission to the Building Code Compliance (BCC) Unit/DOB:

   a. A roof plan to indicate sustainable roofing zone(s) and all exemptions as Section BC 1512.
   b. A signed and sealed Local Law 92/94 of 2019 Sustainable Roof Zone form, certifying sustainable roofing zone compliance.
   (https://www1.nyc.gov/assets/buildings/pdf/sustainable_roof_zone_form.pdf)

   Solar PV applications shall be filed as part of a New Building application or a PW-1/Alt 2 if the filing is not signed off by the original design professional.

   During the initial filing of the above documents, no electrical filing will occur.

2. Construction Documents Requirements

   (The Designer) shall provide roof plans with a code compliant sustainable roofing zone. Roof plan(s), elevations(s), and drawings of the solar installation shall be submitted. Roof plan(s) shall show the included and excluded areas of the sustainable roofing zone. Fire Department access areas shall be clearly indicated. Additional information such as drawings showing anchorage, details, diagrams, and tabulation of areas included and excluded from such zone shall also be submitted.

3. Solar PV System Drawings

   The following drawings should be included in the construction documents set. For electrical drawings, refer to DR 8.1.1.3, Section D, Power Distribution, 3. Power Distribution Drawing Requirements.

   a. Site Plan

      The designer shall indicate the location of the solar electric generating system elements on the building/site.
      Minimum requirements include:

- North arrow; Streets- distance to street
- Dimension of lot
- Adjacent buildings
- Building height/stories
- Panel locations
- Trees, utility poles, or other falling hazards

b. PV Ballast Racking System Details

The designer shall indicate the design of the PV racking system, including, for ballasted systems, ballast pans and ballast blocks.

c. Sustainable Roofing Zones Schematic

The designer shall show compliance with Section BC 1512 requirements, indicating all applicable and exempt roofing zones. Clearly indicate the site boundaries and roof layout, location, quantity, and size of PV solar arrays, roof pitch and any rooftop obstructions and clearances required. Indicate a North arrow.

d. Sustainable Roofing Zone Notes

The designer shall indicate all exemption zones as outlined in **Section BC 1512.2**.

e. Roofing Section at PV System

The designer shall indicate the roofing system and PV system attachment.

f. Elevation views must be shown to demonstrate compliance with zoning. Additionally, a zoning height/setback diagram is required if panels are proposed to be elevated over 4' high or provide a note stating, "The solar system installation complies with ZR 23-42(n)(1) [commercial].

4. CESIR Requirements

The CESIR (Coordinated Electric System Interconnection Review) review by ConEdison will require a minimum of 6 months. Projects 50 kW or greater (in AC) need to be submitted for CESIR review. Refer to DR 8.1.1.3, Section D, Power Distribution, 1. Electrical Service for the documentation package requirements. The following are the responsibilities of the different entities involved:

a. The SCA

1) The SCA is required to provide signatures for authorization for interconnection, commitment letters, and potentially other clerical work to be submitted by the installer.

b. SCA's Engineer

1) The Engineer of Record shall initiate contact with the utility service during the Schematic design phase as the building load letter is also being prepared to obtain a

pre-qualification of the PV system, including a request for preliminary analysis for grid capacity for the proposed PV system generation load. The designer shall include the proposed PV system capacity in a submission to ConEdison's Energy Services *Project Center*.

2) The engineer shall provide confirmation of information needed on RFI's from the installers/ConEdison.

c. Installer

The solar PV installer is responsible for uploading all required documentation via ConEdison's web portal, "PowerClerk."

C. Appendix

1. ConEdison Application Portals

- Small Distributed Generation Application Portal
  (Projects up to 50 kW)
  https://conedsmalldg.powerclerk.com/MvcAccount/Login

- Large Distributed Generation Application Portal
  (Projects 50 kW to 5MW)
  https://conedlargedg.powerclerk.com/MvcAccount/Login

Project teams may refer to the link below for application procedures:
https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/dcf68efca391ad6085257687006f396b/$FILE/December%202019%20SIR%20-%20FINAL%20-%20Clean.pdf

Solar projects up to 50 kW will follow an expedited process (no engineering review, self-certification).

8.3 Green Infrastructure

8.3.1 Green Roofs

Description/Design Approach:

A. General

1. Green roofs, also known as 'living roofs,' are systems consisting of vegetation, growing media (i.e., soil), filtration media, and drainage media, and can be applied to flat or minimally sloped roofs. For stormwater management, green roofs can provide multiple functions including:
   - Retention, via the uptake and release of water by plants (evapotranspiration).
   - Detention, via the temporary storage and slow release of water by in specialized detention layers placed under the growing media and plants.
   - Filtration, via the movement of water through the growing media and geotextile layers.
   - Resiliency benefits, such as heat island reduction.
   - Ballast for a photovoltaic array when a combination green /photovoltaic roof is approved for use.

2. For SCA projects, green roofs are typically only provided to satisfy the requirements of the Department of Environmental Protection (DEP) Unified Storm Water Rules (USWR) as part of the Stormwater Pollution Prevention Plan (SWPPP). If water quality and retention can be provided by other means at grade, the SCA preference is for the roof to have photovoltaic arrays installed to meet the city's decarbonization efforts. Green roofs may be included in SCA projects for aesthetic and/or pedagogical reasons, which would typically be intensive green roofs, when approved by CPM.

B. Extensive Green Roofs

1. Definition: Extensive green roofs typically have a maximum of 6" to 8" of growth media with primarily sedum vegetation to provide stormwater management and reduce heat island effect. They are designed to be lightweight, low-maintenance, drought tolerant without the need for irrigation, and cost-effective. Extensive green roofs are recommended for most SCA applications unless they are part of a curriculum.

2. Vegetation

   a. For extensive green roofs in NYC, manufacturers and installers recommend low-growing (< 4" tall), drought-tolerant plants that absorb water when available and conserve it by closing their leaf pores during the day and opening them at night.
   b. Optimal species for extensive green roofs in NYC include Sedums, Alliums, Sempervivums, Euphorbias, and Delospermas. Some systems may only have a variety of sedums.
   c. Extensive green roofs are exempt from SCA Green School Guide requirements to use native or adaptive species, as there are very few species native to NYC that evolved to survive in typical green roof conditions.

d. Plantings shall be provided in carpet or tile. Trays are not permitted.

3. Growth media
   A specific blend of lightweight expanded clay or rock, sand and compost intended to meet specific retention targets of the overall green roof assembly, while offering long term plant health. The FLL standards adopted in the US offer guidance on specific media requirements

   a. Growth media minimum depth for stormwater quality is 6", with DEP considering 8" to meet water quality requirements for the site.
   b. Minimum depth is 4" for challenging sites, but this will then typically require on-grade green infrastructure to address the remainder of the DEP water quality requirements.
   c. The growth media must meet the strict gradation requirements indicated in the DEP stormwater manual and material submitted during construction must be checked carefully in order to ensure DEP acceptance.
   d. Needled mineral wool may be substituted for soil on a 1:1 depth basis after the initial 4" of growth media to a maximum of 1" of depth at this time. Refer to below

4. Retention layer
   Retention Layers are focused on water quality and plant health and aim to reduce the outflow volume that otherwise would reach the sewer. A retention layer holds onto water for extended periods of time to make water plant-available during periods of drought so that the soil and plants can release the water into the atmosphere as vapor.

   a. They must have seepage outlets to release water slowly into primary roof drains.
   b. They must have overflow outlets aligned with overflow roof drains to prevent any standing water in the growing media layer above. Standing water in the growing media layer will cause root rot.
   c. Storage layers without outflow (i.e., true stormwater retention layers) are not to be provided.
      1) Non-Rigid Retention Layers
         a) Rock fiber materials (e.g. needled mineral wool) retain more water than growth media (soil) and can act as a filter layer.
         b) Restrict to 1" thick total.
         c) Install over a separate drainage and air layer

4. Filter layer

   a. A geotextile is required directly below the growth media layer to prevent fine particulate from clogging drainage.
   b. Water-permeable, UV-stabilized polymer fabric.
   c. May be a separate layer or incorporated into the top of a storage layer.
   d. Depending on the vegetative roof manufacturer, a filter layer may not be required if using a non-rigid stormwater storage layer without voids (e.g., needled mineral wool), which provides filtration (see below).
   e. Must continue vertically up all green roof terminations to at least 1/2" higher than the level of the green roof media surface.

5. Detention layer
   If the on-grade site does not have space to install detention system required for site connection approval, a detention layer can be installed as part of a green roof system to meet some or all of the required release rate required by DEP. Temporary detention storage is added below the vegetative layers of the green roof to temporarily detain peak stormwater volume, and slowly release it over a relatively short period of time (between 12 to 72 hours).

   a. Semi-Rigid Detention Layers with Small Voids
      1) These are sometimes referred to as “honeycomb” or “egg crate” systems.
      2) Depth may vary from 1"-6"; 1"-3" typical; 1.5"-3" is recommended.
      3) Typically semi-rigid, i.e., packaged as rolls (preferred); may be rigid.
   b. Rigid Detention Layers with Large Voids
      These are also known as stormwater risers, stormwater cells, blue roof cells, or “milk crate” systems. Use only where other solutions such as detention or retention tanks are not feasible.
      1) Depth may vary from 4" to 12" or more.
      2) Install across entire roof deck, including beneath non-vegetated areas. (Otherwise, would require too many additional layers of insulation in order to make adjacent pavers level with green roof surface.)
      3) For increased detention and optimal green roof health, may be combined with a semi-rigid detention layer between the growing media and the rigid detention layer.

6. Root barrier
   Required to prevent plant root penetration into the roofing membrane.

   a. Must be coordinated with the roof membrane manufacturer and comply with their requirements.
   b. A root barrier may be separate from or combined with Roof Membrane Protection Layer

7. Drainage Layer
   Required below all non-rigid detention layers without voids (e.g., needled mineral wool or polymer moisture retention mats).

   a. Minimum flow rate to be determined by plumbing engineer and green roof manufacturer or installer.
   b. Typically 1/2" to 3/4" deep. A thicker drainage layer with greater capacity may be required if:
      1) The nearest roof drain is distant.
      2) The green roof area receives directed stormwater from scuppers above.
      3) More growing media (a thicker green roof) is used, although a different type of detention layer is recommended for such applications.
   c. May provide an additional detention function by creating turbulence or friction to slow drainage. Consult with green roof manufacturer or installer to ensure that this does not duplicate or diminish the function of the stormwater detention layer above.
   d. Not required with most semi-rigid or rigid stormwater detention layers with voids, but may be recommended by green roof manufacturer or installer.

8. Edging

    a. Perforated vertical edging is required at all green roof terminations adjoining pavers and VFZs.
    b. Stainless steel, aluminum or hot-dipped galvanized steel.
    c. The top of edging shall be at least 3/4" above level of green roof.
        1) If desired, the top of edging can be made level with adjoining non-vegetated roof surface if level of green roof is depressed by 3/4".
        2) However, green roof manufacturers and installers do not consider edging protruding 3/4" to be a tripping hazard.
    d. Return (horizontal) leg of edging must be placed above roof insulation and may be placed immediately below the filter layer or beneath the uppermost stormwater storage layer or (if applicable) air and drainage layer.
    e. Held in place by weight of green roof layers above. Should not require fasteners.

9. Typical roofing components
   These are the roofing components covered under other specification sections.

    a. Insulation
    b. Roof membrane

C. Intensive Green Roofs

1. Definition: Intensive green roofs typically have a minimum of 8” and typically 12” of growth media to support a larger variety of plants than an extensive green roof. have higher plant diversity of usually less drought tolerant plant species albeit with a higher aesthetic value and are therefore often deployed in more visible areas. Intensive roofs are more costly, require permanent irrigation and tend to demand more maintenance,

2. Intensive green roofs should seek to use native or adaptive species where feasible, consistent with the educational or ecological function of the plantings

D. Vegetation-free zones (VFZs)

1. General Parameters

    a. VFZs should be minimized in order to maximize the stormwater and other benefits of green roofs.
    b. Extents and uplift resistance requirements of areas subject to high winds should be determined by the structural engineer and green roof manufacturer or installer.
    c. Extents of areas that require frequent access or maintenance should be determined by the design team in consultation with the SCA.
    d. VFZ surfaces must have an initial Solar Reflectance Index (SRI) of 82 or higher.
    e. VFZs greater than 1’ wide must use pavers. Narrower, small, isolated VFZs less than 10 square feet in area, on roofs below 100 feet in height, may use gravel infill.

2. VFZ Applications and Widths
   Other than specific VFZ widths required in areas subject to high winds, recommended VFZ widths are as follows:

   a. 6' VFZ:
      1) Bulkhead doors (required by NYCBC)
      2) Bases of ladders (to provide an even, stable surface)
      3) Exhaust louvers less than 6' above finished roof surface (to prevent browning of green roof from hot air)
      4) Areas adjacent to south-facing, highly reflective surfaces (to prevent browning of green roof from concentrated sunlight)
   b. 2' VFZ:
      1) All building perimeters (parapets, bulkheads, etc.) to provide sufficient access for maintenance.
      2) Access to expansion joints or critical flashings to provide sufficient access for maintenance and/or replacement.
      3) Watershed areas from accessory structures, such as splash blocks below scuppers and downspouts to prevent erosion of green roof from splashing water.
   c. 1' VFZ:
      1) Exhaust fans
      2) Roof drains
   d. No VFZ required:
      1) Hatches
      2) Mechanical dunnage posts or other structural penetrations
      3) Ductwork, pipe, and conduit penetrations

3. VFZ Materials

   a. Concrete Pavers
      1) Weight 24 lb/sf minimum. (Typical 2” paver is 25 psf)
      2) Use two layers (4" to 5" thick) only where required, as determined by structural engineer for wind loads. Additional layer is preferable to a single layer with “lock-down” pedestals or risers.
      3) A second layer of pavers should not be necessary solely to counteract buoyancy of built-up insulation (see below) added to make pavers level with green roof.
      4) In general, pavers, like green roof surfaces, should follow the slope of the (low-slope) roof. Use tapered shims only where necessary to maintain a flush surface across pavers on different slopes.
   b. Paver Pedestals (Shims, Pads, Plates)
      Preferred method to make pavers level with adjacent green roof surface.
      1) Typical pedestal or shim height is 3/8" to 5/8", but may be as high as 1" to 1 1/2".
      2) Tabs on tops of pedestals should also provide consistent 1/8" spacing between adjacent pavers.
   c. Paver Risers (Elevators, Stands, Pedestals)
      May be used in some circumstances (see limitations below), instead of pedestals, to make pavers level with adjacent green roof surface.
      1) Limit height to 4" in order to avoid issues with bracing.

2) Adjustable risers may be used, but fixed, single-component risers are preferred.
3) Wide, stable bases and tops should not require any fasteners.
4) Tabs on tops of risers should also provide consistent 1/8" spacing between adjacent pavers.

d. Gravel
Gravel is not permitted.

4. Roof Drains

Roof drains must be separated from vegetated areas by a minimum 1' VFZ, and protected by a drain body extension. If for some reason this is not possible, roof drains should be protected by a perforated metal box structure with a hatch in order to:
a. Facilitate maintenance.
b. Reduce clogs from windblown debris.

E. Wind Resistance and Erosion Control for Vegetated Areas

1. Erosion Blankets/Netting
Required where vegetation is installed in areas with high winds (to be determined by structural engineer or green roof manufacturer or installer).

a. Required in specific green roof areas where vegetation is installed as carpets, tiles, or trays.
b. Required throughout all green roof areas where vegetation is installed as plugs or seedlings.
c. Natural Erosion Blankets: Coconut coir or other natural fibers are preferred in order to minimize the use of plastic netting, particularly in areas not subject to high winds
d. Plastic Netting: Required instead of natural materials in areas subject to high winds. Must not be used solely to prevent erosion. SCA preference is to avoid the use of plastics where possible.

2. Disk Anchors
Must be used to secure either erosion blankets or netting in areas with high winds.

a. Layout to be determined by green roof manufacturer or installer.
b. Pavers may not be used to secure netting.

F. Irrigation

1. Permanent Irrigation
Not permitted.

2. Periodic Irrigation
Periodic irrigation is critical during the initial plant establishment period or during extended periods of hot, dry weather:

a. Provide at least one rooftop hose bibb or hydrant at each main green roof level.

b. Provide enough hose bibbs to ensure that all green roof areas can be irrigated. Assume each hose bibb can cover an area with a maximum radius of 50 feet.
c. Smaller isolated green roof areas on top of stair or elevator bulkheads do not require their own hose bibbs if they are within the coverage of this 50-foot radius.

3. Irrigation Frequency and Quantity
Provide irrigation as directed by green roof installer. In the absence of such guidance, provide regular, soaking irrigation as follows:

a. No less than 3X per week during the 3-month plant establishment period after initial green roof installation or substantial replanting.
b. Daily after any period of 3 days or more under any of the following weather conditions, until the condition ends:
    1) Temperatures 40ºF to 90ºF (including during winter) and no precipitation.
    2) Temperatures above 90ºF and limited precipitation (< 1/2" over three days).
    3) High humidity (> 80% RH) with nighttime temperatures above 70ºF.
c. If possible, irrigation is during the early morning hours.