BluSeal Tunnel Liner
WATER INFILTRATION MANAGEMENT

WHAT IS IT?
BluSeal Tunnel Liner is a system of product supply, project management, training and site support to ensure desirable ground water infiltration control.
Bluey are leading Australian tunnel waterproofing specialists with proven experience on leading infrastructure projects.

**WHERE DO WE USE BLUSEAL TUNNEL LINER?**

BluSeal Tunnel Liner is chosen where there is a need for ‘dryness’ or management of groundwater infiltration in a tunnel.

BluSeal Tunnel Liner provides the highest surety of durability, environmental management and aesthetic outcomes required on a modern day construction project.

**WHY BLUSEAL TUNNEL LINER?**

Water infiltration control

Understand and manage the risks associated with ground water in an underground environment.

Proven large scale application and project management of major infrastructure projects.

**SHEET MEMBRANE TUNNEL LINING PROJECTS**

- Epping to Chatswood Rail Link, Sydney
- Eastlink Project, Melbourne
- Northern Gateway Project, Auckland (New Zealand)
- City West Cable Tunnel, Sydney
- NSBT Gibbon Street Shaft, Brisbane
- Boggo Road Tunnel, Brisbane
- Airport Link Project, Brisbane
- Electrified Double Track Tunnel, Berapit (Malaysia)

**SPRAY APPLIED LINING AND TUNNEL INJECTION SEALING PROJECTS**

- Cross City Tunnel, Sydney
- North Kiama Bypass, NSW
- M5 East Tunnel Sealing, Sydney
- Eastern Distributor Tunnel Sealing, Sydney
- M2 Tunnel Widening, Sydney
BluSeal Tunnel Liner

EXPERIENCE

Bluey’s four key offerings in major tunnel infrastructure projects, with proven experience and successful results

PROJECT MANAGEMENT ACTIVITIES
Selection and procurement of specialist membrane welding & testing equipment
Training and supervision of local installers to meet the demand of numerous concurrent waterproofing work fronts
Materials handling and delivery from abroad
Quality control of both material supply and site installation
General site management of the installation works

TRAINING
Bluey’s Engineers specialise in onsite techniques to ensure that the Client, its designers and applicators receive full support during the entire material selection, installation and testing process. Bluey is able to offer training and quality inspections on site either directly or through third party trained specialists accredited by Bluey. For all of our products we are also able to recommend competent applicators who have experience in applying our range of products.

PRODUCT SUPPLY
When Bluey is engaged for work on your project, you can be sure that you will have access to the best value products around the World.
Due to our ongoing work on large projects in the region, we have a broad understanding of the most efficient manufacturers of each product depending upon the size, location and technical details of your underground structure.
Bluey will work through the design process and ensure that the right product is selected to give the best outcome. Consideration will be given to the local environment, tunnel methodology, installation techniques, and performance criteria. Bluey will also take care of some of the more complex logistical issues such as selection of membrane roll lengths to reduce wastage, roll widths, container packing methods and delivery schedules to keep ahead of construction activities.

SITE SUPPORT
Onsite, Bluey uses its experience in tunnel lining to ensure that waterproofing and drainage works are well managed so that you can get on with the more important task of building the tunnel.
We ensure that the design of gantries and membrane details are developed to ensure installation can keep ahead of concrete lining. Our role onsite extends beyond project management of membrane lining, for example, we will work together with shotcreting crews to ensure the quality is acceptable for membrane placement. Our experience will keep all parties satisfied that activities are being coordinated to ensure a good outcome for the Client.
Most importantly of all, we will develop systems of safe work in the tunnel environment to ensure that the waterproofing and drainage systems are installed without harm to others. We will take care of the procedures for handling and storage of plastic materials within the tunnel environment to significantly reduce manual handling requirements and also eliminate fire safety issues. Our experience in this field will prove to be a valued asset.
It is our job to plan every aspect of tunnel and drainage installation in your underground environment. Our Project Managers will guide you through the entire project to ensure that all aspects of the installation are considered and well planned for.
**BluSeal Tunnel Liner**

**SYSTEM SELECTION**

**WATERPROOF LINING SYSTEMS**
Tunnel sealing and drainage systems typically fall into the following categories:
- Drainage Layer Linings
- Spray-on Liquid Membrane Linings
- Sheet Membrane Linings

**ASSESSMENT**
These systems have varying application benefits and limitations.
The system will generally be designed around final tunnel requirements for ‘dryness’
Within the framework of other considerations:
- Site Conditions
- Economic Implications
- Concrete Lining Methodologies and Program
- International Standards

**SITE CONDITIONS**
Ingress of water at the time of excavation and membrane application
Substrate preparations planned to be carried out
Underground access constraints

**ECONOMIC IMPLICATIONS**
Budget available
Constructors risk perception depending on previous experience (fix it later)
Not a budget priority to the contractor

**CONCRETE LINING METHODOLOGIES AND PROGRAM**
In situ concrete
Shotcrete permanent lining systems
Planned sequencing of the works

**INTERNATIONAL STANDARDS**
Specification for tunnelling, British Tunnelling Society and The Institution of Civil Engineers, 3rd Edition 2010
DVS 2225 – Joining of Lining Membrane Made of Polymer Materials in Geotechnical and Hydraulic Engineering
International Association of Geosynthetic Installers – HDPE and LLDPE Geomembrane Installation Specifications
DS 853 - Deutsche Bahn AG - German Railway Standards
BluSeal Tunnel Liner

SURFACE PREPARATION

INSPECTION & ACCEPTANCE OF SHOTCRETE / SUBSTRATE SMOOTHNESS

Maximum aggregate size 4 to 10mm (depending on system)
Irregularities shall not exceed 200mm on any 1m curved edge
Cover or remove protruding objects such as rockbolts
Seal or divert running water
Maintain drainage prior to concrete pour

DRAINAGE LAYERS

DRAINAGE LAYER LININGS
Technically not a ’watertight’ liner
Provides an annulus drainage path
Alleviates the build up of external hydrostatic pressures on the structure
Typically used for tunnels constructed in good quality rock

DRAINAGE LAYERS

DRAINAGE MEDIUMS

...
**BluSeal Tunnel Liner**

**SURFACE MEMBRANE**

**SPRAY APPLIED MEMBRANE**

**SPRAY-ON LIQUID MEMBRANE LININGS**

Developed out of their similar use within the mining industry

Have only been used on a limited basis world-wide for waterproofing of tunnels

Materials include: acrylics / bitumen / cement latex / polyurethane / polyurea

**SPRAY MEMBRANE USES**

Remediation of rock-face weathering

Management of minor water infiltrations

Waterproofing membrane in specific cases

**SPRAY-ON LIQUID MEMBRANE LININGS**

Membrane can not be applied to damp or wet shotcrete surfaces

Consistent quality difficult to achieve in tunnel environment

Less durable than PVC or VLDPE sheet membranes

Generally not suitable for use in tanked tunnels
**BluSeal** Tunnel Liner

**SHEET LININGS**

**SHEET MEMBRANE LININGS**
Most robust and watertight protection for a tunnel structural lining
Impermeable water barrier between concrete lining and surrounding strata
Internationally recognised as the most reliable method of tunnel waterproofing
Used as either:
- ‘Umbrella’, shedding water from the tunnel ‘crown’ down into an invert drainage.
- Fully ‘encapsulated’ or ‘tanked’ structural lining, which limits water ingress.

**VARIATIONS IN SHEET MEMBRANE SYSTEMS**
Material type and thickness
Drainage and protection layers
Welding and fixing methods
Secondary protection provisions
External compartmentalisation systems to maintain water tables

**INSTALLATION OF GEOTEXTILE FLEECE**
Installed as membrane protection or drainage
Generally non-woven 100% polypropylene
Minimum weight of 700 g/m²
Flammability class B2
**BluSeal Tunnel Liner**

**SHEET LININGS**

**INSTALLATION OF ROUNDELS (MEMBRANE FIXING DISCS)**

Nail fixed through the geotextile fleece

Compatible for hot air (spot) welding to the sheet membrane

Fixed on an average of 1 per m² for walls and 2-3 per m² for crowns

**INSTALLATION AND WELDING OF MEMBRANE SHEET WATERPROOFING**

Drained tunnels shall generally be 2mm thick

PVC-P or VLDPE

The membrane shall have a ‘signal’ layer

Flammability class shall be appropriate for the site

Heat weld to previously installed roundel fixings

Install with sufficient slack to avoid potential overstressing

Install ‘snug enough’ to avoid folds developing during concrete placement

All seams are pressure tested

- Rock substrate
- Shotcrete support and smoothing layer
- 2mm PVC membrane (fixed to rondels by hand hot air welding and to adjacent membrane sheets by 100mm lap and double wedge welding)
- Geotextile fleece (installed against smoothing shotcrete by nail fixing)
- Rondels fixed by nail on geotextile through to shotcrete (temporary holding membrane in location until permanent lining concrete installation)
BluSeal Tunnel Liner
SHEET LININGS

PORTALS AND CROSS PASSAGES
Three way curvature
Heavy reinforcement

TBM CROSS PASSAGES
Connection to precast segments
BluSeal Tunnel Liner
SHEET LININGS

INSTALLATION ACCESS EQUIPMENT
Fixed gantry, mobile or automated gantry
BluSeal Tunnel Liner
SHEET LININGS

TERMINATIONS
Pressure terminations
Epoxy tape terminations

PENETRATIONS
Through fixings (condom bolts)
Drainage and grouting

WATERSTOPS
Compartmentalisation
Longitudinal and Radial
BluSeal Tunnel Liner

CASE HISTORIES

BRISBANE AIRPORT LINK PROJECT
Twin 5.1km tunnels connecting Brisbane city with the northern suburbs and airport precinct.

PROJECT DETAILS
Drained tunnel
TBM bored
Cast insitu concrete lining
1 litre/s/100m tunnel length inflow
No damp patches

SOLUTION
Bluey designed unique dimple sheet fixings
Materials selected to allow double seam welding and testing
Manufactured in Norway to Bluey specification
Bluey partnered German Installer Naue
Project complete with no damp patches

FEATURES
Drained and tanked tunnel profiles with associated groundwater drainage systems and external compartments between profiles
System compatibility for both insitu concrete and shotcrete permanently lined tunnels
Tanked connections between mined and TBM tunnels

BENEFITS
Tunnel functionality for high speed tollway traffic flows with no ‘drips’ from above or visible damp patches from below
Groundwater impacts minimised with tunnel inflows controlled and handled by the designed drainage and pumping systems
**BluSeal Tunnel Liner**

**CASE HISTORIES**

**MELBOURNE EASTLINK PROJECT**
Twin 1.6km tunnels under the environmentally sensitive community parkland area of Mullum Mullum Creek

**PROJECT DETAILS**
- Fully tanked tunnel lining
- 40m water head
- 13 cross passages

**SOLUTION**
- International Standard waterproofing design conformance
- 2mm and 3mm membrane double seam welding
- Radial waterstop at every block joint
- Bluey DVS qualified supervision
- Every membrane seam pressure tested and verified

**FEATURES**
- 150,000 square metres of 2mm LLDPE sheet membrane to both the invert and obvert (arch) of the tunnels
- Waterstop joint protection and lining compartmentalisation
- External lining z-profile compartments
- Post completion injection systems

**BENEFITS**
- Minimal long term environmental impact on the surrounding water tables with nil effects on the Mullum Mullum creek water levels above
- Negligible water inflows that needed to be handled by operational drainage pumping systems for the life of the tunnels
BluSeal Tunnel Liner

CASE HISTORIES

EPPING TO CHATSWOOD RAIL LINK
12KM TWIN TUNNELS 7M DIAMETER

PROJECT DETAILS:
- Drained tunnel
- TBM bored
- Cast in-situ concrete lining
- 1 litre/s/100m tunnel length inflow
- No damp patches

SOLUTION:
- Bluey designed unique dimple sheet fixings
- Materials selected to allow double seam welding and testing
- Manufactured in Norway to Bluey specification
- Bluey partnered German Installer Naue
- Project complete with no damp patches

AUCKLAND NORTHERN GATEWAY PROJECT
300M TWIN TUNNELS DUAL CARRIAGeway ROAD TUNNEL

PROJECT DETAILS:
- Drained tunnel lining
- Environmentally sensitive
- Cross passages
- Road header excavation
- Cast in-situ concrete lining

SOLUTION:
- International Standard waterproofing design conformance
- 2mm and membrane double seam welding
- Radial waterstop every 50m
- Bluey DVS qualified supervision
- Client supplied labour for installation
- Every membrane seam pressure tested and verified

SYDNEY CITY WEST CABLE TUNNEL PROJECT
SHAFT, BACK DRIVE AND CAVERNS

PROJECT DETAILS:
- Fully tanked lining
- Aggressive ground water
- Sensitive electrical equipment
- Road header and hand excavation
- Cast in-situ concrete lining

SOLUTION:
- International Standard waterproofing design conformance
- 2mm and membrane double seam welding
- Radial waterstop at every construction joint
- Bluey DVS qualified supervision
- Subcontractor labour for installation
- Every membrane seam pressure tested and verified
SUMMARY

Australia is an international leader in tunnel waterproofing applications. Work standards have improved significantly in recent years through training and partnering programs.

Contractors are saving time and money by engaging the right methods, equipment and people at the early phases of project planning.

There is now a rapidly growing list of successfully sealed tunnels completed in Australia in terms of cost, program and final outcome for water infiltration.

We are striving to improve this record by working together with industry, learning from our experiences and continuing to engage international expertise.
Bluey Technologies

PRODUCT RANGE

**bluCem**
- BluCem AP10
- BluCem RF20
- BluCem FC
- BluCem HB range
- BluCem HE10
- BluCem HE80
- BluCem HE80AG
- BluCem HE80HT
- BluCem HS100 range
- BluCem HS200 range
- BluCem EA02
- BluCem GP60
- BluCem UF40
- BluCem UW range

**bluGeo**
- BluGeo Powerthread range
- BluGeo SD Anchors range
- BluGeo ST Rock Bolts range
- BluGeo Swellex range
- BluGeo Tekflex

**bluRez**
- BluRez Crackseal 111
- BluRez Crack Seal 150
- BluRez Crackseal NV
- BluRez Carbostop
- BluRez Carbostop 42D
- BluRez Epoxy 225
- BluRez Epoxy 480
- BluRez Epoxy 480UT
- BluRez Epoxy 575 CG
- BluRez Epoxy 655

**bluSeal**
- BluSeal Anchor Knob Sheet
- BluSeal Britdex Membrane
- BluSeal Moulding Putty
- BluSeal Dust Control 10
- BluSeal Road Sealer 10
- BluSeal Containment Liner
- BluSeal PVC Tunnel Liner
- BluSeal Injection Kit
STATEMENT OF RESPONSIBILITY

The technical information and application advice given in this publication is based on the present state of our best knowledge. As the information herein is of a general nature, no assumption can be made as to a product’s suitability for a particular use or application and no warranty as to its accuracy, reliability or completeness either expressed or implied is given other than those required by Commonwealth or State Legislation. The owner, their representative or the contractor is responsible for checking the suitability of products for their intended use.

NOTE:

Field service where provided, does not constitute supervisory responsibility. Suggestions made by Bluey Technologies Pty Ltd either verbally or in writing may be followed, modified or rejected by the owner, engineer or contractor since they, and not Bluey Technologies Pty Ltd are responsible for carrying out procedures appropriate to a specific application.

© Bluey Technologies Pty Ltd