

Montgomery County Public Schools Facilities Guide
DIVISION 7 - THERMAL AND MOISTURE PROTECTION

SECTION 07600
VEGETATED ROOFING SYSTEM ON METAL DECK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Extensive Vegetated Roof Assembly with protected membrane systems approach.
 - a. Mechanically attached base layer and adhered polyisocyanurate insulation.
 - b. Adhered asphalt coated, high density, fesco board.
 - c. Hot applied 3-ply SBS built-up base membrane applied to cover board and parapet walls.
 - d. Hot process fully adhered thermoplastic cap sheet.
 - e. Protection mat.
 - f. Molded plastic tray with incorporated drainage layer.
 - g. Hose bibs provided for emergency watering of plants.
 - h. Engineered Soil and fully-planted vegetated trays
 - i. Continuous path Roof Paver system.
 - j. Single Source Full System Warranty.

1.2 DEFINITIONS

- A. Vegetated Roof: An area of planting and landscape, built up on a waterproofed substrate at any level that is separated from the natural ground by a man-made structure.
- B. Vegetated Roof System: The complete system of materials that functions to provide a watertight protected membrane and an Extensive vegetated roof design to assist in storm water management, energy conservation and a long-term life-cycle expectation.
- C. Extensive Green Roof: Low maintenance landscaping consisting of shallow soil depths (<6 inches) with plant varieties that are restricted primarily to sedums or other species that can withstand harsh conditions and are an adaptive species to the area of planting.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

- C. Roof Membrane Design: Provide a roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7.
- D. Flashings: Comply with requirements of Division 7 Section "Sheet Metal Flashing and Trim." Provide base flashings, perimeter flashings, detail flashings and component materials that comply with requirements and recommendations of the following:
 - 1. FMG 1-49 Loss Prevention Data Sheet for Perimeter Flashings.
 - 2. NRCA Roofing and Waterproofing Manual (Fifth Edition) for construction details and recommendations.
 - 3. Vegetated Roof Systems must conform to and comply fully with the most current applicable local and Maryland Department of Environment stormwater management regulations, performance and construction standards and specifications.
- E. Emergency Response Plan:
 - 1. Any damage to the building caused by the Work, leaks or accidents must be addressed immediately by the Contractor as an emergency.
 - 2. The Contractor must respond to leaks or problems at the site during construction with a repair crew within three hours of phone notification.
 - 3. Provide a complete emergency telephone list for at least three responsible company representatives that will be on call during the course of the Project; include cell phone numbers, pager numbers and home phone numbers.
 - 4. Designate one emergency contact in writing to Architect on a weekly basis.

1.4 SUBMITTALS

- A. Any Substitution must also comply with the LEED requirements listed for the specified item.
- B. The Contractor and their sub-contractors shall submit the LEED building certification items listed herein. LEED Building submittals shall include the following:
 - 1. A completed Environmental Building Materials Certification Form. Information to be supplied for this form shall include:
 - a. Cost breakdowns for the materials included in the contractor's or sub-contractor's work. Cost breakdowns shall include total cost plus separate labor, equipment, and material costs. A materials only cost must be identified.
 - b. The amount of post-consumer and post industrial recycled content in the supplied product(s).
 - c. The manufacturing location for the supplied product(s).
 - d. The location (source) of the raw materials used to manufacture the supplied product(s).
 - e. For all field applied adhesives, sealants, and paints, indicate the Volatile Organic Compound (VOC) content in grams/liter or lbs/gallon.
 - 2. Material Safety Data Sheets, for all applicable products. If the MSDS does not show the product's VOC content, this information must be provided through other

published product literature from the manufacturer, or stated in a letter of certification (on the manufacturer's letterhead) from the product manufacturer.

- C. Product Certificate: Submit notarized certificate, indicating complete list of products intended for use under Work of this Section, including product names and numbers and manufacturers' names, with statement indicating that products to be provided meet the requirements of the Contract Documents.
- D. Product Data: For each type of roofing material indicated.
- E. Shop Drawings: Show locations and extent of roofing. Include plans, sections, details, and attachments to other Work, for substrate joints and cracks, flashing sheets, roof penetrations, vertical intersections, roof slope, expansion joints, and membrane terminations.
 - 1. Show locations, extent, and details of roof pavers.
 - 2. Vegetation to be placed no closer than 6' to major mechanical systems
- F. Submit a letter signed by the manufacturer and Contractor acknowledging that the submitted roof membrane design complies with ASCE-7 for wind speed code requirements.
- G. Samples for Verification: For each of the following products:
 - 1. 12-by-12-inch square of inner ply membrane sheet, single ply membrane.
 - 2. 12-by-12-inch square of polyiso board insulation.
 - 3. 12-by-12-inch square of HD Perlite board.
 - 4. 12-by-12-inch square of protection mat and drain board
 - 5. Two sample vegetated modules, showing same or similar product grown to maturity, with homogenous mix of cutting grown plants with 95% or greater coverage, as it will be delivered to job site. (Photo of fully grown- in trays may be substituted)
 - 6. Border aggregate & roof pavers, full sized, in each color and texture required.
- H. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- I. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Product Compatibility: Indicate manufacturer has verified compatibility of roofing system components, including but not limited to: Roofing base and ply sheets, membrane backer and flashing sheets, reinforcement fabric felts and mats, adhesives, mastics, coatings, and sealants.
 - 2. Adhesive Flammability: Indicate manufacturer has verified cold process adhesives and coatings are non-flammable.
- J. Qualification Data: For Installer, manufacturer, and field technical inspector per Section 1.6 - "Quality Assurance".

- K. Project Closeout Reports: Provide a report upon delivery of the project warranty. This report to include:
 - 1. Project Specifications.
 - 2. Project Summary.
 - 3. Progress reports as a result of roof inspections.
 - 4. Job-site progress photos.
 - 5. Warranty document.
 - 6. Owner's Manual describing maintenance and emergency repair.

- L. Maintenance Data and Training Materials: For roofing system to include in maintenance manuals and Owner's training library. Provider of vegetated roof shall provide written maintenance protocol.

- M. Warranties: Submit specimen copy of the manufacturer's standard roofing warranty modified as required by this Section and other Contract Documents; Work cannot start prior to the Architect's review and comment on this specimen copy.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty. Installers must be B.U.R. and N.D.L. approved for the past ten years.
 - 1. Installer Shall:
 - a. Submit an affidavit attesting that Contractor has in place and fully implemented a written Health, Safety and Environmental Plan and the plan is compliant with all applicable Federal, State and Local regulations.
 - b. Be a Manufacturer Approved/Certified Contractor experienced with the specified roof system. And, shall obtain written certification from the manufacturer of the BUR system certifying that installer is approved by manufacturer for installation of the specified roofing system.
 - c. Installer of vegetated trays must be trained and certified by company providing vegetated tray system.
 - d. Provide comprehensive 20 year no dollar limit warranty for repairs for all aspects of roof, including vegetated tray system.
 - e. Provide installer's field supervision. Installer must maintain full-time supervisor/foreman on job-site during times that roofing work is in progress. Supervisor must have a minimum of 5 years experience in roofing work similar to nature and scope of specified roofing.

- B. Technical Representative Qualifications: An authorized full-time employee representative of manufacturer experienced in the installation and maintenance of the specified roofing system and qualified to determine Installer's compliance with the requirements of this Project.
 - 1. Factory Trained Technician Qualifications: An individual employed in the roofing

industry for minimum of 7 years; provided inspection services on five similar projects within the past 12 months; received structured training by the manufacturer providing roofing for this project, and authorized by manufacturer to produce daily reports and decline work not in compliance with warranty requirements and Contract Documents.

2. If manufacturer does not employ full time technical inspectors, the roofing contractor must acquire a full time factory trained technician on the Project that is a full time employee of the manufacturer or an independent roofing consultant employed by the Contractor.
3. Each day that production is being performed, the technical representative/inspector must be on the project for a minimum of 4 hours.
4. The technical representative will be responsible to determine and enforce the most stringent requirements between the warranty and Contract Documents.

C. Protection of Installed Materials

1. Against Loads: Protect existing structure and work of this section against concentrated loads and any other loads or equipment that would cause damage. Use boards or other approved means to safely distribute the loads.
2. Against Traffic: Do not permit traffic on areas of this section except for workmen doing the work during installation, until covered with protective boards or with specified finish materials. Take necessary preventative measures to protect work of the section from damage, until traffic is permitted.
3. Rejection of Damaged Work
 - a. Damaged materials or work will be rejected.
 - b. Rejected materials or work must be immediately removed and replaced with new materials at the contractor's expense.

D. Conform to NRCA Roofing Specifications and roofing membrane manufacturer's instructions.

E. Source Limitations:

1. Obtain roof system components through sources acceptable to roofing manufacturer providing total system warranty. Provide a letter, on the roofing manufacturer's letterhead and signed by representative of the roofing manufacturer, accepting the products selected by the installer.
2. The roofing manufacturer provided the total system warranty for the work of this section must also be the manufacturer providing the system required under Section 07510.

Water Test: Before installation of vegetated trays, roof is to be flood tested for water tightness for 24 hours and results communicated to Owner. Owner must be present for conduct of flood test.

F. Fire-Test-Response Characteristics: Provide roof membrane with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated.
- G. Project Meetings: Comply with requirements for pre-installation conferences in Division 1 Section "Project Management and Coordination."
1. Pre-Construction Conference
 - a. General: Before starting roof deck construction or re-roof preparation, conduct conference at Project site. Comply with requirements for pre-installation conferences in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roof deck construction or re-roof preparation and roofing system as follows:
 - 1) Will be scheduled by the Architect/Owner's Representative after notice of award.
 - 2) Attendance: Architect/Owner's Representative, General Contractor, Manufacturer/warranty issuer, and Third Party Inspectors (if required).
 - 3) Minimum agenda: Submittal list of subcontractors, materials and progress schedule. Designation of responsible personnel. Walkover inspection. Review of the building and grounds; review the scope of work; review manufacturers installation standards and review of the environmental and atmospheric plan.
 2. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:
 - a. Participants: Authorized representatives of the Owner, Construction Manager, Architect, Consultant, General Contractor, Roofing Subcontractor, Roofing Manufacturer, and installers of roof components/accessories and roof-mounted equipment shall attend the pre-installation meeting.
 - b. Review methods and procedures related to roofing installation, including manufacturer's written installation instructions.
 - c. Review construction schedule and confirm availability of Products, Subcontractor personnel, equipment and facilities.
 - d. Review deck installation criteria and finishes for conformance with roofing system criteria, including issues of flatness and fastening.
 - e. Review structural loading conditions and limitations of roof deck both during and after roofing application.
 - f. Review flashing details, special roofing details, roof drainage, roof penetrations, equipment curbs, and other conditions affecting roofing installation.
 - g. Review governing regulatory requirements, and requirements for insurance and certificates as applicable.
 - h. Review safety requirements, including temporary fall-arrest measures.
 - i. Review field quality control procedures.

3. Progress Meetings

- a. General: Review methods and procedures related to roofing system as follows:
 - 1) Will be scheduled by the General Contractor.
 - 2) Attendance: Architect/Owner's Representative, Consultants, General Contractor, Roof Sub-contractor, Manufacturer, Third Party Inspector (if required).
 - 3) Minimum agenda: Review of work progress. Maintenance of progress schedule. Maintenance of quality and work standards. Review of the building and grounds. Review of the scope of work.

4. Final Inspection

- a. General: Review methods and procedures related to roofing system as follows:
 - 1) Will be scheduled by General Contractor upon completion.
 - 2) Attendance: Architect/Owner's Representative, Consultants, General Contractor, Roof Sub-contractor, Manufacturer, Third Party Inspector (if required).
 - 3) Minimum agenda: Walkover inspection. Identification of problems, which may impede issuance of warranty.

H. Random Sampling

- 1. During course of work, the Architect may secure samples according to ASTM D140-93 of materials being used from containers at job site and submit them to an independent laboratory for comparison to specified material.
- 2. Should test results prove that material is not equal to specified material:
 - a. Contractor shall pay for all testing.
 - b. Roofing installed and found not to comply with the specifications shall be removed and replaced with no change in the contract price.
- 3. Review roof observation and repair procedures after roofing installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to manufacturer recommendations.
- B. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- C. Storage of Materials
 - 1. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

- a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
 2. Store materials marked "keep from freezing" in areas where temperatures will remain above 40 degrees Fahrenheit.
 3. For insulation, remove plastic packaging shrouds. For felt rolls, slit the top of the plastic shrink-wrap only. Cover top and sides of all stored materials with tarpaulin. Secure tarpaulin. Store in a dry location. Comply with manufacturer written instructions for handling, storing, and protecting during installation.
 4. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces.
 5. Do not double-stack rolls.
 6. Rooftop storage: Disperse material to avoid concentrated loading.
 7. Materials may not be stored without a canvass tarpaulin, or on direct contact with the ground or roof surface. Do not leave unused felts and other sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 degrees F (10 degrees C).
 8. Should Contractor be required to quickly cover material temporarily, such as during an unanticipated rain shower, all materials shall be stored on a raised platform covered with secured canvas tarpaulin, top to bottom.
 9. Contractor is responsible for the safekeeping of materials stored onsite.
- D. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer written instructions for handling, storing, and protecting during installation.
- E. Vegetated modules are to be kept out of direct sun to prevent overheating. Modules are to be installed on the roof top without delay. No long term storage—do not deliver vegetated modules until roof is ready to receive.
- F. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck. Vegetated modules must be conveyed to roof using a rack designed specifically for this use and constructed according to engineer approved and stamped plans.
- G. DO NOT stack modules during conveyance to rooftop or installation.
- 1.7 PROJECT CONDITIONS
- A. Environmental Limitations: Apply roofing within the range of ambient and substrate temperatures recommended by roofing system manufacturer. Do not apply roofing to a damp or wet substrate or when temperature is below 32 deg F.
1. Do not apply roofing in snow, rain, fog, or mist.
 2. Do not apply any roofing materials during inclement weather.
 3. Comply with manufacturer's recommendations for minimum and maximum temperatures and humidity during application.
 4. Consider effects of wind chill on adhesives, and ensure they will not prematurely set before proper adhesion takes place.

5. Keep water-based Products from freezing. Do not apply water-based Products if temperatures are below 40 degrees F.
6. Vegetated modules to be installed only when temperature is above 35 deg F, there is no ice on the roof and soil mix is unfrozen.

1.8 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Upon project completion and Manufacturer acceptance, the contractor shall deliver to the Owner a twenty (20) year N.D.L. Quality Assurance Total System Warranty and Owner's Manual.

1. Vegetated Roof System Complete Assembly Warranty:

- a. System Warranty: covers components of the green roof assembly, including membrane, flashings, root barrier, protection mat, drain board, insulation, and termination details.
 - 1) Duration of membrane/flashing: 20 year (watertight condition)
 - a) Wind speeds not to exceed 60 mph.
 - 2) Duration of insulation: 20 year 80% of original thermal value.
- b. Plant Establishment Warranty
 - 1) Vegetated modules
 - a) Duration of Warranty: 2 years
 - b) The Warrantor guarantees that sedum plantings selected, approved and provided by the Warrantor or its certified representatives will be pre-grown so that at time of installation they cover the planted roof area at approximately 95% of surface area.
 - c) Warrantor provides replacement of dead plant material as required to meet prescribed coverage rate during first two years after installation. Plant materials destroyed through acts of negligence, owner modifications, wind events greater than 50mph or other acts of God, are not covered.
- c. Inspections, Preventative Roof Maintenance and Establishment:
 - 1) Roof inspection services are as follows:
 - a) Visual inspection of the rooftop surface conditions.
 - b) Inspection of the exposed flashing systems including, but not limited to, the metal edge system, base flashings on equipment and adjoining walls, counter flashing and

termination details, drains, soil stacks and vents, and HVAC equipment, sky lights and access hatches.

- 2) Preventive roof maintenance services are as follows:
 - a) Flashing components - tears, splits and breaks in the exposed membrane flashings will be repaired with appropriate mastics and membranes.
 - b) Exposed fasteners will be sealed. Termination bar and counter flashings will be sealed.
- 3) Plant and Growing Media establishment services are as follows:
 - a) Using a green roof maintenance firm that is acceptable to the Warrantor, with preference being given to local small businesses, roofing contractor to arrange for vegetated roof visual inspection and hand weeding to be conducted every two weeks during growing season. Woody or invasive plants must not be allowed to establish in the vegetated roof system.
 - b) During April 1 to 15 of each year, administer an annual soil test for PH and fertility levels. Maintain pH in the range of 6.5 to 8.0. In the event that pH is outside of the 6.5 to 8.0 range, consult vegetated roof system manufacturer for the appropriate amendment. Maintain fertility with additives without the application of fertilizer in the normal range using a typical field soil fertility test.
 - c) Vegetated roof to be hand watered to saturation following periods of drought (3 weeks with no rain.) During extreme heat, this period may be shortened. Plants should be checked every 2 weeks.
 - d) Hose bibs should be provided at intervals of approximately 150 ft.
- d. The Warrantor shall provide photos and roof inspection reports based upon regular inspections as defined above.
- e. Warranty Exclusions:
 - 1) Natural or accidental disasters including, but not limited to, damage caused by lightning, hailstorms, floods, hurricane force winds (74 mph or greater), tornadoes, earthquakes, fire, vandalism, animals, penetration of the membrane, or chemical attack by outside agents.
 - 2) Use of materials not specified by the Warrantor.
 - 3) Overburden materials of any type installed after warranty issue are not covered and will be the responsibility of the owner, in the event they must be removed to identify leak sources and effect repairs. Deck materials built over the vegetative roof are not covered. Poured concrete pavers are not covered. Overburden materials include soil, vegetation, drain board, root barrier materials, metal edging, pavers, and gravel or aggregate surfaces.
 - 4) Any intentional or negligent act on the part of the Owner or third party including, but not limited to, misuse, traffic, storage or

- discharge of materials or effluent on the roof. Any repair of these items will be at Owner's expense.
- 5) Distortion, expansion or contraction of the vegetated roof system caused by faulty original construction or design of building components, including parapet walls, copings, chimneys, skylights, vents or roof deck.
2. Refer to attached warranty for specific inclusions and exclusions.
 3. All roof sections on this Project, including built-up bituminous roofing, to be warranted by one manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The roof system specified in this section is based upon Johns Manville SBS Modified Bituminous Membrane Roof Spec VR-4PID or Firestone 20 year asphalt roofing system, specification I-2C-31-G Garden roof assembly. Only these manufacturers are acceptable.
- B. Subject to compliance with the Contract Documents, comparable systems of other manufacturers named within Section 07510 may be submitted for approval of the Architect.

2.2 INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 3, HCFC-free, with felt or glass-fiber mat facer on both major surfaces.
 1. Compressive Strength: 25 psi minimum.
 2. Dimensional Stability: 2% maximum linear change when conditioned at 158 deg F and 97% relative humidity for seven days.
 3. Curing Time: 24 hours minimum, plus an additional 24 hours minimum per inch of thickness, at a minimum of 60 deg F before shipment from the manufacturer.
 4. Board Thickness: 2 inches maximum.
 5. Board Size: 4-foot by 8-foot maximum board size for mechanically attached insulation boards, and 4-foot by 4-foot maximum board size for insulation boards adhered to substrate.
- B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches, unless otherwise indicated.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- D. Cover Board:
 1. Extensive Design cover board: Basis of Design Product Firestone or Johns Manville, as above
 2. Intensive design cover board (required to support system weights above 40psf): Basis of Design Product Firestone or Johns Manville, as above

2.3 INSULATION ACCESSORIES

A. Insulation Adhesive: Solvent-free, cold fluid-applied, bituminous-urethane adhesive formulated to adhere roof insulation to substrate, with the following physical properties:

1. Asbestos Content, EPA 600/R13/116: None.
2. Volatile Organic Compounds (VOC), maximum, ASTM D 3960: 20 g/L.
3. Non-Volatile Content, minimum, ASTM D 1644: 98 percent.
4. Density at 77 deg F, minimum: ASTM D 1875: 8.5 lb/gal.
5. Elongation at 77 deg. F, minimum, ASTM D 412: 1200 percent.
6. T-Peel Strength at 77 deg. F, minimum: ASTM D 1876: 15 lbf.
7. Adhesion Strength in Shear at 77 deg. F, minimum, ASTM D 816: 80 psi.
8. Low-Temperature Flexibility, maximum, ASTM D 816: -60 deg. F.

2.4 ROOF AND FLASHING BASE MEMBRANE

1. Hot Fluid-Applied Base Membrane Adhesive: Basis of Design Product: Firestone or Johns Manville, as above

2.5 CAP MEMBRANE

A. Cap Sheet: Basis of Design product; compatible with Johns Manville or Firestone system, as above

1. Performance requirements:
 - a. Membrane Thickness: 45 mils, nominal.
 - b. Exposed Face Color: White.

B. Other acceptable cap membranes:

1. Fabric-Reinforced Ketone Ethylene Ester Sheet: Uniform, flexible sheet formed from a Ketone Ethylene Ester, internally fabric or scrim reinforced. KEE membrane must meet and/or exceed all requirements outlined in ASTM D 6754 Standard Specification for Ketone Ethylene Ester (KEE) Sheet Membranes; or,
2. Non-woven fiberglass-reinforced or polyester-reinforced PVC, ASTM D4434, Type II, Grade 1 or Type III.

2.6 AUXILIARY MATERIALS

A. Miscellaneous Accessories: Provide pour-able sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.

1. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain under the membrane as required. Fabricate to slopes indicated.

2. Provide sumps 8' by 8' according to MCPS detail. Vegetated modules placed around sump area, 8' from roof edge.

2.7 IRRIGATION SYSTEM

1. System to be used only to keep green roof in optimal condition during prolonged periods of heat and drought and to optimize the evaporative cooling effect of green roof during such weather events.
 - a. Hose bib outlets to be provided at convenient locations (recommend `150 ft spacing) for watering of vegetated plants as required.

2.8 GROWING MEDIA

- A. Reference ASTM E 2396-05 and ASTM E 2399-05 for design standards.
- B. Basis of Design product: LiveRoof
 1. Mix specifically designed to meet project requirements based on climactic region and plant requirements.
 2. Soil to be enhanced German FLL 93+% (by dry weight) inorganic content.
- C. Additional Acceptable Vegetated roof manufacturers subject to compliance with the quality level detailed in 2.8.B:
 1. Weston Solutions, Inc. – Green Grid G3 system with thin edge trays

2.9 PRE-PLANTED VEGETATED MODULES

- A. Tray Specifications:
 1. Composition: 100% post-industrial recycled polypropylene with 100 mil thick walls.
 2. Dimensions: 2' long x 1' wide with 3" tall sides; soil height raised to approximately 4.25" with removable soil elevator.
 3. Soil height approximately 4.25".MCPS requires a minimum 4" soil depth for stormwater retention and water treatment.
 4. Module system to have minimum 337 cu ft of soil per 1000 square feet of coverage
 5. Module bottom to have positive drain holes placed at lowest point; must provide water dispersal via drain channels of approximately 7.0 gallons per minute per lineal foot.
- B. Module Standards:
 1. 100% recyclable
 2. High durability and resistance to deformity, to withstand at least 12 months of in tray plant propagation and transportation to site.

2.10 SEDUM PLANTINGS

- A. Reference ASTM E 2400-06 for design standards.
- B. The selection of the plants will be done with sedum varieties accepted by the warrantor. The species will be in accordance with the known varieties that have been successfully incorporated into extensive roof design for the particular plant hardiness zone of the specified project. Plant selection that varies from the plant species recommended by the warrantor will not be warranted in any fashion.
 - 1. Green roof plants that are nursery grown with-in 300 miles of project and by a nursery specifically engaged in the propagation of green roof plants.
- C. Wind Erosion Control: As recommended for use with specified system by vegetative roofing system manufacturer.
- D. Plants selected should be low growing (less than 4") and require minimum maintenance by owner.

2.11 AGGREGATE BALLAST

- A. Aggregate Ballast: Washed, crushed stone or smooth stone that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following size:
 - 1. Size: ASTM D 448, Size 7, ranging in size from 1/2" to 1 inch.

2.12 ROOF PAVERS

- A. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
 - 1. Size: 24 by 24 inches. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.
 - 2. Compressive Strength: 7500 psi, minimum; ASTM C 140.
 - 3. Colors and Textures: Match Architect's samples.
 - 4. Pavers need to make a continuous smooth pathway with no gaps.
 - 5. Paver Supports: Integral corner pedestals.
 - 6. Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including adjustable or stackable pedestals, shims, and spacer tabs for joint spacing of 1/8 to 3/16 inch.
 - 7. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hanover Architectural Products, Inc.
 - b. Sunny Brook Pressed Concrete Co.
 - c. Wausau Tile, Inc.; Terra-Paving Div.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Install hot process 3-ply membrane system with no smell asphalt and cap membrane according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-Up Roofing."
 - 1. Install roofing system according to applicable specification plates of NRCA's "The NRCA Roofing and Waterproofing Manual."
- D. The presence and activity of the manufacturer's representative, architect's representative, and/or Owner's representative shall in no way relieve Contractor of contract responsibilities or duties.
- E. Start installation of roofing membrane system in presence of roofing system manufacturer's technical personnel.
- F. Any damages resulting from failure of the contractor to maintain the work area, including areas under construction, areas of storage, and areas used for access, in water tight conditions shall be the full responsibility of the contractor, and the costs resulting there from, including time required by the owner's employees shall be charged to the Contractor.
- G. Extreme care shall be taken to protect the new roofing and insulation. Water tight "Tie-in" shall be installed upon completion of each day's work. The "tie-in" shall be completely water tight so as to protect the insulation and roofing. Completely remove the "tie-in" before beginning the next day's work.
- H. Material, debris, equipment, and other requirements for completion of this project shall be scattered over the roof deck to avoid damage to the structural deck. Contractor assumes full responsibility for loading on the structural deck of roofing materials during

all roofing operations. Architect/Engineer reserves the right to reject any loadings deemed unacceptable.

- I. Contractor shall use reasonable care in transporting materials across the finished roof surface. Contractor shall minimize the use of any portion of the completed roof surface. Extreme care shall be taken to prevent damage to any roofing surfaces. Contractor shall protect all existing roof surfaces exposed to any more than casual foot traffic with no less than 1 layer of 1" thick polystyrene insulation directly on the roof surface and 1 layer of minimum 15/32 plywood. Contractor shall make permanent repairs to damaged areas of the existing roofing and flashing where workers have damaged the existing roofing or flashings.
- J. Contractor shall maintain the job site in a safe, clean, and orderly fashion at all times. All doors and exits shall be made safe and secure from any possibility of falling debris or danger from any work associated with this project. PROPER AND ADEQUATE ACCESS AND EGRESS TO AND FROM THE BUILDING SHALL BE MAINTAINED AT ALL TIMES.
- K. Upon completion of the roofing work the contractor shall thoroughly clean the area of all trash, debris, dust, dirt, etc. resulting from the contractor's work. In addition, all HVAC units shall be shut off and thoroughly washed with tap water.
- L. The Contractor shall furnish all required storage enclosures, safeguards, and comply with all safety standards. Storage areas where hazardous or potentially hazardous products or equipment (including kettles) is stored shall be restricted to general access.
- M. Rooftop hoisting equipment shall be properly assembled and maintained. Only persons that are thoroughly familiar with hoisting equipment shall operate such equipment. All such equipment shall be erected and supported so that it will not damage the existing structural deck or new roofing.
- N. Debris shall be removed in a safe and orderly manner by appropriate means, and all roof debris becomes the property of the roofing contractor. Contractor shall be responsible for the lawful removal and disposal of all trash and debris.
- O. Contractor shall employ only orderly and competent workers, skillful in the performance of the type work required.
- P. Contractor shall erect all required roof barriers and safety lines as required by OSHA and comply with OSHA regulations for safety.
- Q. Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Work included in the Construction Documents. The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to:
 - 1. Employees on the Work and other persons who may be affected thereby;
 - 2. The Work and materials and equipment to be incorporated therein; and
 - 3. Other property at the site or adjacent thereto.
- R. The Contractor shall give notices and comply with applicable laws, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons and property and their protection from damage, injury, or loss. The Contractor shall promptly remedy damage and loss to property at the site caused in whole or in part by

the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible.

- S. Contractor shall comply with the most current (Occupational Safety and Health Administration) OSHA requirements as to the proper implementation of safety equipment as deemed necessary by such requirements for all employees of the Contractor working on the Site, Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible. In addition, the Contractor shall provide at all times a minimum of three (3) complete additional safety equipment units, i.e. harnesses, rigging gear, hardhats, etc., as deemed necessary by the OSHA requirements for all workers. The three- (3) additional units are for the use by the Owner, Owners' Representatives, Architect, Engineer, and A/E Inspectors.
- T. Fire Extinguishers - Contractor shall provide one (1) fire extinguisher for each kettle on the project plus one (1) additional fire extinguisher per every 100 squares of roofing area. All fire extinguishers shall be a minimum of 25 lbs.
- U. No roofing work shall be performed below 40 degrees, or when the wind chill factor is below 40 degrees, or when rain is eminent (30% chance or greater). No roofing shall be performed when the average wind is above 25 mph without written permission from the Architect/Engineer. No roofing work shall be performed after 30 minutes prior to sundown. The roof deck shall be dry and free from any moisture, ice, or other deleterious materials prior to roofing.
- V. All materials susceptible to moisture shall be protected in dry, above ground, watertight storage. ALL ROLL GOODS, INSULATION, CANT STRIP, AND TAPERED EDGE SHALL BE STORED IN WATER TIGHT, ENCLOSED TRAILERS, and these materials shall be loaded onto the roof on a daily basis. All labels shall be intact and legible, clearly showing the product, manufacturer, and other pertinent information.
- W. Any materials becoming wet or damaged will be rejected and shall be removed from the job site immediately. Any insulation found to be improperly stored at the job site should be considered wet at the discretion of the Architect/Engineer and removed from the job site.
- X. Asphalt tanker truck shall be thermostatically controlled and equipped with a working, readable thermometer. An additional calibrated working thermometer shall be maintained at the job site.
- Y. Substrate: Free of foreign particles prior to laying roof membrane.
- Z. Traffic and equipment: Kept off completed plies until adhesive has set.
- AA. Wrapper and packaging materials: Not to be included in roofing system.
- AB. Entrapped aggregate: Not permitted within new membrane.
- AC. Wood cants: Install and secure preformed 45-degree wood cant at roof step down expansion joints.
- AD. Ply shall never touch ply, even at roof edges, laps, tapered edge strips, and cants.
- AE. Fit plies into roof drain rims; install lead flashing and finishing plies; secure clamping collars; install domes.

- AF. Extend roofing membrane to top edge of cant at wall and projection bases.
- AG. Cooperate with inspecting and testing agencies engaged or required to perform services for installing roofing membrane system.

3.3 INSULATION INSTALLATION

- A. General: Install insulation boards as follows:
 - 1. (1) layer polyisocyanurate board, mechanically attached to sloping roof deck. All roof structure should be sloped $\frac{1}{4}$ " per foot to achieve the desired slope.
- B. Design and install insulation to guarantee complete positive drainage with a minimum roof slope of 1/4:12.
- C. Insulation shall be installed in strict accordance with the recommendations and requirements of the Primary Roofing Material Manufacturer, the recommendations of the National Roofing Contractor Association (NRCA), the requirements for Factory Mutual and UL Class A Construction, and these Contract Documents, the most restrictive applying. All roofing materials shall be as described in Part 2 Products and shall be provided and/or approved by the Primary Roofing Material Manufacturer. Any materials not manufactured or provided by the Primary Roofing Material Manufacturer shall have the written approval from the Primary Roofing Material Manufacturer stating materials are acceptable and compatible with the other materials and systems required. Phased application is not acceptable. No more roofing, flashing, or insulation shall be removed than can be completely replaced within the same day.
- D. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- E. Comply with roofing system manufacturer's written instructions for installing roof insulation.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Install top layer of 1" thick perlite insulation over one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers (max. board thickness shall be 2 inches) with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- H. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- I. Install $\frac{1}{2}$ " per foot pre-manufactured crickets in locations shown on drawings.
- J. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

- K. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 2. Install subsequent layers of insulation in a hot asphalt adhesive.
 - 3. Fasten to resist uplift pressure at corners, perimeter, and field of roof.

- L. Install perlite cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Stagger joints from joints in insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.

3.4 ROOFING MEMBRANE INSTALLATION, GENERAL

- A. Coordinate installing roofing system components so insulation and roofing membrane sheets are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.
 - 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
 - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 - 3. Remove and discard temporary seals before beginning work on adjoining roofing.

- B. Hot Process Asphalt Heating
 - 1. Asphalt tanker truck specifically designed for applying hot asphalt is required.
 - a. Unit must be capable of maintaining materials between 375 - 400 degrees F and oil bath temperatures between 500 - 550 degrees F.
 - b. Consult manufacturer for information on safe operation and maintenance.

- C. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.5 ROOFING AND FLASHING MEMBRANE APPLICATION

- A. Apply hot asphalt membrane according to manufacturer's written instructions.
- B. Reinforced Base Membrane: Install two ply sheets starting at low point of roofing system, and then come back with one more SBS cap sheet. Align ply sheets without

stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.

1. Embed each ply sheet in Type III hot asphalt applied at 25-30 lbs. per square to form a uniform membrane without ply sheets touching.
2. Install the cap membrane in 25-30 lbs. per square of hot asphalt at the proper viscous temperature to insure a fully adhered, 150 mil monolithic membrane system. Refer to Section 3.7.
3. Application shall be in strict accordance with the recommendations of the manufacturer. Wet mil thickness should be checked or gauged as work processes.

C. Refer to Drawings for the following vegetative roof assembly components:

1. Concrete Parapet Wall Flashing
2. Roof Drain
3. Low Parapet Flashing
4. Continuous Pipe Penetration
5. Plumbing Vent
6. Scuttle and Smoke Vent
7. Expansion Joint with Metal Cover
8. Door Threshold Flashing

3.6 FULLY ADHERED CAP MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow it to relax before installing.
 1. Install sheet according to ASTM D 5036.
- B. Install cap membrane into the hot asphalt while it is still viscous to insure a good monolithic membrane.
- C. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.
- D. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
 3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
- H. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

3.7 FLASHING MEMBRANE INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Install flashing membrane in the hot fluid base membrane while it is still viscous to insure a good monolithic membrane.
- C. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

3.8 LAYING (PLACING) VEGETATED MODULES

- A. Module installation to follow behind installation of slip sheet/root barrier, irrigation system, pavers, ballast, and edging.
- B. Vegetated trays should not be installed within six feet of major mechanical equipment. They may be placed up to one foot from edge of roof.
- C. Module installation to be conducted in strict accordance with manufacturer installation guidelines. Surface to be clean and swept free of soil, dirt, stones or grit before placing each module. Rows to be straight, modules to be tight against each other with edges overlapping and arranged in proper directional orientation.
- D. Module installation to be conducted in accordance with green roof design.
- E. Modules to be placed directly on top of manufacturer recommended slip sheet/root barrier.
- F. It is recommended that any custom cutting/fitting be oriented on the high side (top), or sides of the roof. It is recommended that the cut side of the module be set tight against the edging or toward the side of an intact module so as to prevent soil spillage. If custom cutting must be done on the low, draining, side of the roof, it is imperative that no filter cloth be inserted as it could impede drainage. It is best to orient the cut side against another module, facing upstream.
- G. After installing modules, they should be immediately watered so as to thoroughly moisten the media from top to bottom. Water shall be of suitable quality for plant growth and irrigation system or hoses and sprinklers may be used for such purpose. Note: it takes approximately 1 inch of water, or 1¼ gallons per module to moisten each module thoroughly.

G. INSTALLATION SEASON Module Installation to be conducted:

1. When plants are properly adapted and acclimatized to local weather conditions.
2. When weather is above 35° F and there is no ice on the roof and engineered soil is unfrozen.
2. No later than the cut off date required by the green roof system provider's warranty terms, if applicable.

3.9 AGGREGATE BALLAST OR ROOF-PAVER INSTALLATION

E. Lay ballast according to manufacturer's written instructions.

1. Install strips/areas (minimum width of 18") of stone/paver ballast for walkways and maintenance paths at all roof perimeter, building walls and penetrations (including drains) to act as vegetation barriers for the flashings as well as barriers to wind and fire and where indicated on Drawings.
2. Install curbs as designated to separate the soil areas from stone/ paver strip areas.

F. Install inspection maintenance boxes and grills over drains to ensure access at top of soil level.

G. Install paver stands on fabric protection mat. Level paver on stands or pedestals as required. Pavers shall be in an even plane with no noticeable unevenness.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Technical Representative: Contractor will engage a qualified manufacturer's technical representative acceptable to Owner for on-site monitoring to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion of roofing membrane and flashing.

1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

C. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reapply roofing, and repair flashing.

1. After roof inspection by MCPS, repair leaks and make further repairs until roofing installation is watertight.

D. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.

3.11 PROTECTING AND CLEANING

- A. Protect roofing according to manufacturer written recommendations to prevent damage and wear during application and remainder of construction period.
- B. Protect installed insulation from damage due to UV-light exposure, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 SCHEDULE OF WARRANTIES AND SERVICE AGREEMENTS

- A. The following documents are referenced in this Section and are attached following this Section; complete and submit documents in accordance with requirements:
 - 1. 20-year Warranty for New Vegetated Roof System Assemblies.
 - 1. Construction Edge Detail set.
 - ~~4.2.~~ Maintenance protocol for vegetated roof.

END OF SECTION