

**SOPREMA (PMMA) LOW-ODOR ALSAN RS WATERPROOFING LIQUID APPLIED &
LIVEROOF GREEN ROOF SYSTEM**

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

- A. The following specification outlines the requirements green roof assembly [protection course (if required), drainage course (if required), extruded polystyrene insulation (if required), vegetation pre-grown tray system and fully reinforced, quick curing, cold fluid-applied, low-odor (PMMA) polymethyl methacrylate liquid resin waterproofing membrane (with optional approved broadcast mineral aggregate surfacing or approved coating) and all other ancillary waterproofing work including but not limited to, installation of drains, pipe flashings, penetration flashings, sealants and metal work as specified.
1. All membrane materials shall have a superior coefficient of expansion, to allow for differential movement between the horizontal and vertical surface of the flashed penetration or projection.
 2. New membrane system **MUST** provide fast-drying primers to allow substrate preparation, priming and membrane application to be completed the same day.
 3. The use of cold fluid-applied reinforced low-odor (PMMA) polymethyl methacrylate membrane materials will be required for all field membrane and flashings.
 4. Any occupied and/or heated spaces **MUST** be waterproofed using a fully reinforced system.

1.02 SECTION INCLUDES

- A. Adhered cold fluid-applied reinforced low-odor (PMMA) polymethyl methacrylate waterproofing system including, membrane, penetration flashings, base flashings, and expansion joints.
- B. Complete removal of all existing overburden materials and roofing/waterproofing membrane.
- C. Substrate preparation, cleaning, leveling and patching
- D. Temporary waterproofing
- E. Waterproofing membrane installation
- F. Flashing installation and expansion joint installation
- G. Preparation for overburden installation
- H. Extruded polystyrene insulation installation

I. Pre-grown vegetation tray system installation

1.03 RELATED SECTIONS

- A. Supplementary General Conditions
- B. Basic Requirements
- C. Wood Blocking and Nailers
- D. Sheet Metal Flashing and Trim
- E. Plumbing Specialties
- F. Overburden Installation
- G. Landscaping

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) C 836 Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane.
- B. Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau (FLL), Guidelines for the Planning, Execution and Upkeep of Green Roof Sites (2002).
- C. Dow Chemical Company, TechNote 508 “Ballast Design Guide for IRMA Roofs”.
- D. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual.
- E. ACI-308 - Recommended Practice for Curing Concrete
- F. ASTM - D638 - Test Methods for Tensile Properties of Plastics
- G. ASTM - D4258 - Standard Practice for Surface Cleaning Concrete for Coatings
- H. ASTM - D4259 - Standard Practice for Abrading Concrete
- I. ASTM - D4541 - Method for Pull-Off Strength of Coatings using Portable Adhesion Tester
- J. ASTM - E96(A) - Test Methods of Moisture Transmission of Material
- K. ASTM E-108, ANSI/UL 790 for fire resistance.
- L. Steel Structures Painting Council (SSPC)

1.05 SUBMITTALS FOR REVIEW

- A. Membrane System Product Data: Provide current standard printed product literature indicating characteristics of membrane materials, flashing materials, components, and accessories product specification and installation.
- B. Confirmation that all waterproofing and overburden components are being supplied and warranted by a single-source manufacturer (except as approved in writing by membrane manufacturer).
- C. Product Samples: Submit product samples of membrane and flashing materials showing color, texture, thickness and surfacing representative of the proposed system for review and approval by the Owner's Representative.
- D. Submit sample copies of both the Manufacturer and Applicator warranties for the periods stipulated. Each specimen must be a preprinted representative sample of the issuing company's standard warranty for the system specified.
- E. Submit copies of current Material Safety Data Sheets (MSDS) for all components of the work.
- F. Membrane Shop Drawings: Submit shop drawings of cold fluid-applied reinforced polymethyl methacrylate membrane showing all a project plan, size, flashing details, and attachment for review and approval by the Owner's Representative and Membrane Manufacturer.

1.06 QUALITY ASSURANCE

- A. Membrane Manufacturer: Company specializing in manufacturing the products specified in this section with ten (10) years documented experience. Membrane Manufacturer shall submit the following certifications for review:
 - 1. Substrates and conditions are acceptable for purpose of providing specified warranty.
 - 2. Materials supplied shall meet the specified requirements.
- B. Applicator: Company specializing in performing the work of this section with (3) years documented experience and **approved by system manufacturer for warranted membrane installation**. Applicator shall submit the following certification for review:
 - 1. Applicator shall submit documentation from the membrane manufacturer to verify contractor's status as an approved applicator for warranted installations.
- C. Evaluate moisture content of substrate materials. Constructor shall determine substrate moisture content throughout the work and record with Daily Inspection Reports or other form of reporting acceptable to the Owner or designated Representative, and Membrane Manufacturer.
- D. Random tests to determine tensile bond strength of membrane to substrate shall be conducted by the Contractor at the job site using an Elcometer Adhesion Tester Model 106 or similar device. Contractor shall perform tests at the beginning of the Work, and at intervals as required to assure specified adhesion with a minimum of three (3) tests per 5000 square feet. Smaller areas shall receive a minimum of three (3) tests. Test results shall be submitted to the

Owner or his designated Representative and the Membrane Manufacturer. Contractor shall immediately notify the Owner or his designated Representative and Membrane Manufacturer in the event tensile bond test results are below specified values.

1. Adequate surface preparation will be indicated by tensile bond strength of membrane to substrate greater than or equal to 220 psi (1.5 N/mm²) for pedestrian traffic and 300 psi (2.0 n/mm²) for vehicular (low speed) traffic and water flow/containment.
 2. In the event the tensile bond strengths are lower than the minimum specified, additional substrate preparation is required. Repeat testing to verify suitability of substrate preparation.
- E. Monitor quantities of installed materials. Monitor application of resin mixture, reinforcing fleece and flashing. Perform Work in accordance with manufacturer's instructions.
- F. Mock-up areas shall be used to determine required methods and tools to obtain degree of substrate preparation required by the membrane manufacturer. Conduct tests as required to verify that substrate preparation meets specified requirements. Tests shall include, but are not limited to, tensile bond strength and moisture content of substrate.
1. Prepare and clean a three (3) foot (0.9 m) by three (3) foot (0.9 m) area of each substrate material type.
 2. Submit findings in writing to Owner or his designated Representative and Membrane Manufacturer.
 3. Mock-up areas shall be maintained for quality control for the entire project.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable building and jurisdictional codes for roofing/waterproofing assembly and fire resistance requirements.
- B. Comply with requirements of OSHA, NIOSH or local governing authority for work place safety.
- C. Comply with authority or agency "Confined Space Policy" during and throughout all work to be performed.

1.08 PRE-INSTALLATION MEETING

- A. Convene a pre-installation meeting at the job site (1) week before starting work of this section. Require attendance of parties directly affecting work of this section, including but not limited to, Architect, and Owner's Representative, Roofing/Waterproofing Contractor, and Membrane Manufacturer's Representative. Review roofing/waterproofing preparation and installation procedures, coordination and scheduling required with related work, and condition and structural loading limitations of deck/substrate.

1.09 DELIVERY, STORAGE, AND PROTECTION

- A. The Contractor together with the Owner or his designated Representative shall define a storage area for all components. The area shall be cool, dry, out of direct sunlight, and in accordance with manufacturer's recommendations and relevant regulatory agencies. Materials shall not be stored in quantities that will exceed design loads, damage substrate materials, hinder installation or drainage.
- B. Store solvent-bearing solutions, resins, additives, inhibitors or adhesives in accordance with the MSDS and/or local fire authority. After partial use of materials replace lids promptly and tightly to prevent contamination.
- C. Roll goods shall be stored horizontally on platforms sufficiently elevated to prevent contact with water and other contaminants. DO NOT use rolls which are wet, dirty or have damaged ends.
- D. Roofing/waterproofing materials must be kept dry at all times. If stored outside, raise materials above ground or roof level on pallets and cover with a tarpaulin or other waterproof material. Plastic wrapping installed at the factory should **not** be used as outside storage covers.
- E. Follow manufacturer's directions for protection of materials prior to and during installation. Do not use materials which have been damaged to the point that they will not perform as specified. Fleece reinforcing materials must be clean, dry and free of all contaminants.
- F. Copies of all current MSDS for all components shall be kept on site. Provide any and all crewmembers with appropriate safety data information and training as it relates to the specific chemical compound he or she may be expected to deal with. Each crewmember shall be fully aware of first-aid measures to be undertaken in case of incidents. Comply with requirements of OSHA, NIOSH or local governing authority for work place safety.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply roofing/waterproofing membrane during or with the threat of inclement weather.
- B. Application of cold fluid-applied reinforced low-odor polymethyl methacrylate roofing/waterproofing membrane may proceed while air temperature is between 32 °F and 95 °F (0 - 35 °C) providing the substrate is a minimum of 5 °F above the dew point.
- C. When ambient temperatures are at or expected to fall below 32 °F (0 °C) or reach 95 °F (35 °C) or higher, follow Membrane System Manufacturer's recommendations for weather related restrictions and application procedures.
- D. Ensure that substrate materials are dry and free of contaminants. DO NOT commence with the application unless substrate conditions are suitable. Contractor shall demonstrate that substrate conditions are suitable for the application of the materials.
- E. Where required by the Owner or his designated Representative, Contractor shall implement odor control and elimination measures prior to and during the application of the

roofing/waterproofing materials. Control/elimination measures shall be field tested at off-hours and typically consists of one (1) or a multiple of the following measures:

1. Sealing of air intakes with activated carbon filters. Install filters in accordance with requirements and recommendations of the filter manufacturer. Seal filters at joints and against building exterior walls to prevent leakage of unfiltered air where required due to size of intake opening. Provide track system to secure filters.
2. Erection and use of moveable enclosure(s) sized to accommodate work area(s) and stationary enclosure for resin mixing station. Enclosure shall be field constructed or pre-manufactured of fire retardant materials in compliance with local code requirements in accordance with requirements of the Owner or his designated Representative. Equipment enclosure(s) with mechanical air intake/ exhaust openings and Odor Control Air Cleaners, as required to clean enclosed air volume and to prevent odor migration outside the enclosure. Exhaust opening shall be sealed with activated carbon filter.
3. Placement of odor elimination stations inside and outside of the enclosure(s) as required by field condition, in coordination with the Owner or his designated Representative.
4. Protection of Contractor personnel and occupants of the structure and surrounding buildings as necessary to comply with requirements of OSHA, NIOSH and/or governing local authority.
5. When disposing of all refuse or unused materials, observe all EPA, OSHA or local disposal requirements.

1.11 COORDINATION & PROTECTION

- A. Coordinate the work with the installation of associated metal flashings, accessories, appurtenances, etc. as the work of this section proceeds.
- B. Building components shall be protected adequately (with tarp or other suitable material) from soil, stains, or spills at all hoisting points and areas of application. Contractor shall be responsible for preventing damage from any operation under its Contract. Any such damage shall be repaired at Contractor's expense to Owner's satisfaction or be restored to original condition.
- C. Provide barricades, retaining ropes, safety elements (active/passive) and any appropriate signage required by OSHA, NIOSH, and NSC and/or the Owner or designated Representative.
- D. Protect finished roofing/waterproofing membrane from damage by other trades. Do not allow waste products containing petroleum, grease, acid, solvents, vegetable or mineral oil, animal oil, animal fat, etc. or direct steam venting to come into direct contact with the membrane. Contact membrane manufacturer for further exposure limitation and restrictions.

1.12 WARRANTY

- A. Manufacturer's Total System Premier Warranty: Provide Twenty (20) Year manufacturer's waterproofing warranty under provisions of this section. This waterproofing warranty provides for cost of labor and materials for loss of watertightness, limited to amounts necessary to effect repairs necessitated by either defective material or defects in related installation workmanship, with no dollar limitation ("NDL"). The warranty shall also include the insulation, garden roof components, pavers and pedestals when they are supplied or approved by membrane manufacturer and installed in accordance with membrane manufacturer general installation guidelines. All components of the waterproofing installation that are to be covered under the terms of the warranty should be expressly itemized in the Warranty or Warranty Rider:
1. Insulation Warranty: The insulation is to retain 80% of its original thermal value for a period of ten (10) years.
 2. Paver Warranty: The pavers and pedestals system will not crack, split, spall or disintegrate as a result of freeze-thaw cycling for a period of ten (10) years.
 3. Green Roof Components Warranty: The specified components of the green roof installation (excluding vegetation and plantings) will maintain their physical integrity for a period of ten (10) years.
 4. Vegetation / Plantings: To be determined based on project requirements, climate and local conditions. Contact membrane manufacturer to verify exact warranty terms and conditions.
- B. Waterproofing Contractor's Warranty: Provide Five (5) year "Applicator Maintenance Warranty" covering workmanship for all work of this section including installation of membrane, flashings, metal work, and roofing/waterproofing accessories.
- C. Submit (2) executed copies of both the manufacturer and applicator warranties for the periods stipulated, starting from the date of substantial completion. Each warranty must be signed by an authorized representative of the issuing company.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The products herein specified are totally pre-engineered products of the listed manufacturer and establish criteria for the approval of substitutions. Products must be part of a pre-engineered system, equivalent in function, quality, composition and method of application to be considered for approval as an "Approved Substitute."
1. Alsan RS System by Soprema, Inc., Wadsworth, OH

2.02 MANUFACTURERS – MEMBRANE

- A. Membrane: Two-component, with catalyst, cold fluid-applied reinforced low-odor (PMMA) polymethyl methacrylate waterproofing membrane with a 360 degree needle punched non-

woven 110 g/m² polyester reinforcing fleece, for a finished dry film membrane thickness of .105 inch nominal per ply; conforming to ASTM C 836. Provide products manufactured and supplied by the following:

1. Soprema System's Alsan RS 260 LO Field resin for use in an adhered waterproofing system.

B. Physical Properties:

Property	Value	Test Method
Color	Pebble Gray	-
Physical state	(Liquid) Cures to solid	-
Nominal thickness (with Alsan RS Fleece)	105 mils	ASTM D 5147 (Sect. 5)
Elongation @ peak load, avg.	54%	ASTM D 412 (dumbbell)
Peak load @ 73°F, avg.	799 lbf/in ² (5509 kN/m ²)	ASTM D 412 (dumbbell)
Tear strength	98 lbf (0.4 kN)	ASTM D 5147 (Sect. 7)
Shore A hardness, avg.	78	ASTM D 2240
Water absorption, (Method I) (24h @ 73°F)	0.44%	ASTM D 570
Water absorption, (Method I) (48h @ 122°F)	1.40%	ASTM D 570
Low temperature flexibility	14°F (10°C)	ASTM D 5147 (Sect.11)
Dimensional stability (maximum movement)	-0.19%	ASTM D 5147 (Sect.10)
Usage time*	15-20 minutes	-
Rainproof after*	45 minutes	-
Solid to walk on after*	90 minutes	-
Solid to drive on with air rubber tires after*	5 hours	-
Overburden may be applied after	5 hours	-
Completely hardened after	5 hours	-
Crack spanning	2mm / 0.08 inch	-
Resistance to temperatures up to (short term)	250°C/482°F	-
*All times are approximate and depend upon wind, humidity and temperature.		

2.03 FLASHINGS

- A. Membrane Flashings: Two-component, with catalyst, cold fluid-applied reinforced low-odor (PMMA) polymethyl methacrylate flashing/vertical grade waterproofing membrane with a 360 degree needle punched non-woven 110 g/m² polyester reinforcing fleece, for a finished dry film membrane thickness of .105 inch nominal per ply; conforming to ASTM C 836. Provide products manufactured and supplied by the following:

1. Soprema System's Alsan RS 260 LO Flash resin for use in an adhered waterproofing system.

2.04 ACCESSORIES

- A. **Polymethyl Methacrylate Primer:** Two-component, high solids polymethyl methacrylate resin for use in improving adhesion of membrane to wood, asphalt and concrete substrate surfaces. Monitor application rate and adjust depending on substrate absorbency:

1. Soprema System's Alsan RS 276 Primer resin for use in an adhered waterproofing system applied over cementitious/masonry and wood substrates.
 2. Soprema System's Alsan RS 222 Primer resin for use in an adhered waterproofing system applied over asphalt surfaces.
- B. Epoxy Primer (Protection from Substrate Wetness):** Two-component, solvent-free, 100% solids, epoxy resin for use in improving adhesion of membrane to cementitious/masonry substrate surfaces. Monitor application rate and adjust depending on substrate absorbency.
- C. Reinforcement Fleece:** A 360 degree needle punched non-woven 110 g/m² polyester reinforcing fleece used to improve tear strength, puncture resistance, flexural fatigue and crack bridging capabilities while maintaining membrane uniformity:
1. Soprema's Alsan RS Fleece reinforcement fabric for use in an adhered waterproofing system.
- D. Surface Leveling/Pitching Mortar Resin:** Multi component, high solids low-odor polymethyl methacrylate mortar resin mix for use in leveling, pitching and smoothing deck substrate surfaces:
1. Soprema System's Alsan RS 263 LO Self-Leveling Mortar resin for use in an adhered waterproofing system.
- E. Patching, Filling and Smoothing Resin:** Two-component, high solids polymethyl methacrylate paste resin for use in filling surface cracks, voids and depressions and for smoothing/leveling surfaces prior to application of membrane system:
1. Soprema System's Alsan RS Paste resin for use in an adhered waterproofing system.
- F. Tools, Accessories, and Cleaners:** Supplied and/or approved by membrane manufacturer for product installation.
- G. Catalyst/Curing Agent:** White granular powder, based on dibenzoylperoxide, used as a reactive agent to induce curing of all polymethyl methacrylate resins:
1. Soprema's Alsan RS Catalyst Powder for use with all regular-odor polymethyl methacrylate resins.
 2. Soprema's Alsan RS LO Catalyst Powder for use with all low-odor polymethyl methacrylate resins.
- H. Leveling and Patching Aggregate:** Silica sand shall be washed, kiln-dried, and dust-free, suitable for troweling or pourable self-leveling, round grain or angular with the following size specification:
1. For voids less than ¼" in depth: 0.4 - 0.8 mm
 2. For voids ¼" to 2" in depth: 0.7 - 1.2 mm
- Mixing Proportions shall be a ratio of resin to sand at 1:2 by volume or as approved by membrane manufacturer.

- I. **Backer Rod:** Expanded, closed-cell polyethylene foam designed for use as filler or with cold-applied joint sealant.
- J. **Wood Nailers and Cant Strips:** New wood nailers and cant strips shall be pressure treated for rot resistance (e.g., "Wolmanized" or "Osiose K-33"), #2 or better lumber. Asphaltic or creosote treated lumber is **not** acceptable.
- K. **Miscellaneous Fasteners:** Appropriate for purpose intended and approved by membrane system manufacturer; length required for thickness of material [with metal washers]; as supplied by membrane manufacturer.
- L. **Caulking:** Single component, non-sag elastomeric polyurethane sealant, as recommended or supplied by membrane manufacturer for use in making airtight and watertight seals where required.
- M. **Adhesive/Sealants:** Single component SBS-based sealant compound as recommended by membrane manufacturer for use in adhering certain geotextile seam overlaps:
 - 1. Soprema Sopramastic sealant compound.
- N. **Drains:** [New Construction] spun/cast aluminum roof drain, strainer, as supplied or approved by membrane manufacturer.
- O. **Drain Covers:** Min. 18-gauge stainless steel metal hatch inspection chamber with removable cover for inspection of roof drain:
 - 1. Soprema SopraDrain Box roof drain cover.
- P. **Temporary and Night Sealant:** As recommended or required by membrane manufacturer.
- Q. **Protective Mat:** Thermoplastic polyolefin single-ply membrane having a thickness of min. 60 mils with air-heat welded seams as provided and approved by membrane manufacturer.
- R. **Pavers:** Architectural concrete pavers with compressive strength greater than or equal to 7000 psi, water absorption not greater than 5% and meeting ASTM C-67 for freeze/thaw cycles as recommended by manufacturer.
- S. **Supportive Pedestals:** Pedestals to support and space pavers with leveling shims or similar method to adjust paver height as recommended by membrane and paver's manufacturer.
- T. **Soil Edge Restraints:** 16-gauge stainless steel slotted to allow for drainage; designed to hold back growing media; available in various heights to meet pre-grown vegetation tray system height; back flange allows for non-penetrating application over the waterproofing membrane.
 - 1. Soprema SopraEdge topsoil edge restraint.
- U. **Stone Ballast:** Well screened and washed stone gravel meeting ASTM D-448-80, gradations #57, 2, 4 or 5; as approved by membrane manufacturer.
- V. **Pre-grown Vegetation Tray System:** Soil media shall be engineered soil, 94% by dry weight inorganic content for minimal shrinkage and decomposition and shall conform to

German FLL granulometric standards. Plants shall be matured, succulent ground covers, water-conserving accent plants and highly drought-tolerant perennials and sedums. Modules shall be 1-foot by 2-foot by 6-inch deep modules (approximate weight 50 pounds per square foot fully saturated) constructed of 100% post-consumer recycled polypropylene having 100 mil. thick walls minimum. Green roof modules shall be delivered to the site filled with the specified plants, as selected by the Owner; plants shall be grown to maturity at approximately 95% soil coverage:

1. LiveRoof LLC (Spring Lake, MI) Live Roof Standard System pre-grown tray system offered by Soprema, Inc., (Wadsworth, OH).

2.05 INSULATION / EXTRUDED POLYSTYRENE

A. Insulation: Rigid, extruded polystyrene roofing and root resistant board meeting or exceeding the requirements for ASTM C-578, Types VI or VII, with minimum compressive resistance of 60 psi in accordance with ASTM D-1621, 2.0 inch minimum thickness, with the following characteristics:

1. DOW Chemical Extruded Polystyrene Insulation Board; STYROFOAM Brand Plaza Deck – High Load 100, offered by Soprema, Inc. (Wadsworth, OH)
 - a. Board Density 32 kg/m³
 - b. Board Size 48 x 96 inches
 - c. Board Thickness 2.0 inches
 - d. Thermal Conductivity 0.028 W/mk
 - e. Water Absorption 0.1% - vol.(ASTM C-272)
 - f. Board Edges Square

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck/substrate openings, curbs, and protrusions through deck/substrate, wood cant strips and reglets are in place and solidly set.
- C. Verify deck/substrate is structurally supported, secure and sound.

3.02 PREPARATION OF SUBSTRATE

- A. **General:** All existing overburden materials, roofing/waterproofing membrane, base flashings, edge metal, flanged metal flashings, cants, wood blocking, nonfunctional

penetrations/curbs, drain assemblies, metal trim, counterflashing, etc; are to be removed down to the structural deck.

1. The contractor shall determine the condition of the existing structural deck/substrate. All defects in the deck or substrate shall be corrected before new waterproofing work commences. Areas of deteriorated deck/substrate, porous or other affected materials must be removed and replaced with new to match existing.
2. Prepare flashing substrates as required for application of new waterproofing membrane flashings.
3. Inspect substrates, and correct defects before application of new waterproofing. Fill all surface voids greater than 1/8 inch wide with an acceptable fill material.
4. Remove all ponded water, snow, frost and/or ice from the work substrate prior to installing new waterproofing materials.
5. The final substrate for waterproofing shall be clean, dry, free of loose, spalled or weak material including coatings, mineral aggregate, and flood coat/gravel surfacing, oil, grease, contaminants, abrupt changes in level, waterproofing agents, curing compounds, and free of projections which could damage membrane materials.

B. Concrete:

1. New concrete shall have cured a minimum of 28 days in accordance with ACI-308.
2. New or existing concrete shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, bituminous products and previous waterproofing materials.
3. New or existing concrete shall be dry with maximum moisture content of six (6) percent. Determinations of moisture content shall be performed by the Contractor. Contractor shall be responsible to perform periodic evaluations of moisture content during the work. Moisture evaluation results shall be submitted in writing to the Owner or his designated Representative and Waterproofing manufacturer for acceptance.
4. Where the substrate moisture content exceeds acceptable levels, or where moisture migration to the area below the membrane application cannot be positively eliminated, Contractor may utilize an approved thixo agent / quartz mix primer or epoxy primer in lieu of the polymethyl methacrylate primer. The use of thixo agent / quartz mix primer and epoxy shall be contingent on the written approval by Waterproofing Manufacturer's Technical Department.
5. Where required, concrete shall be abrasively cleaned in accordance with ASTM D4259 to provide a sound substrate free from laitance with an open concrete surface. When using mechanical methods to remove existing waterproofing products or surface deterioration, the surface profile is not to exceed 1/4 inch (peak to valley).
6. The substrate shall be sound and all spalls, voids and blow holes on vertical or horizontal surfaces must be repaired prior to placement of the primer coat. Spalls and other deterioration shall be repaired in accordance with the requirements of the Owner or his designated Representative and Membrane manufacturer.

7. Areas of minor surface deterioration of 0.50" (13 mm) or greater in depth shall be repaired to prevent possible ponding of the system, leading to excessive usage of primer and resin.
8. Extent and location of thin surface patching shall require approval of the Owner or his designated Representative and Waterproofing Manufacturer prior to the application of any system component.
9. For concrete materials with a compressive strength of less than 3,500 psi contact Waterproofing Manufacturer Technical Department for substrate preparation requirements.

C. Masonry:

1. Walls shall be built with hard kiln dried brick or waterproof concrete block construction.
2. Areas of soft or scaling brick or concrete, faulty mortar joints, or walls with broken, damaged or leaking coping shall be repaired in accordance with the requirements of the Owner or his designated Representative and Flashing Membrane Manufacturer.
3. Where the substrate moisture content exceeds acceptable levels, or where moisture migration to the area below the membrane application cannot be positively eliminated, Contractor may utilize an approved thixo agent / quartz mix primer or epoxy primer in lieu of the plain polymethyl methacrylate primer. The use of thixo agent / quartz mix primer and epoxy shall be contingent on the written approval by Waterproofing Manufacturer's Technical Department.

D. Wood/Plywood:

1. Plywood shall be identified with American Plywood Association (APA) grade trade marks and shall meet the requirements of product standard PS1. Strip plywood joints with four inch (4") wide strip of waterproofing membrane. Cover knot holes or cracks with strips of waterproofing membrane.

E. Steel/Metal:

1. Clean and prepare metal surfaces to near white metal in accordance with SSPC - SP3 (power tool clean) or as required by membrane manufacturer. Extend preparation a minimum of three (3) inches beyond the termination of the membrane flashing materials. Notch steel surfaces to provide a rust-stop.
2. Stainless steel (series 400, 300) shall be abraded to provide a rough open surface.

F. Other Flashing Surfaces:

1. Remove all contaminants as required by membrane manufacturer. Surface preparation shall be performed by means approved by Owner or his designated Representative.

G. Finish Leveling, Patching and Crack Preparation:

1. General: Resin/sand mix is the preferred material for all substrate finish leveling, crack

and wall/deck preparation and patching. Resin/sand patching mix provides a fast-set time of approximately 30 minutes and does not require surface grinding.

2. Primer/sand mix is an alternative substrate leveling and patching material over horizontal surfaces. Primer/sand patching mix provides a set time of approximately 30 minutes, and does not require surface grinding. Primer/sand mix is typically applied in conjunction with general surface priming.
3. Substrate Leveling & Patching: Substrate conditions are to be evaluated by the Contractor, the Owner, or his designated Representative, and Membrane manufacturer. Perform leveling and patching operations as follows:
 - a) Level uneven horizontal and low-slope surfaces with a leveling mixture of low-odor polymethyl methacrylate Alsan RS 263 LO Self-Leveling Mortar [depth < ½", (12mm)] resin. Depths < ½" should be build up in separate layers. Spread and plane this resin with a squeegee, trowel and/or roller to achieve a flat surface. Spike roller may be used to smooth out the surfaces.
 - b) Fill cavities on horizontal and low-slope surfaces with a patching mixture of polymethyl methacrylate primer and approved kiln-dried sand in a 1:3 primer to sand ratio by volume or with polymethyl methacrylate paste resin using trowels to apply the resin mortar in place and achieve flat surface.
 - c) Fill cavities on sloped and vertical surfaces with polymethyl methacrylate paste resin using trowels to apply the resin mortar in place and achieve flat surface.
 - d) Silica sand must be kept absolutely dry during storage and handling.
- a) Any surface to be leveled or filled must first be primed with an appropriate polymethyl methacrylate primer and polymethyl methacrylate resin mortars shall be placed in lifts no greater than the maximum thickness indicated by the manufacturer.
4. Joint and Crack Preparation: Joints, cracks and fractures in the structural deck/substrate shall be prepared as defined below prior to installation of the waterproofing membrane. Note: Joints, cracks, and fractures may telegraph through the waterproofing membrane.
 - a) Non-Moving Cracks: Determine that crack is non-moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polymethyl methacrylate paste resin. Allow for a minimum of one (1) hour cure or as required by product manufacturer.
 - b) Moving Cracks: Determine that crack is moving. Clean out crack by brushing and oil-free compressed air. Fill crack with polymethyl methacrylate paste resin. Allow for a minimum of one (1) hour cure or as required by product manufacturer. Apply resin and 4 inch (10 cm) wide strip of membrane (resin and fleece) in strict accordance with Membrane manufacturer's written instructions.

3.03 WOOD NAILER LOCATION AND INSTALLATION

- A. Install pressure-treated wood nailers as specified, or as required by the Membrane manufacturer.
- B. Secure Wood Nailer: Wood nailers shall be firmly fastened to the deck. The wood nailer attachment must be able to resist a minimum force of 200 lbs. per lineal foot, in any direction. Mechanically fasten wood nailers as required to resist a force of 200 lbs per lineal foot, but with no less than 5 fasteners per 8 foot or 6 fasteners per 10-foot length of nailer. Refer to current FM Loss Prevention Bulletin 1-49 for additional attachment recommendations.

3.04 PLUMBING / WATER LINE INSTALLATION

- A. A permanent line should be installed for the connection of an irrigation system (if required, e.g. the integral 2' o.c. drip tape in capillary mat) and frost-resistant taps located for the connection of garden hose for routine maintenance and/or manual watering of the green roof during periods of extraordinarily dry weather (if irrigation is not installed).

3.05 PRIMER APPLICATION

A. General:

1. Mix and apply two-component primer in strict accordance with written instructions of Membrane Manufacturer. Use only proprietary materials, as supplied by the membrane manufacturer.
2. The substrate surface must be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth wipe or a combination of methods.
3. Do not install primer on any substrate containing newly applied and/or active asphalt, coal-tar pitch, creosote or penta-based materials unless approved in writing by Membrane Manufacturer. Some substrates may require additional preparation before applying primer.

B. Mixing of Polymethyl Methacrylate Primer:

1. Premix polymethyl methacrylate primer thoroughly with a spiral agitator or stir stick. Add pre-measured catalyst amount into mixed primer container and mix the components for approximately 2 minutes with a clean spiral agitator on slow speed or stir stick without creating any bubbles or streaks. DO NOT AERATE. The primer solution should be a uniform color, with no light or dark streaks present.
2. Do not thin primer. Determine required primer coverage for each substrate material/condition and apply in strict accordance with written instructions of Membrane Manufacturer.
3. Mix only that amount of primer that can be used within 15 minutes.

C. Mixing of Two-Component Epoxy Primer:

1. Mix A and B components together with a spiral agitator or stir stick. Use slow speed. DO NOT AERATE. The primer solution should be a uniform color, with no light or dark streaks present.
2. Do not thin primer. Determine required primer coverage for each substrate material / condition and apply in strict accordance with written instructions of Membrane Manufacturer.
3. Mix only that amount of primer that can be used within 15 minutes.

D. Application of Primer:

1. Apply primer in accordance with manufacturer's written instructions and details.
2. Roll or brush the primer evenly onto the surface to fully saturate the substrate in one application. Do not allow primer to pond or collect in low areas.
3. Apply primer only up to the edge of the membrane flashing terminations. Primer application past the membrane terminations requires surfacing with an approved material.
4. For polymethyl methacrylate primer applications over cementitious substrates where protection from substrate wetness is required, apply primer coat at a heavier application rate until pore saturation is achieved.
5. For epoxy based primer applications, apply kiln-dried sand into the final coat of primer while still wet at the rate of 30 lbs. per 100 square feet (1.5 kg/m²). Use quartz size # 0 (0.4 – 0.8 mm).
6. Allow polymethyl methacrylate primers to cure for a minimum of thirty (30) minutes before membrane application. Allow epoxy-based quick-dry primers to cure for a minimum of two (2) hours before membrane application. Membrane must be applied to primer only when completely dry and without tack.
7. Premature exposure to moisture may require removal and application of new primer. DO NOT apply new primer over exposed primer older than six (6) months, primer prematurely exposed to moisture, or primer used as temporary waterproofing, unless approved in writing by the Membrane Manufacturer.

E. Disposal of Primer:

1. Cured primer may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.
2. Uncured primer is considered a hazardous material and must be handled as such, in accordance with local, state and federal regulation. Do not through uncured resin away.

3.06 MEMBRANE APPLICATION

A. General:

1. Mix and apply cold fluid-applied reinforced polymethyl methacrylate waterproofing membrane in strict accordance with written instructions of Membrane Manufacturer. Use only proprietary membrane resins and materials, as supplied by the membrane manufacturer.
2. The primed substrate surface shall be dry, with any remaining dust or loose particles removed using clean, dry, oil-free compressed air, industrial vacuum, cloth-wipe or a combination.
3. Protect all areas where membrane has been installed. Do not work off installed membrane during application of remaining work before three (2) hours of curing. Movement of materials and equipment across installed membrane is not acceptable. If movement is necessary, provide complete protection of affected areas.
4. Closely follow the Membrane Manufacturer's recommendation for hot and cold weather application. Monitor surface and ambient temperatures, including the effects of wind chill.

B. Mixing of Resin:

1. Mix resin with a spiral agitator for a minimum of 2 minutes until the liquid has a uniform color.
2. Add the pre-measured low-odor Catalyst Powder to resin and mix with the same agitator for 2 minutes or until the powder is completely mixed. The catalyst is completely dissolved when there are no white specs remaining.

C. Application of Resin/Fleece

1. Apply mixed resin to the prepared surface in accordance with manufacturer's written instructions and details. The resin should be rolled or brushed liberally and evenly onto the surface using a broad, even stroke. Cover one working area at a time, between 15 – 20 ft.² (1.4 – 1.9 m²).
2. Roll out dry polyester fleece onto the liquid resin mix, making sure the SMOOTH SIDE IS FACING UP (natural unrolling procedure), avoiding any folds and wrinkles. The fleece will begin to rapidly saturate with the liquid resin mix. Use a medium nap roller or brush to work the resin into the fleece, saturating from the bottom up, and eliminating air bubbles, wrinkles, etc. The appearance of the saturated fleece should be light opaque amber with no white spots. White spots are indications of unsaturated fleece or lack of

adhesion. It is important to correct these faults before the resin cures.

3. Apply additional liquid resin mix on top of fleece in accordance with manufacturer's written instructions and details to finish the saturation of the fleece. Roll this final coating into the fleece, which will result in a glossy appearance. The fleece can only hold so much resin and all excess should be rolled forward to the unsaturated fleece, eliminating ponding or excessive build-up of the resin. Any excess resin left on the top of the fleece will weather and peel off. The correct amount of resin will leave no whiteness in fleece and there will be a slightly fibrous surface texture. The final resin coating should be smooth and uniform.
4. Prevent contact between mixed/unmixed resin and new/existing membrane. If any unmixed resin contacts membrane surface remove immediately and clean thoroughly with a cloth rag.
5. At all fleece seams, allow a 2" (5 cm) overlap for all side joints and a 4" (10 cm) overlap for all end joints.
6. At membrane tie-offs, clean in-place membrane with Alsan RS Cleaner once resin has cured. Allow cleaner to fully evaporate before application of new resin.

D. Disposal of Resin:

1. Cured resin may be disposed of in standard landfills. This is accomplished by thoroughly mixing all components.
2. Uncured resin is considered a hazardous material and must be handled as such, in accordance with local, state and federal regulation. Do not throw uncured resin away.

3.07 FLASHING APPLICATION

A. General:

1. Install flashing system in accordance with the requirements/recommendations of the Membrane manufacturer and as depicted on standard drawings and details. Provide system with base flashing, edge flashing, penetration flashing, counter flashing, and all other flashings required for a complete watertight system.
2. Wherever possible, install the flashings before installing the field membrane to minimize foot traffic over newly installed field membrane.
3. All membrane flashings shall be installed concurrently with the waterproofing membrane as the job progresses. Temporary flashings are not allowed without prior written approval from the Membrane manufacturer. Should any water penetrate the new waterproofing membrane because of incomplete flashings, the affected area shall be removed and replaced at the contractor's expense.
4. Provide a minimum vertical height of 8" for all flashing terminations. Flashing height shall be at least as high as the potential water level that could be reached as a result of a

deluging rain and/or poor slope. Do not flash over existing through-wall flashings, weep holes and overflow scuppers.

5. All flashings shall be terminated as required by the Membrane Manufacturer.

B. Metal Flashing – General:

1. Metal flashings shall be fabricated in accordance with the current recommendations of SMACNA and in accordance with standard drawings and project details.
2. Metal flashing flanges to which membrane is to be bonded shall be a minimum of four (4) inches in width, and secured to the substrate six (6) inches on center staggered with fasteners appropriate to the substrate type. The flanges shall be provided with a roughened surface that has been cleaned of all oil and other residue.
3. Metal edges that will be overlaid with membrane shall be provided with a 1/4" min. hemmed edge.
4. Apply primer, resin and fleece to metal flange, extending membrane to outside face of metal edging, and to vertical face of metal base/curb flashing.

C. Membrane Flashing – General:

1. Membrane flashings shall be fabricated with primer appropriate for the substrate surface, flashing grade type resin of the same base chemical type as the field membrane, and fleece of the same weight as the field membrane unless specified otherwise.
2. Primer, resin, and fleece mixing and application methods as specified for field membranes are also suitable for membrane flashing grade.
3. Fleece shall overlap 2" (5 cm) minimum for all joints. Fleece shall be cut neatly to fit all flashing conditions without a buildup of multiple fleece layers. Work wet membrane with a brush or roller to eliminate blisters, openings, or lifting at corners, junctions, and transitions.

D. Pipes, Conduits, and Unusually Shaped Penetrations:

1. Flash all penetrations using cold fluid-applied reinforced polymethyl methacrylate roof membrane. Flashing material shall be resin as specified by membrane manufacturer with appropriate fleece reinforcement.
2. Flashing is typically constructed as a two-part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a two (2) inch (5 cm) overlap between vertical and horizontal flashing components.

E. Drains and Scuppers:

1. Acceptable drain and scupper materials are cast iron, cast aluminum, and copper.
2. Connect new drains and scuppers to existing storm sewer system.
3. Alternatively, replace all broken or damaged parts of existing drains and scuppers, or provide and install an acceptable insert.
4. Flash drains and scuppers using cold fluid-applied reinforced polymethyl methacrylate roof membrane. Flashing material shall be the same resin used in the field membrane with fleece reinforcement.

5. Flashing material shall extend four (4) inches minimum onto drain, scupper, or insert flange.
6. Install clamping ring if provided as part of the drain or scupper design. Install a strainer basket to prevent debris from clogging the drainage line.

F. Hot Stacks:

1. Protect the membrane components from direct contact with steam or heat sources when the in-service temperature exceeds 150 °F. In all such cases flash to an intermediate "cool" sleeve.
2. Fabricate "cool" sleeve in the form of a metal cone using galvanized metal in accordance with Membrane manufacturer's details.
3. Flash all penetrations using cold fluid-applied reinforced polymethyl methacrylate roof membrane. Flashing material shall be resin as specified by membrane manufacturer with appropriate fleece reinforcement.
4. Flashing is typically constructed as a two-part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a two (2) inch (5 cm) overlap between vertical and horizontal flashing components.

G. Flexible Penetrations:

1. Provide a weathertight gooseneck of round cross-section for each penetration or group of penetrations. Set in Water cut-off mastic and secure to the structural substrate.
2. Acceptable gooseneck material is copper, of a sheet weight appropriate for the application.
3. Flash all penetrations using cold fluid-applied reinforced polymethyl methacrylate roof membrane. Flashing material shall be resin as specified by membrane manufacturer with appropriate fleece reinforcement.
4. Flashing is typically constructed as a two-part assembly consisting of a vertical wrap and a horizontal target patch. There must be a minimum of a two (2) inch (5 cm) overlap between vertical and horizontal flashing components.

H. Walls, Curbs and Base Flashings:

1. Wall, curb and base flashings shall be installed to solid substrate surfaces only. Adhering to gypsum-based panels, cementitious stucco, synthetic stucco, wood or metal siding and other similar materials are not acceptable.
2. Flash all walls, curbs and base flashings using cold fluid-applied reinforced polymethyl methacrylate roof membrane. Flashing material shall be resin as specified by membrane manufacturer with appropriate fleece reinforcement.
3. Reinforce all transition locations and other potential wear areas with a four (4) inch wide polyester fleece bottom layer evenly positioned over the transition prior to installing the exposed flashing layer.
4. Reinforce all inside and outside corners with a four (4) inch diameter conical piece of fleece prior to installing the exposed flashing layer.
5. All pins, dowels and other fixation elements shall be flashed separately with a vertical flashing component prior to installing the exposed flashing layer.

6. Extend flashing a minimum of four (4) inches onto the field substrate surface.

I. Drip Edges and Gravel Stops:

1. Metal drip edges and gravel stops shall be installed to solid substrate surfaces only. Securement to gypsum-based panels, cementitious stucco, synthetic stucco, wood or metal siding or coping and other similar materials is not acceptable.
2. Flash all drip edges and gravel stops by extending the field membrane all the way to the edge of the exposed face prior to installing the metal edging. Strip in the metal flange with a separate 8-inch wide strip of membrane adhered to both the securement flange and to the field membrane.
3. For conditions where water infiltration behind the exposed drip edge or gravel stop face is possible, install a separate polyester fleece bottom layer positioned behind the face area and extending a minimum of four (4) inches past the securement flange onto the field substrate prior to installing the drip edge or gravel stop.

J. Field Fabricated Control or Expansion Joint Flashing:

1. Control or expansion joints in excess of two (2) inches in width require the use of a separate engineered joint system.
2. Control or expansion joints two (2) inches or less in width may be flashed with two layers of cold fluid-applied reinforced polymethyl methacrylate roof membrane and a compressible foam or rubber insert. Use a polyester reinforcing fleece bottom layer as and polyester fleece top layer.
3. Grind or otherwise bevel the inside edges of the joint opening to provide a smooth transition edge for the fleece.
4. Flashing typically consists of a polyester reinforcing fleece bottom layer looped into the joint as a cradle, a compressible foam or rubber insert at 25% compression fitted into the joint, and a polyester fleece top layer applied over the joint. Extend both fleece layers four (4) inches minimum onto the field substrate on both sides of the joint.
5. Apply the field membrane over the entire joint area.

K. Electrical Conduit, Gas Lines and Lightning Protection

1. Supports for electrical conduit and gas lines greater than one (1) inch in diameter require the use of a separate engineered support system.
2. Supports for electrical conduit and gas lines one (1) inch or less in diameter, and bases for lightning protection rods and cable, can be adhered directly to the membrane surface with a single-component, high quality polyurethane sealant.

3.08 SURFACING AND FINISHES

A. Approved Coating-Type Finish Surfacing

1. Where specified, provide and install approved polymethyl methacrylate coating applied over clean, fully cured membrane.

2. Follow Coating manufacturer's recommendations for coating thickness, application techniques, required primers, environmental limitations, and all other similar considerations.
3. Broadcast optional sand surfacing into wet surface of coating to provide traction surfacing. Seal sand surfacing with an additional coating application.

B. Alkalinity Protection

1. Polymethyl methacrylate resin is alkalinity resistant unless otherwise stated by the membrane manufacturer. If required, additional bond/wearing layer consisting of one application of manufacturer approved resin on horizontal/vertical surfaces and one application of approved broadcast mineral aggregate surfacing shall be applied wherever stone, concrete, or masonry elements will be placed directly over the flashing to improve adhesion of the overburden materials to the membrane surface.

3.09 TEMPORARY CLOSURES & WATERSTOPS

- A. Contractor shall be responsible to ensure that moisture does not damage any completed section of the new waterproofing system. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition. All temporary closures shall be made as recommended or required by the membrane manufacturer.

3.10 PROTECTION

- A. Upon completion of waterproofing and flashings (including all associated work), institute appropriate procedures for surveillance and protection of roofing during remainder of construction period. Protect all areas where membrane has been installed.

3.11 FLOOD TEST

- A. A flood test of the completed membrane and flashing system shall be conducted prior to the installation of any overburden. The flood test shall be of a 24 hr. minimum duration, and shall apply a water head of 2" over the entire application area. Any incidents of water entry shall be evaluated and all necessary repairs conducted, followed by an additional flood test.

3.12 INSULATION / EXTRUDED POLYSTYRENE BOARD INSTALLATION

- A. Loose lay extruded polystyrene insulation boards in a staggered manner. Butt all boards tightly leaving a maximum acceptable opening between panels of three-eighths (3/8) inch. Install insulation within the required distances of all projection, penetrations, etc. In multi-layer applications the bottom layer must be the thickest layer and have a minimum thickness of 2" (50.8 mm).

3.13 OVERBURDEN INSTALLATION

- A. Protection Layer Installation:

1. Install the specified protection layer onto the newly installed roofing system at specified modular green roof system locations. The contractor must mark drain locations prior to installation to allow for access to cut the required drain openings. Installation shall follow the manufacturer's recommendations; overlap adjoining sheets 1-½ inches minimum and join together with hot air welding. Prior to installation, protection layer shall be unrolled and allowed to relax, in accordance with the manufacturer's recommendations.

B. Drain Cover Installation:

1. All internal roof drains shall be fitted with inspection/maintenance boxes and grills, built up to ensure access at pre-grown tray soil level.

C. Stone Ballast Placement:

1. Install stone ballast evenly over the insulation/filter fabric at a minimum rate of one-thousand (1000) pounds per square or as per manufacturer's recommendations and other applicable codes, wind design guides and architectural layout.

D. Pavers Placement:

1. Architectural pavers shall be installed at the roof perimeter, access hatches and any walkway/maintenance paths per the architectural layout and/or design drawings.
2. Architectural pavers will be installed on approved paver tab or pedestal system in accordance with the pedestal system manufacturer's specifications, recommendation, project requirements and as defined in the architectural layout.
3. Ensure the finished paver surface is spaced and butted properly, level and free from tripping hazards.

3.14 PRE-GROWN VEGETATION TRAY SYSTEM INSTALLATION

- A. Provide a shop drawing showing the pre-vegetated modular green roof system layout, placement pattern, leveling adjustments, perimeter terminations and all associated installation details. All joints shall be aligned in a straight pattern following the proposed design.
- B. Protect all pre-vegetated modular green roof system modules from damage, prior and subsequent to installation. The contractor shall immediately replace any damaged modules with new modules, at no additional cost to the building owner.
- C. Install the pre-vegetated modular green roof system modules as specified on the approved shop drawings and in accordance with the green roof design. Modules shall be installed in straight rows, placed tightly against each other, with edges overlapping and arranged in proper directional orientation. The perimeter soil elevators shall only be removed once individual modules have been surrounded by L shaped edging system or other modules, to prevent soil spillage.

- D. After module installation is complete the modules shall be immediately watered in accordance with the manufacturer's recommendations, to thoroughly moisten the soil media from top to bottom. The water shall be of suitable quality for plant growth; it will require approximately 1-inch of water per module to thoroughly moisten each module.
- E. If required by the building owner, a maintenance service plan is to be implemented pursuant to a signed written change order. The maintenance service plan requirements will include inspection of the roof membrane, routine inspection and maintenance of drainage layer flow paths, as well as soil testing, watering, and procedures for prolonged dry weather, weed control, displaced soil, drainage inspection, debris/trash removal and pesticides.

3.15 CLOSEOUT

A. Correction of Work:

- 1. Work that does not conform to specified requirements including tolerances, slopes, and finishes shall be corrected and/or replaced. Any deficiencies of membrane application, termination and/or protection as noted during the Membrane manufacturer's inspections shall be corrected and/or replaced at Contractor's expense.

B. Clean-Up:

- 1. Site clean-up, including both interior and exterior building areas that have been affected by construction, shall be restored to preconstruction condition.

END OF SECTION