MASTER® BUILDERS SOLUTIONS

bluey

BluSeal PVC Liner

UNDERGROUND AND BASEMENT WATERPROOFING GUIDELINES

Blu**Seal** PVC Liner

UNDERGROUND AND BASEMENT WATERPROOFING

At Bluey, we endeavour to provide market leading waterproofing systems, tailored to meet the needs of our clients. With customer service and quality at the forefront of our minds, we can assist you and your project from conception through to completion. By assisting with specifications, technical detailing, and design, we can offer a complete waterproofing package.

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UNDERGROUND AND BASEMENT WATERPROOFING

Typically, all structures built below ground, be it buildings, basements, or tunnels need to be watertight. Failure to adequately waterproof an underground structure during the construction phase, often leads to costly and time consuming remediation works.

We at Bluey have both the knowledge and knowhow to ensure your project meets or exceeds the design waterproofing specification.

Bluey have previously provided waterproofing solutions and project management services for some of the most significant civil infrastructure projects in Australia and NZ including:

- Northwest Rail Link – Tunnel and shaft waterproofing
- Pacific Highway Upgrade – Tintenbar to Ewingsdale – Tunnel waterproofing
- City East Cable Tunnel – Waterproofing
- Waterview Tunnel NZ – Cross passage waterproofing
- Eastlink Motorway Melbourne – Tunnel waterproofing
- Airport Link Brisbane – Tunnel waterproofing
- Epping to Chatswood Tunnel – Waterproofing
- Glenfield to Leppington Rail Line – Tunnel waterproofing

The type of waterproofing system depends on the the type of structure, depth below ground, water table location at the site, dryness specification and construction methods. Bluey's PVC waterproof membranes provide a very flexible system with strong tear resistance, excellent weldability and can protect a structure against moisture, water seepage, and hydrostatic pressure from groundwater.

An effective waterproofing system requires adequate planning and detailed specification by a designer in conjunction with Bluey, prior to the onsite installation of the membrane. The structure must be designed and constructed such that the waterproofing membrane is suitable for the unique site conditions and able to fulfil its function properly during its service life.

To ensure the membrane is installed correctly, all installation work must be carried out by suitably trained applicators, using the correct welding equipment. Site personnel performing the welds must be properly trained prior to installation of the membranes. All waterproofing installations must undergo the appropriate testing procedures, as specified.

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REQUIREMENTS FOR CONSTRUCTION

The main criteria for the planning and installation of BluSeal PVC waterproofing membranes are:

- Type of structure and its purpose
- Dryness specification
- Water table at the site location
- Type of groundwater the membrane will be exposed to (aggressive, salt water, contaminated water etc.)
- Substrate in which the membrane will be fixed to (rock face, shotcrete etc.)
- Construction method, construction staging and joints in the structure
- Details and design of expansion joints

A fully tanked shaft base, with waterstops installed at construction joints

TYPICAL WATERPROOFING SYSTEMS

Structures that require waterproofing are typically designed to be either tanked or drained systems.

TANKED SYSTEMS

Tanked systems do not allow water to pass through the stucture into the building or tunnel. They are most commonly used in underground basements, sub stations tunnels etc.

Tanked systems consist of a waterproof PVC membrane lining on the walls and base of the structure. The PVC membrane is designed to withstand ground moisture, water infiltration and hydrostatic pressure.

Sheets are welded together and water stops installed at construction joints to form a complete seal around the structure footprint.

DRAINED SYSTEMS

Drained systems differ from tanked systems, as they allow water to travel through drainage paths, away from the structure. They consist of a waterproof PVC membrane lining on the walls, and a drainage system on the base.

Drained systems are still completely waterproof and will protect the structure against ground moisture water leaks, however, as the water is allowed to drain off-site hydrostatic pressure will not build up.

Refer to the installation section to review the membrane installation procedures for both tanked and drained systems.

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WATERPROOFING PRODUCTS

GEOTEXTILES

Geotextile fleeces are used as a protection layer for the waterproof membrane. In a drained system, they also provide a drainage function. Typically, the geotextile shall be installed on the substrate (rock or shotcrete) to protect the membrane against any sharp protrusions such as steel fibres or angled rock faces.

The protective fleece shall be a non-woven 100% polypropylene geotextile of uniform thickness and surface texture. The weight of the geotextile shall depend upon on relevant project specifications, but generally it shall not be less than 500g/m^2.

PVC MEMBRANES

The purpose of a membrane layer is to provide a continuous and impervious barrier to groundwater filtration.

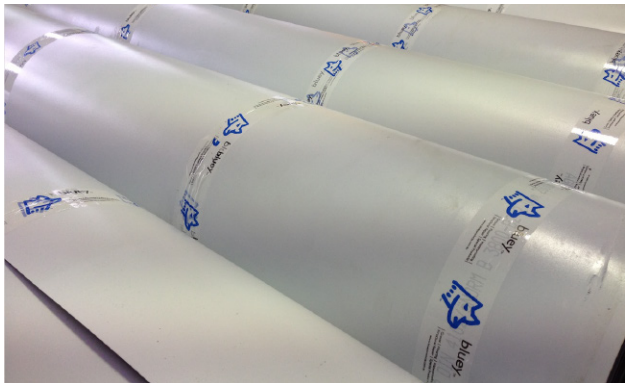
BluSeal PVC membrane sheets are available in 1.5mm, 2mm or 3mm thicknesses, and include a signal layer.

The signal layer is a different colour to the base membrane sheet, and acts as an indicator for membrane damage during visual inspections. Where the base membrane shows through the signal layer, an inspection shall be carried out to determine whether repairs are required.

MINIMUM PVC MEMBRANE REQUIREMENTS

The PVC membrane should meet the following physical properties, for all membrane thicknesses:

TESTED CHARACTERISTIC	STANDARD	RESULT
TENSILE STRENGTH	BS EN 527-3	Longitudinal and transversal minimum 16N/mm^2
ELONGATION AT BREAK	BS EN 527-3	Longitudinal and transversal minimum 300% (-10%/ +20%)
IMPACT RESISTANCE	BS EN 12691-A	Watertight at >750mm
JOINT STRENGTH	EN 12317-2	No cracks to occur next to seam
TEAR RESISTANCE	EN 12310-1	>80N/mm
COLD BENDING	EN 495-5	Free from cracks (-25°C)
PUNCTURE RESISTANCE	EN 12236	>1200mm
RESISTANCE TO STATIC PUNCHING	BS EN 12236	>0.35kN
HYDROSTATIC PRESSURE RESISTANCE	BS EN 1928-B	Waterproof (2kPa and 60kPa)
ROOT RESISTANCE	EN 14416	No penetration



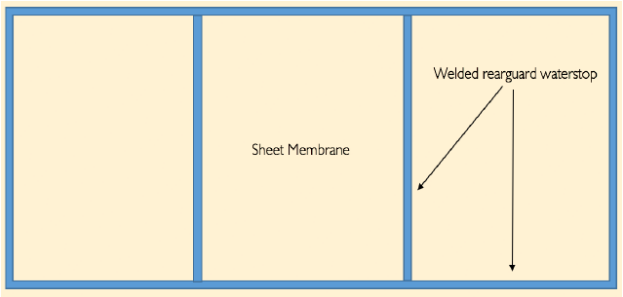
BluSeal PVC
WATERPROOFING PRODUCTS

PVC WATER STOPS

Waterstops are used as compartmentalisation devices and are designed to prevent water flow between compartments. The main advantage of a compartmentalised system is that any damage to the waterproofing system remains localised, and does not affect the integrity of the other compartments. This also allows for ease of rectification work through grout injections.

Waterstops are typically installed at 'high' risk areas leak areas such as construction joints, but may also be used as protection for the membrane at formwork stop ends.

Waterstops can also be used to terminate the membrane at the top of the basement.



Pre-fabricated waterstop junctions

INJECTION HOSES

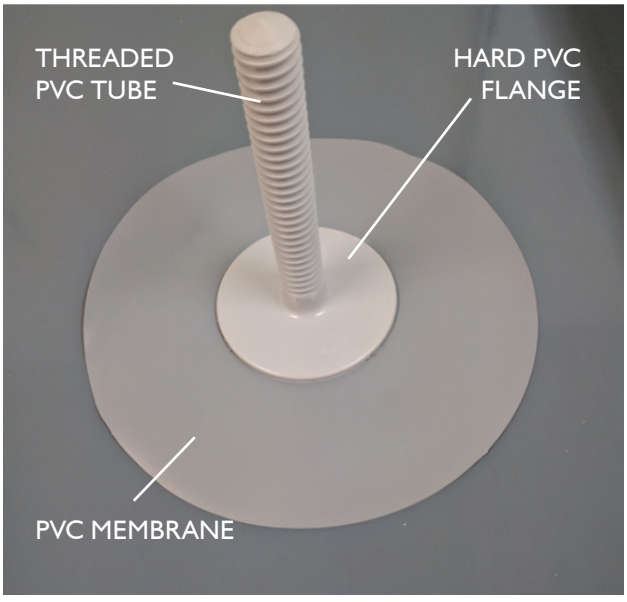
Injection hoses are typically installed in areas where there is a high risk of leakage, such as construction joints. Injection hoses should also be installed at waterstop locations to assist if rectification works are required.

If water leakage is present after concrete placement, these hoses may be injected with a waterstopping grout. Upon contact with water, the grout rapidly swells and blocks the path of water travel.

BA ANCHORS

The purpose of a BA Anchor is to provide an anchorage point for steel fixing, without the need for penetration of the waterproof PVC membrane.

BA Anchors consist of a hard PVC tube with a flange, in which a threaded rod may be inserted. A collar of PVC membrane is factory welded to the flange, which ensures a high quality weld and watertight seal.



A typical BA Anchor

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GEOTEXTILE INSTALLATION GUIDE

GENERAL NOTES FOR INSTALLATION

The installation of BluSeal PVC membranes shall be carried out by specialised applicators, technically trained in the welding and installation of membranes.

Prior to commencement of installation onsite all materials must be inspected for damage. The rolls of membrane, geotextile, waterstop etc. shall be stored onsite in a horizontal position in a dry place, protected from the weather.

For permanent membrane installation, all preset welding machine parameters such as temperature, speed and pressure shall be determined during pre-installation tests performed by the Waterproofing Supervisor and Leading Hands.

The installation works must be performed in dry conditions. Welding is not permitted at air temperatures below 5° C.

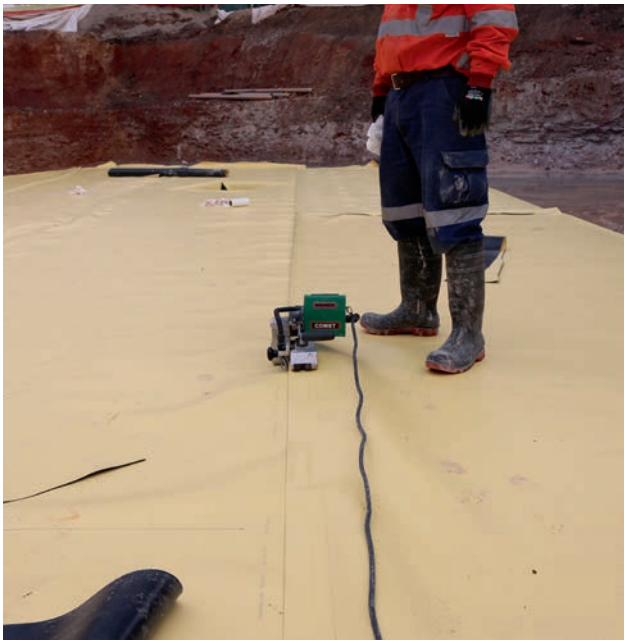
PREPARATION OF SUBSTRATE

Prior to waterproofing installation, the substrate shall be inspected by the Waterproofing Supervisor. Typically, the surface shall be either bare rock face or shotcrete.

The surface should be clean, smooth and free of defects. All sharp protrusions are to be removed, or cut back prior to membrane installation. Protrusions may include but are not limited to: bolt fixings, nails, survey markers, reinforcement bar, or heads of rock bolts.

For shotcrete surfaces, the aggregate size should not exceed 4mm and irregularities shall not exceed 200mm over a distance of 1000mm (should not exceed a 5:1 length-depth ratio).

Example of an acceptable substrate



INSTALLATION OF GEOTEXTILE

The geotextile fleece shall be attached to the substrate using suitable nail fixings. Depending on the location of installation and substrate quality, between 0.5 and 2 (no.) nail fixings shall be used per square metre.

The geotextile fleece shall be laid with sufficient slack to avoid potential overstressing and tearing during membrane placement.

Adjacent sections of geotextile fleece shall be overlapped by 100mm and joined by hot air welding. To join sheets, the hot air stream from the heat gun should be introduced evenly and briefly between the overlapped geotextile sheets, firm pressure should then by applied by hand. To avoid future damage to the membrane, nail fixings shall be covered by the geotextile overlaps to ensure no protrustion of nail heads.

BluSeal PVC
PVC MEMBRANE INSTALLATION GUIDE

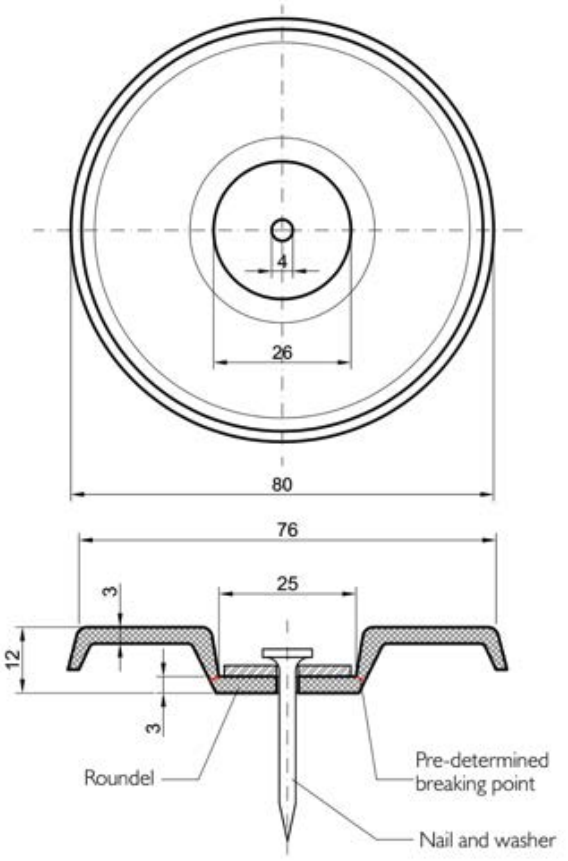
INSTALLATION OF PVC MEMBRANE

The membrane shall be attached to the substrate by spot welding to roundels (membrane fixing discs), which are nail fixed to the geotextile substrate. Installing the membrane in this way allows the membrane to be temporarily held in place without penetration.

The membrane shall be placed with sufficient slack to avoid potential overstressing and tearing during concrete placement. It should also be sufficiently snug to the surface to avoid any folds developing during concrete placement.

Roundels shall be of PVC, to facilitate hot air spot welding, as welding can only be performed on like materials. Roundels shall either be flat, flexible disc types or recessed ribbed rigid disc type. Roundels shall typically be installed in two columns, approximately 500mm from each longitudinal sheet edge to allow adequate room for subsequent seam welding. The spacing of roundels will vary with the location and application type, but the following table shall be used as a general guide:

APPLICATION	FREQUENCY
Overhead	2 – 3 per m^2
Vertical (Walls, Shafts etc.)	1 per m^2
Horizontal (Base, Inverts etc.)	0 – 0.5 per m^2



The membrane shall be attached to the substrate, against the pre-installed geotextile surface by hot air 'spot' welding to the pre-installed roundel discs. At each roundel location, briefly introduce a stream of hot air from the heat gun between the roundel and membrane sheet, whilst applying a firm pressure by hand.

When installing the membrane, it is important that the signal layer is installed on the inside of the structure, to allow for visual inspection of potential membrane damage.

Once membrane has been fixed, seal all seams using an automated double seam welder.

BluSeal PVC
INSTALLATION GUIDE

INSTALLATION OF WATERSTOPS

Where required, waterstops are to be installed on the surface of the PVC membrane. The locations of the waterstops shall be marked out by a surveyor.

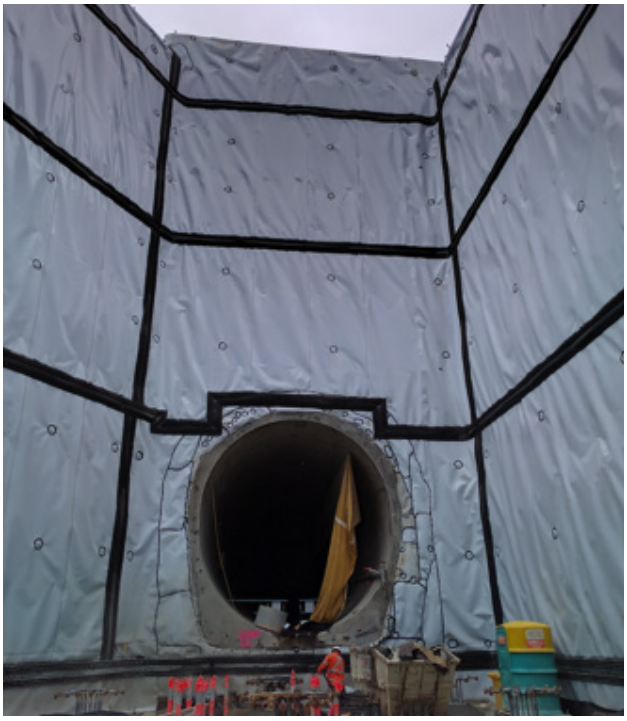
The surface of both the waterstop and the membrane must be clean and dry pior to installation. If required, the membrane surface may be lightly ground using a flap disc on an orbital grinder to remove the oxidised layer.

To achieve the compartmentalisation effect, the waterstop is to be hand welded on both longitudinal edges to the primary membrane. All welds are to be visually inspected via needle test to ensure that a continuous weld has been achieved.

INSTALLATION OF BA ANCHORS

BA Anchors are to be installed at the locations specified on the construction drawings, and are to be marked out by a surveyor. They are to be installed after the membrane has been fully welded and installed.

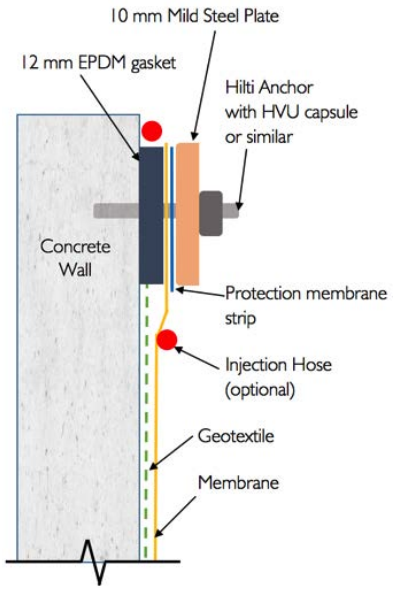
To install the BA Anchor, a hole is drilled through the membrane and into the substrate behind. The hole is thoroughly cleaned using a brush and dust blower. Fill the hole with sufficient epoxy to fully encapsulate the shaft of the anchor. Insert the BA Anchor into the hole, rotating to ensure the entire thread is covered with epoxy.
The collar of the BA Anchor is then hand welded to the primary membrane to ensure a water tight seal is achieved.



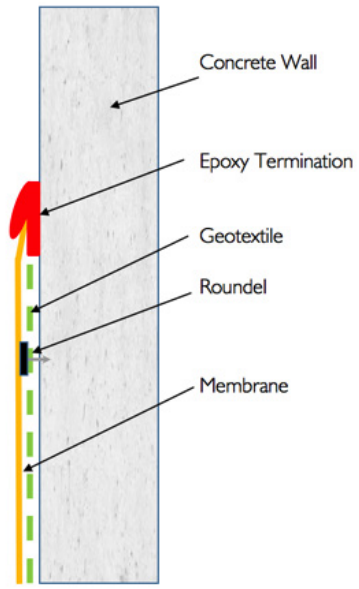
A fully tanked shaft, with waterstops installed at construction joints

Installation (Hand weld) of a BA Anchor

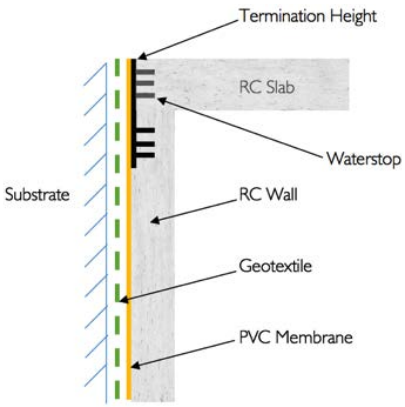
BluSeal PVC
TYPICAL TERMINATION DETAILS



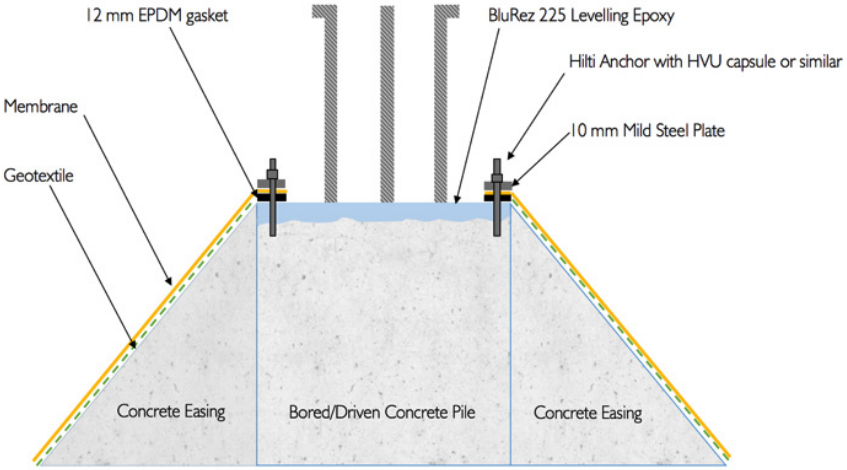
▲ *Flanged Termination*



▲ *Epoxy Termination*



▲ *Slab Edge/Waterstop Termination*



▲ *Pile Top Press Termination*

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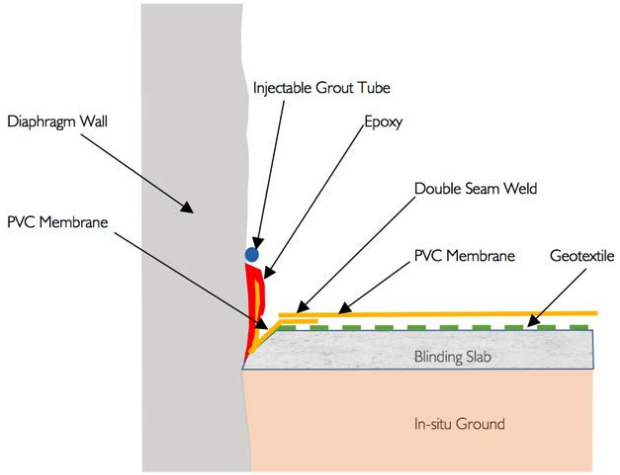
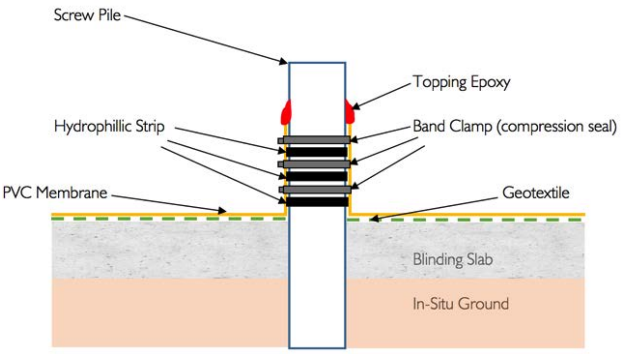
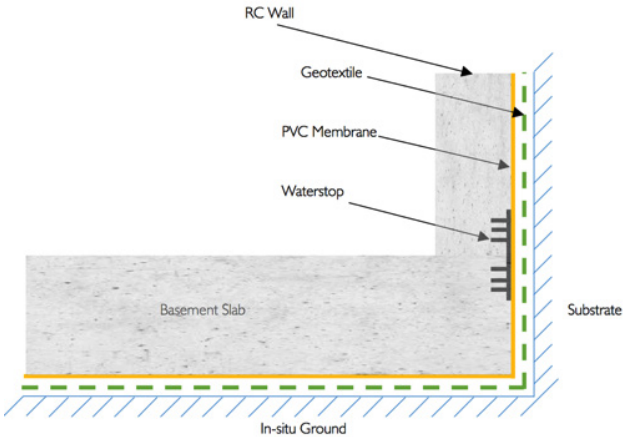
TYPICAL TERMINATION DETAILS



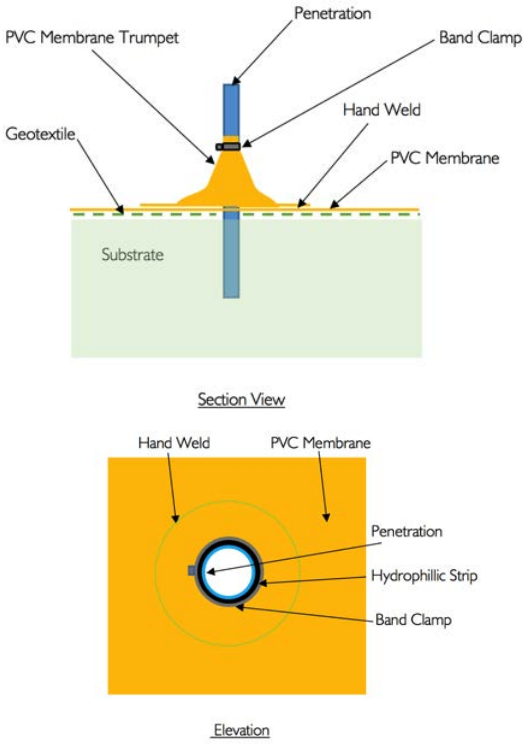
▲ *Diaphragm Wall Termination*



▲ *Typical High Pressure Pipe Termination*



▲ *Basement Slab Edge*



▲ *Trumpet Penetration*

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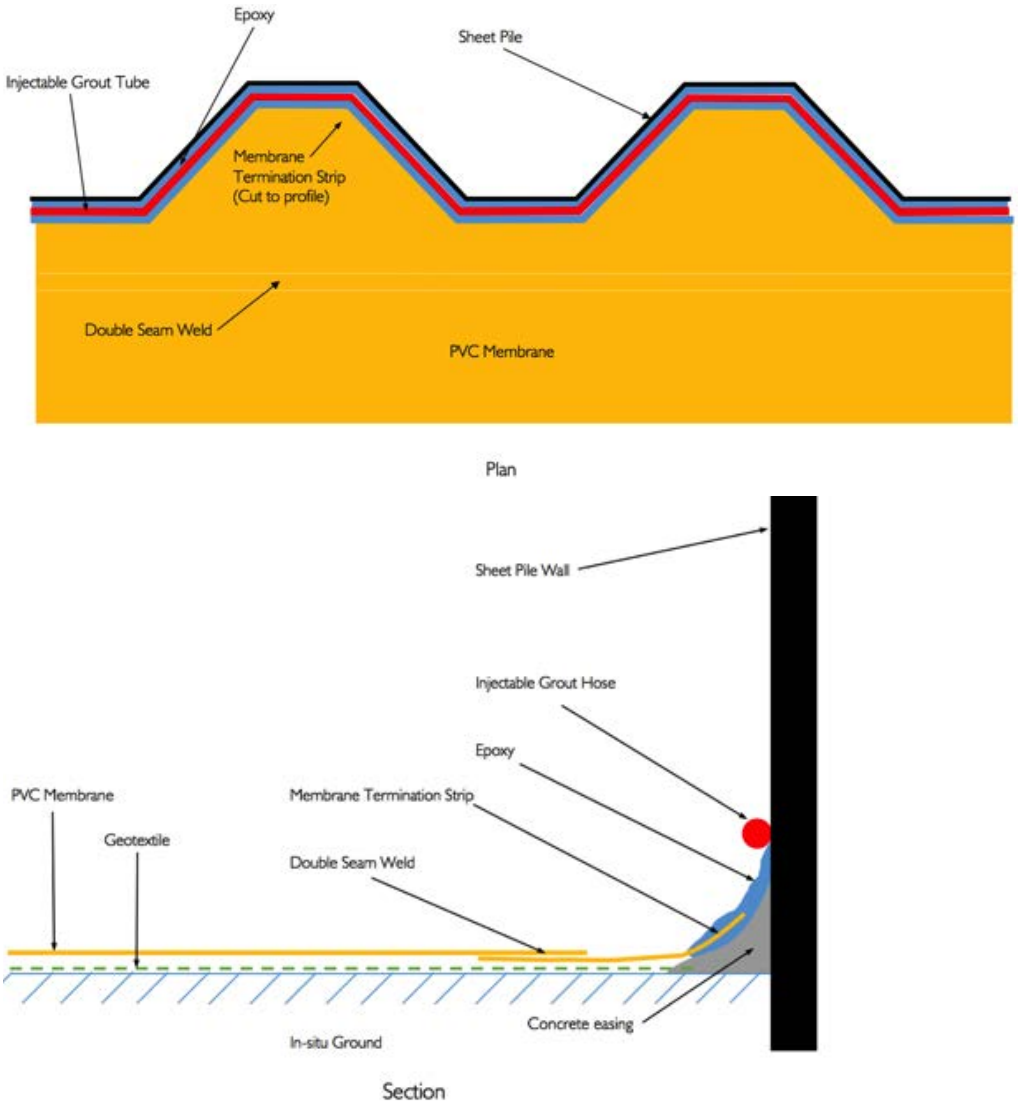
TYPICAL TERMINATION DETAILS



▲ *Sheet Pile Wall Termination*

BluSeal PVC
WELDING TECHNIQUES

DOUBLE SEAM WELDS

Double seam welding is the preferred welding method for all membrane seams. A double seam wedge welder shall be used to perform the welds (pictured right).

To perform the weld, trim the overlap between membrane sheets using a retractable Stanley knife, minimum 80mm - 100mm allowable

Turn on the machine and ensure the correct parameters are set. Once the machine has reached the set temperature, load the material into the machine and immediately clamp the drive wheels on the membrane. The machine will begin to track along the seam automatically.

Ensure the machine stays in line with the seam and that both weld tracks remain within the overlap area.

Once the welding machine has reached the end of the seam, immediately release the clamp and remove the machine, to avoid burning of the membrane.

It is the least favoured method of membrane welding and shall only be considered when other welding techniques are not a practical option.

A double seam wedge welder

HAND WELDS

Hand welding is the process of fusing two similar thermoplastic materials through heat. The required tools are: a heat gun with a flat angled nozzle, Stanley knife, and a silicon roller.

Hand welding may be required for:

- Patch repairs
- Sealing to BA Anchors, waterstops, drainage elements, penetrations or other ancillary items in the waterproofing system.
- For installation of membrane where there is an abrupt change to the substrate.

To perform the weld, the membrane sheets should overlap by a minimum 80mm. The overlap area must be clean, and free of oil, dust, grease and other contaminants.

The weld shall be carried out in three stages as described below. Once introduced to the overlap, the heat gun shall be used in a continuous, flowing motion and not allowed to linger in contact with the membrane. The roller shall be applied using firm pressure and evenly over the weld area.

Hand welding tools: Heat gun, roller and nozzle

BluSeal PVC
WELDING TECHNIQUES

TACKING

Tack the overlap intermittently towards the rear of the weld to fix and hold the sheets in place. Briefly apply the heat flow at the point to be tacked. Remove the heat gun and immediately apply pressure to the heated area with the roller. This stage of the process is illustrated in the image middle right.

PRE-WELDING

Pre-weld the rear section of the overlap, such that the remaining opening is 35 to 40mm wide. Apply the heat flow in a continual motion along the weld, while simultaneously moving the roller parallel to the air outlet of the heat nozzle firmly, keeping a distance of 20mm. Pre-welding the rear of the weld creates a heat trap, which facilitates the final welding process.

FINAL WELDING

The final seal should be both air and watertight.
Similarly, apply the heat flow in a continual motion whilst simultaneously applying pressure with the roller over the remaining width of the overlap. Always roll over the edge of the welding seam.

QUALITY ASSURANCE

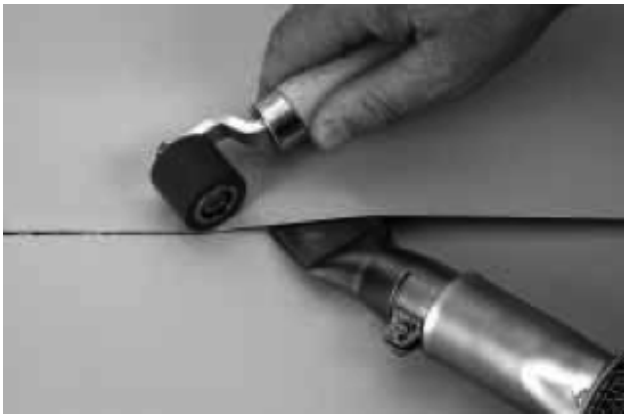
To ensure quality control is maintained, the welding and testing guidelines are based upon the following German industry standards:

- DVS 2225-1 - Joining of Lining Membranes Made from Polymeric Materials (Geomembranes) in Geotechnical and Hydraulic Application - Welding, Bonding by Adhesives and Vulcanising; and
- DVS 2225-2 - Joining of Lining Membranes Made of Polymer Materials in Geotechnical and Hydraulic Engineering – Site Testing

Weld tests are used to verify that all welds are watertight. The test methods and frequency shall depend upon the client specifications. It is expected that a minimum of 20% of all welds are to be tested.

Tack welding being performed

Pre-welding being performed



Final welding being performed

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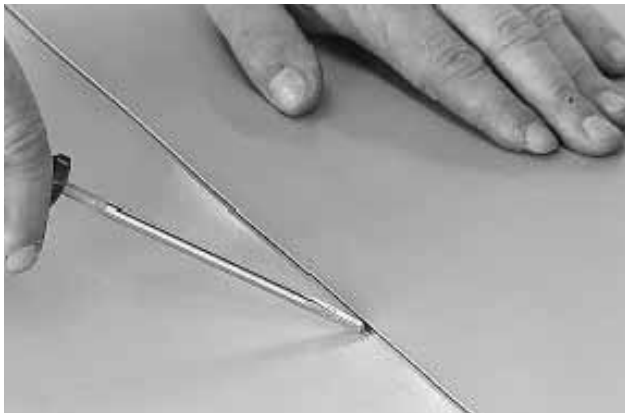
TESTING METHODS



Needle test being conducted

A typical double seam weld, with air channel in between welds

Typical pressure test equipment: Needle attached to pressure gauge

The two preferred test method are:

VISUAL INSPECTION

Visual Inspections (Needle tests) are used for hand welded seams. To perform the test, insert the tip of a screwdriver with a light pressure along the edge of a weld and visually check for irregularities.

Any cavity or irregularity detected will be rectified using a heat gun, and further patching (if required).

DOUBLE SEAM PRESSURE TEST

Pressure testing is used for seams sealed using the double seam wedge welder.

To perform the test, seal the air duct between the two welded seams by placing a clamp at both ends.

Insert the test needle (connected to a metered gauge and air pump) into the air duct, ensuring a tight fit is achieved.

Inflate the air duct using an air pressure pump to a pressure of at least 2.0 bar, and close the release valve. Check the air pressure after 20 minutes.

To be considered watertight, the pressure in the duct must not drop by more than 20%, after the 20 minutes has elapsed.

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