1.0 GENERAL

1.1 Related Work and UBC Guidelines

1. Section 07 00 10 Building Envelope – General Requirements
2. Section 07 21 00 Thermal Insulation
3. Section 07 55 00 Membrane Roofing
4. Section 07 62 00 Sheet Metal Flashing & Trim
5. Division 32 - for landscape maintenance
6. UBC LEED Implementation Guide – for water use for irrigation
7. Safety and Risk Services policies for health and safety

1.2 Related External Documents

1. Latest edition of the British Columbia Building Code (BCBC). The BC Building Code requires that all roofs, except when permitted (tents, inflatable structures, certain small "assembly occupancy" buildings), must be Class A, B, or C, as determined in accordance with CAN/ULC-S107-10 "Standard Methods of Fire Tests of Roof Coverings."
2. RCABC Roofing Practices Manual.
3. Refer to Canadian Landscape Standard, current edition, Section 13 - Landscape over Structure and BC Standard for Extensive Green Roofs, and CMHC Roof Deck Design Guidelines.

1.3 Description

1. A vegetated (green) roof system has a variety of typologies primarily based on growing media depth and vegetative selection. Common types include extensive, rooftop agriculture, modular, and intensive.
2. All typologies include, at minimum, the following basic components: vegetation, growing media, filter fabric, edging, vegetative free zone ballast, drain mat, and root barrier.
3. A loose laid vegetated roofing system includes all base components installed with individual layers laid over each other.
4. A modular (tray) vegetated roofing system includes all base components with some components being loose laid and others enclosed in a multifunctional modular product.

1.4 Coordination

.1 The guidelines apply to all work completed within buildings on the UBC Vancouver campus. Green roofs are NOT supported at the UBC Okanagan campus.

.2 In instances where conflicts are found between these guidelines and provincial regulations or codes, please notify the UBCV Technical Review Team Architect.

.3 These guidelines are intended to be read by design consultants and their content integrated into construction drawings and specifications. Construction documents are not to reference the technical guidelines directly.

.4 The Registered Coordinating Professional (CRP) is required to coordinate these requirements with other disciplines. Projects with vegetated roof system require close and early design coordination among the landscape architect, architect, structural engineer, building envelope consultant, mechanical engineer and manufacturer to ensure that the landscape design objectives are integrated into the structural design. Special consideration around waterproof membrane compatibility, irrigation, water drainage and or retention/detention systems, maintenance access, glazing reflectivity, and weightbearing capacity are of critical importance.

.5 CRP to coordinate architectural AND landscape green roof detailing.

.1 For at grade green roof assemblies, CRP to coordinate green roof drainage requirements with both landscape architect and civil engineer.

.6 Submittal of a maintenance plan for the vegetated or vegetated-hybrid system is mandatory at the design stage and requires coordination between the landscape architect, manufacturer, landscape contractor and Landscape Architect in UBC Municipal Services. Special consideration to the establishment phase, warranty conditions, safety, and rooftop access of maintenance equipment should be addressed.

.7 Coordination between the project Landscape Architect, supplier, and Landscape Architect in UBC Municipal Services is required for vegetative and growing media selection. Should the vegetated roof be desired to provide stormwater detention, project specific rainwater detention evaluation should be provided for the green roof assembly.

1.5 Submittals

.1 Submit required documents to consultants in accordance with Section 013300 Submittal Procedures

.2 O&M Submittals
- .1 Submit two (2) copies of the most current technical data sheets. These documents must describe the physical properties of materials [and explanations about product installation, including restrictions, limitations and other manufacturer recommendations].
- .2 Green roof components shop drawings.
- .3 Sheet metal flashing shop drawings.
- .4 Planting material information and maintenance data as per Division 32 requirements.
- .5 Manufacturer's confirmation of training – if needed.
- .6 Environmental Product Declaration (EPD).
- .7 Manufacturer performance test data to confirm performance criteria.
- .8 Manufacturers Safety Data sheet (MSD) for all toxic or potentially toxic materials.

1.6 Quality Control and Assurance

.1 Quality Assurance
- .1 Meet or exceed the RoofStar Guarantee 5-Year guarantee standards. All roofing system products to conform to the RoofStar Guarantee Standards and to the appropriate CSA, CGSB, ULC, CULC, and ASTM Standards for the materials used in the roofing system; products to be listed in the RGC Accepted Materials List of the RoofStar Guarantee Roofing Practices Manual, and to be in conformance with the manufacturers' published product and performance data.
- .2 Certificates of qualification may be part of the documents required for submission. Where applicable, these requirements shall be part of the call for tender(s).
- .3 The contracted installer and his subcontractors must be officially recognized as authorized contractors by the vegetated roofing system supplier at the time of tendering and throughout installation.
- .4 Required work may be carried out only by applicators who have been trained in the application of the green roofing systems and who are employed by an enterprise which has the adequate and necessary equipment.
- .5 A representative of the waterproofing materials manufacturer can be present on the worksite at commencement of work or at any other time during the work, as required.
- .6 The contractor must at all times enable and facilitate access to the worksite and the roofs for the said manufacturer's representative.

.2 Quality Control
- .1 An Independent Inspection Agency acceptable to RoofStar Guarantee, and assigned by RoofStar Guarantee on acceptance by the Consultant and the UBC Development Manager, to conduct field review inspections as per the minimum protocols as set forth by the RoofStar Guarantee for their 5 Guarantee Program. It is understood that in addition to these responsibilities the independent inspection agency will provide re-inspection services at the 2 year anniversary – in the case of the 5 year warranty.
  - .1 Cost for the warranty and inspections are to be included in the contract sum.
  - .2 UBC reserves the right to increase the field review inspection frequency to FULL TIME site inspections while the work is in progress. Extra costs for this to be borne by UBC.
  - .3 Added inspections just prior to the expiration of the warranty, if required, will be arranged and the costs borne by UBC.

.4 A manufacturer's representative to also inspect the work as required for the purposes of providing the manufacturer's labour, material and workmanship warranty upon completion.

1.7 Warranties

.1 Provide the RoofStar Guarantee Roofing System Record, to include the RoofStar Guarantee standard 5-Year Guarantee, copies of Inspection Reports, listing and literature of all products used, and Roof Maintenance Guide. All roofing system products to conform to the RoofStar Guarantee Standards and to the appropriate CSA, CGSB, ULC, CULC, and ASTM Standards for the materials used in the roofing system; products to be listed in the RGC Accepted Materials List of the RoofStar Guarantee Roofing Practices Manual, and to be in conformance with the manufacturers' published product and performance data.

.2 Provide a membrane manufacturer's warranty certificate.

.3 Where adhesive is used in the assembly, include and provide the adhesive manufacturer's warranty.

.4 Active or passive roof leak detection system warranty.

.5 All warranties to commence at Date of Substantial Performance.

.6 Retain relevant articles when an extended vegetative roofing material warranty is requested in addition to a waterproofing system warranty (warranty of the membrane manufacturer). Refer to extended warranty providers requirements to ensure continuity between manufacturers recommendations and warranty requirements.

.7 The membrane manufacturer will issue a written document in the owner's name, valid for a 5-year period, stating that it will remove and reinstall the vegetative system components to repair any leaks in the roofing membrane to restore the roofing system to a dry and watertight condition, to the extent that manufacturing or installation defects of one or several components caused such water infiltration. The warranty must cover the total cost of repair(s) during the entire warranty period. The warranty certificate must reflect these requirements.

2.0 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design Requirements

.1 Green roof systems are to be designed to meet the Guarantee Standards of the Roofing Contractors Association of British Columbia.

.2 Structural Deck System Requirements

- .1 Conventional Vegetated Green Roof Assemblies
  - .1 Concrete roof deck structures
  - .2 Wood framed roof deck structures
  - .3 Steel deck structures
  - .4 Inverted vegetated green roof and podium assemblies
  - .5 Concrete deck structures only

.3 Inverted roof assembly requirements to be as per Section 07 10 00 Damproofing and Waterproofing.

.4 Conventional roof system requirements to be as per Section 07 55 00 Membrane Roofing.

.5 Performance standards for roof insulation to be those set out in Section 07 21 00 Thermal Insulation.

.6 Roof penetrations are to be designed to RCABC standards. Additional information can be found in 2.1.13.

.7 Vapour retarders

- .1 Vapour retarders are to be included in all assemblies and shall be fully adhered to the substrate. Products shall be appropriate to the building envelope configuration and be installed so as to wrap and envelope the insulation, compatible for connection to the building envelope air barrier, and be sealed at all penetrations. Laminate Kraft paper and adhesive is not an acceptable vapour retarder.

.8 Minimum slope for drainage and roof drains
- .1 New and re-roof assemblies shall have a minimum of 2% slope to drain. This can be achieved by structural slope, sloped insulation, cricket and back slopes or any combination of these.
- .2 Roof drain requirements to be as per Section 07 50 00, 2.1.16.

.9 Confirm inclusion of root barrier across project documents. It should be specified/referenced in both architectural AND landscape architecture documents.

.10 For systems with a greater than 15% slope modular systems, consult with the manufacturer for product requirements, placement, and compatibility

.11 Root Barrier
- .1 The root barrier should be detailed overtop the waterproofing membrane, across the entirety of the roof field. It should run up all projections, drains, and/or vertical interfaces to meet the highest point of growing media and ballast.
- .2 Root barrier layer breaks should be detailed with, at minimum, a 1 foot overlap- fastened with a manufacturer approved fastener. Alternatively, 3 foot overlaps without tape are acceptable.

.12 Drainage mat
- .1 Drainage mat must run continuous across the roofing field in order to facilitate water movement to drain. Therefore, it must encompass both the delimitated vegetative free zones and vegetated zones.
- .2 The drainage mat should be detailed between root barrier and filter cloth, across the entirety of both the vegetated and vegetative free zone roofing field. Therefore, it should be detailed under the filter cloth, metal edging, and vegetative free zone ballast. It should be detailed flush to all drains, projections, and interfaces.
- .3 In a protected roofing assembly (PMA) roofing assembly the drainage mat must be an open diffusion product, and it's placement will change. It should be detailed between the XPS insulation layer and the filter cloth, across the entirety of the vegetated and non-vegetated roofing field.

.13 Edging
- .1 The edging should be detailed on top of the drain mat and between the filter cloth and the drainage mat, adjacent to the vegetation free zone ballast.

.14 Vegetation free zone
- .1 Vegetation free zones are essential to reduce potential clogging of essential systems like drains and help maintain plant health by providing maintenance paths. Minimum recommended widths are to improve ease of access for maintenance staff and reduce likelihood of vegetative infiltration of roofing components.
- .2 Vegetation free zones should be detailed around all roof penetrations such drains, roof anchors, parapets, and other rooftop projections like mechanical and electrical services and equipment, and/or high traffic areas.
- .3 The vegetation free zone (river rock) should be detailed between the edging and the perimeter parapets and all roof projections. It should be detailed to go over the root barrier and drain mat to ensure adequate drainage.
- .4 Vegetative free zone ballast should be lower than the adjacent growing media found in the vegetative zone in order to reduce maintenance issues and for maintenance ease of use.
- .5 The vegetation free zone should be detailed at 300mm (12") wide for linear edges and with a 300mm radius around roof drains and other roof projections.

.15 Filter fabric
- .1 To prevent growing media seepage, it's essential that the filter fabric runs up the vertical interface of the edging, to the top of the edging.
- .2 The filter fabric should be detailed overtop of the drain mat, across the vegetated roofing field, overtop and up the vertical interface to the top of the edging.
- .3 Filter fabric breaks should be detailed with, at minimum, a 1' overlap.

.16 Growing media
  .1 Growing media should be detailed between the vegetation and the filter fabric, within the vegetated roofing field.
.17 Vegetation
  .1 Vegetation should be detailed at the top of the system, above the growing media, within the vegetated roofing field.
.18 Roof leak detection system
  .1 For green roofs at grade over suspended slab or at roof level (inverted roofs) with soil or landscape buildup, a RoofStar Guarantee approved passive roof leak detection system must be included in the assembly.
  .2 An active (monitored) roof leak detection system is required for high value buildings such as museums, libraries and research facilities.
  .3 Initial EFVM scan and leak locate system is required for all inverted roof assemblies.
  .4 Active (or monitored) roof leak detection systems must have the capability of issuing email alerts complete with a graphic of the roof indicating the location of the leak and must also be capable of issuing alarms to the BMS system.
  .5 The roof leak detection system can be hard wired or connected via BACnet to the UBC BMS system. Project team to coordinate with the UBC BMS group.
.19 Roof level access path
  .1 Install walkway paths at areas requiring regular maintenance, and from there leading to the main roof access door.
.20 Water retention/detention
  .1 Roofing components, provide both retention AND temporary water detention capacity, targeted at peak outflow reduction but to a limited capacity. If additional water retention/detention is being reviewed for a project for green roofs, selection should be determined by a combination of water retention and/or detention targets, weightbearing capacity, irrigation needs and use of specialized components targeted for water retention/detention within the green roof assembly.
  .2 Above evaluation to be done by the project team and shared with the Sustainability Department (C&CP) and UBCV Technical Review Team Architect.
.21 Basis of design details
  .1 Refer to the basis of design details provided as a starting point for green roof assembly design.
  .2 CRP to use these details for coordination of green roof details with the landscape architect.

2.2 Performance Requirements

.1 Life Cycle Expectation
  .1 Minimum 25-year service life expectancy

3.0 MATERIALS

3.1 Product Selection

.1 Inverted Roof Assembly – Membrane - refer to Section 07 10 00, 3.0 for requirements of this system. Basis of design details have been provided for reference at the end of this section.
.2 Conventional Roof Assembly – refer to Section 07 50 00, 2.2 for requirements of this system.
.3 Vegetation
  .1 Due to the permanent nature of green roofs, it's suggested that vegetative selection includes a majority of perennial coverage, unless design intent stipulates otherwise, like in the case of rooftop agriculture. Vegetation can be installed as seeds, cuttings, plugs, shrubs, trees, or pre-vegetated mats.
  .2 Vegetative selection should be determined by a combination of factors including but not limited to climate, growing media depth, growing media composition, design intent, irrigation, and maintenance requirements.

.4 Growing Media
- .1 Contact the manufacturer's representative to help determine the right growing medium composition for the green roof vegetation. Its recommended that an irrigation system be installed and maintained in good condition to sustain water needs throughout wet and dry seasons.
- .2 Growing media selection should be determined by a combination of factors including, but not limited to, depth of the assembly and vegetative choice. Growing media depth influences both water retention capacity, irrigation requirements, and overall weight. Vegetated roofing assembly growing media, in general, should have higher porosity, lower organic content, and higher mineral aggregate content than typical soil blends.
  - .1 Non-Irrigated Extensive and Semi-Intensive Systems
    Growing medium consisting of an unconsolidated mixture of organic matter and mineral aggregates. The composition is specially formulated by the vegetated roofing system manufacturer for extensive or semi-intensive systems, to provide optimal water retention, permeability, structural stability and density for plants with low water needs.
  - .2 Irrigated Semi-Intensive and Intensive Systems
    Growing medium consisting of an unconsolidated mixture of organic matter and mineral aggregates. The composition is specially formulated by the vegetated roofing system manufacturer for semi-intensive and intensive systems, to provide optimal water retention, permeability, structural stability and density for plants with medium and high water needs.

.5 Retention and/or Retention + Detention
- .1 Water retention capacity can be enhanced through specialized components targeted at water retention. Alternatively, roofing components, provide both retention AND temporary water detention capacity, targeted at peak outflow reduction.
- .2 Additional water retention/detention selection should be determined by a combination of weightbearing capacity, irrigation needs, and any water retention and/or detention targets.

.6 Filter Fabric
- .1 Filter fabric selection should aim to limit breaks and stabilize the growing media to prevent it from infiltrating other system components.

.7 Edging
- .1 Edging selection should be determined by growing media depth, durability, design asthetics, and water flow needs. Metal edging should be, at minimum, as high as growing media depth, and in areas with high water flow rates, should be perforated.

.8 Vegetative free zone ballast
- .1 Ballast selection should be determined by a combination of design aesthetics, weightbearing capacity, maintenance, and any wind uplift requirements. In general, either concrete pavers, or rounded river stones between sizes of 19mm and 38mm are recommended.

.9 Drain Mat
- .1 Consult warranty provider requirements for need and use of a second drain mat layer.
- .2 Drain mat selection should be determined by a combination of compressive strength, water flow rate, and roof assembly needs. For protected membrane assemblies, an open diffusion drain mat is required, laid overtop of the insulation layer. For conventional roofing assemblies, either an open diffusion or dimple drain mat is acceptable, laid over top of the root barrier.

.10 Root Barrier
- .1 :20 Mil polypropylene sheets are required in extensive systems due to shallow vegetative root systems and, in the case of pre-vegetated mats, reduce the likelihood of volunteer species becoming established. 30 Mil polypropylene sheets are requiredin non-extensive systems with more aggressive vegetative root penetration, and/or that have a higher likelihood of volunteer species establishment.

.2 Root barrier selection should be determined by a combination of vegetative choice, site conditions, and maintenance planning.

4.0 MAINTENANCE REQUIREMENTS

.1 Maintenance is required before, during, and after install of the vegetated roof system. Special consideration should be paid to irrigation, weeding, pest control, and fertilization needs of the vegetated roofing sections. Furthermore, regular cleaning of debris from drains and vegetation free zones is required.

.2 Intensive systems will generally require a higher degree of maintenance than extensive systems. Likewise, a sedum mat component will have a shorter establishment period than most perennials and shrubs. Consult with the Landscape Architect, Municipal Services when developing a maintenance program best suited to roof typology and vegetative selection.

.3 A maintenance program should be developed to include, at minimum, limited conditions for vegetation care, before, during, and after handoff to Facilities. Furthermore, it should include special conditions for the establishment period of the vegetation. Lastly, it should include long term conditions for both vegetative care, drain cleaning, and regular roof maintenance.

.4 The first two-year establishment period for the vegetated system generally requires higher frequency maintenance visits than subsequent years.

.5 Maintenance is a requirement of many warranty conditions, thus should be designed, at minimum, to meet warranty conditions.

5.0 LESSONS LEARNED AND COMMON MISSES ON UBC PROJECTS

Items in this section are lessons learned, and may be code or industry best practices which have been missed on past projects. If not applicable to a project, a variance is not required.

.1 All green roof details, whether at roof level or at grade are to be coordinated with the landscape and civil design. Complete details showing the landscape build-up plus drainage are to be included within the architectural detail sheets or booklet. The architectural site plan should coordinate drainage slopes and methods with the landscape and civil designs.

*****END OF SECTION*****