Premier
Hydropavers®
... so much better

TECHNICAL MANUAL

A guide to the product information, pavement design specifications, installation techniques and maintenance of ceramic permeable paving systems

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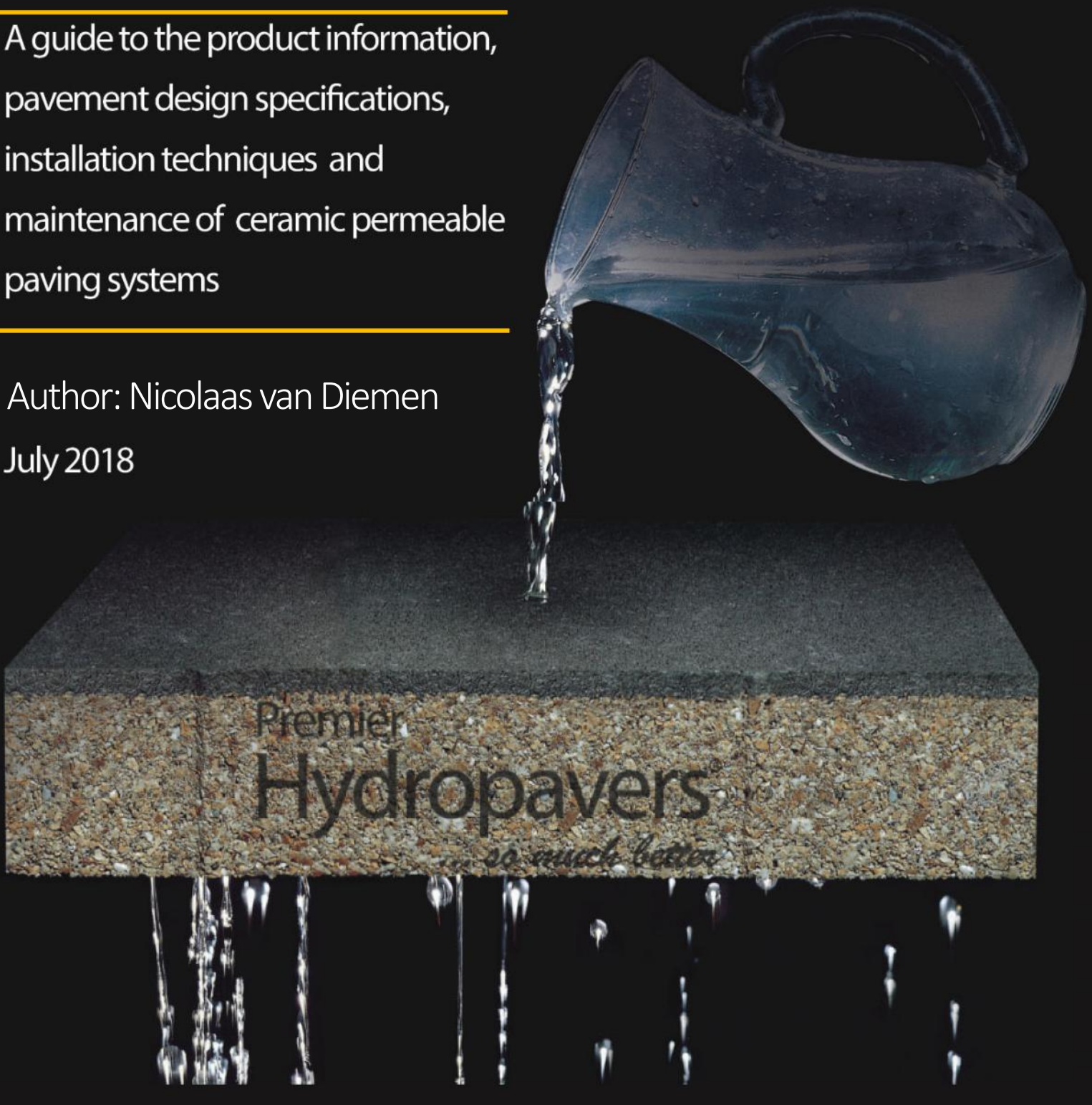

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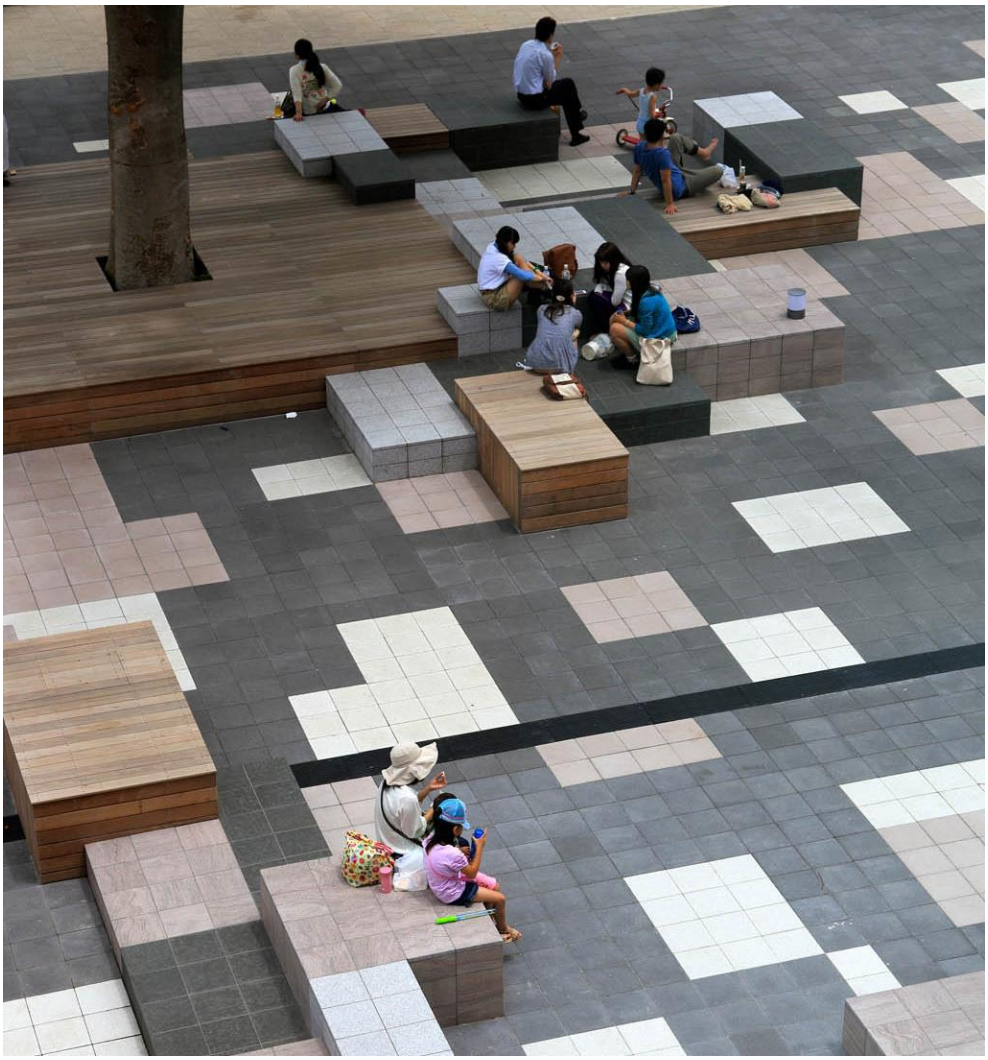
1. Introduction.

Premier Hydropavers® are state of the art ceramic permeable flag and segmental pavers that allow water to infiltrate through the paver making it a system of flexible paving that is strong, durable and safe.

The diversity of colours and the surface texture enables architects, engineers and specifiers to design pavements embracing scale and aesthetics particularly in pedestrian areas.

The strength, size and laying patterns make these pavers suitable for vehicular trafficked areas in most applications.

This comprehensive technical document will assist specifiers, sales representatives, local, state and federal government department personnel and paving contractors to understand the environmental advantages and the design and installation techniques to successfully complete projects using Premier Hydropavers® Permeable Paving Systems.



2. Product Information

Premier Hydropavers® are strong, versatile and attractive ceramic permeable pavers that are pressed at 1600 tonnes and baked at 1200°C. The high strength and durability means the ceramic permeable pavers have a long life, keeping their attractive appearance for many years.

2.1. Properties of the paver.

Premier Hydropavers® are made from crushed recycled ceramic tiles and pressed into moulds at 1600 tonnes and fired at 1200°C. Heating the material to below its melting point forms strong bonds between the individual grains and creates tiny pores. As such, the paver is able to absorb water, for later transpiration into the atmosphere, as well as allowing water to pass through. The paver has a 25% porosity.

2.2. Paver characteristics.

Premier Hydropavers® display numerous characteristics that make them appropriate for use in many paving applications.

- High permeability - These pavers are capable of infiltrating rainfall at a rate of 25mm/minute.
- Strong water absorbing capacity - The pavers absorb water like a sponge. If less than 5 mm of rain falls in a day the water is held in the paver and evaporates once the rain event is over.
- Evapotranspiration - As well as high infiltration rates, these pavers capture and store water. This water is subsequently released into the atmosphere creating a cooling effect. This helps to mitigate the phenomenon known as the “urban heat island effect”.
- Noise reduction - The porous structure of the pavers absorb a large amount of noise.
- Colour range – The pavers are available in a wide range of colours. Being a ceramic product that has been baked at 1200°C the pavers will maintain their colour for years.
- Strength and durability - These pavers have a >50 MPa compressive strength and a breaking load strength of 10 kN (200x100x55 pavers) to 20 kN (300x300x55 pavers). It should be noted that breaking load, not compressive strength, is the strength criteria for assessing the performance of pavers.
- Slip resistance - The pavers exhibit a nonslip surface that has a British Pendulum Number (BPN) of a minimum of 65.

2.3. Paver testing.

Premier Hydropavers® meet all required testing criteria.

Type of paver:	Premier Hydropavers® permeable paver
Dimensions:	300 x 300 x 55 mm
	200 x 100 x 55 mm
	Other sizes available on request
Water Retaining Capacity:	5 mm of any initial rainfall
Permeability rate:	~25 mm of rainfall per minute
Slip skid resistance:	British pendulum number 65 to 85
Frost resistance:	Minus 25°C
Breaking load (200x100x55 pavers):	10 kN
Breaking load (300x300x55 pavers):	20 kN
Modulus of Rupture:	8 MPa
Compressive strength:	> 50 MPa
Dimensional variation:	Length and width ±1.5 mm
	Thickness ±2 mm
	Surface flatness ±0.5 mm
Surface flatness:	No defects visible from a distance of 800mm
Abrasion resistance:	140 mm (suitable for pedestrian traffic)
Resistance to thermal shock:	Meets stipulated requirements
Resistance to crazing:	Meets stipulated requirements
Resistance to pollution:	Meets stipulated requirements
Resistance to household chemicals:	Meets stipulated requirements
Resistance to swimming pool alkali:	Meets stipulated requirements

3. Pavement design and specifications.

Premier Hydropavers® are suitable to be used in a wide range of applications including:

- Domestic driveways.
- Patios and alfresco areas.
- Car parks and industrial hard stands.
- Plazas, pathways and all pedestrian areas.
- Rooftop gardens.
- Commercial kitchens.

Given the wide range of applications for which these pavers can be used, it is important that the proper pavement design specifications are determined.

3.1. Site investigation.

It is vital that a thorough site investigation be completed. During the site investigation the soil type needs to be determined and an infiltration test completed to establish the drainage characteristics of the soil. This can be done by using a two ring apparatus or by conducting a visual/tactile assessment of the soil. There are three types of Permeable Paving Systems:

- System A. Total infiltration.
- System B. Partial infiltration.
- System C. Water harvesting.

3.2. Subgrade strength

It is also important that the strength of the soil be determined. This requires that the California Bearing Ratio (CBR) of the subgrade be assessed. CBR is an indication of the shear strength of the subgrade material and has been used widely as a means of assessing subgrade strength for all pavement designs. The CBR of the soil can either be measured directly or it can be derived from a knowledge of other soil properties. CBRs are often estimated rather than measured. It is not essential to establish the CBR on all projects and an estimate of the soil type in regards to its suitability as a construction material will sometimes suffice. For small projects the soil can be categorised as in the following ways:

- Strong Sandy loams.
- Average Silty loams.
- Weak Clay soils.

 # This is a guide only and, if in doubt, obtain engineering specifications.

3.3. Drainage.

If infiltration rates are too low, as per System B, slotted pipes need to be installed at the formation level to remove excess water. In situations where there is significant fall on the area, the excavation may need to be stepped to assist in the infiltration of the water into the sub-grade.

3.4. Traffic loads.

The traffic loads of the designated area also need to be determined in regards to the type of traffic and the frequency. The two main types of traffic loads are vehicular and pedestrian. Vehicular traffic needs to be categorised as heavy, medium and light. For heavy and medium traffic loads it is recommended that engineering specifications be obtained. For light vehicular traffic and pedestrian areas the base thickness can be determined by following the information in table 1.

3.5. Subbase and base construction.

The base course thickness should be designed on the basis of the strength of the subgrade and the traffic loads applied to the pavement. (See Table 1) The base course material is a no fines crushed rock. This material can be 40-5 mm or 20-5 mm. (See Table 2)

Alternately a mix of 1 part 20 mm screenings 2 parts 14 mm screenings and 1 part 7 mm screenings can be used on small projects. We recommend that on large projects engineering specifications be obtained.

The thickness of the base has two purposes:

1) To support the applied loads.

2) To store water as required.

There is a direct correlation between the amount of fines in the crushed rock and the strength of the base. But in general terms there is an average of 25% porosity within the base material. This equates to being able to store 250 L of water per 1 m^3 of base. In some cases the thickness of the base can be increased to store additional water.

Table 1

Classification of traffic.	**Sub-grade conditions**	**Minimum base thickness**
Heavy traffic Vehicles over 3 tonnes Engineering specifications required	Weak Average Strong	Engineering specifications recommended
Medium traffic Vehicles less than 3 tonnes Car parks Malls	Weak Average Strong	200mm 175mm 150mm
Light traffic Private driveway Streetscapes Cycle paths.	Weak Average Strong	175mm 150mm 125mm
Pedestrian traffic Patios Footpaths Outdoor living areas.	Weak Average Strong	150mm 125mm 100mm

All minimum base thickness requirements are compacted crushed rock thickness.

This table should only be used as a guide and it is highly recommended that the supplier be contacted if additional information is required.

Table 2

Sieve size mm	**20 mm subbase.**	**40mm base**
63		98-100
40	100	85-99
31.5	98-100	-
26.5	-	-
19	85-99	20-70
13.2	-	-
9.5	20-70	-
4.75	0-15	0-15
2.36	0-5	0-5
1.18	-	-

3.6. Compaction.

The base course material should be spread and compacted in layers. The thickness of these layers must be consistent with the compaction capacity of the equipment being used. It is recommended that a vibrating roller be used for no fines base materials.

3.7. Base levelling and surface finish.

The surface of the base needs to be levelled and finished to a + or – 3mm tolerance from predetermined design levels.

3.8. Geotextile materials.

Geotextile materials can be used to great effect as separation layers. It is recommended the fabric be placed between the base course and the bedding material or between the subgrade and the base course.

4. Bedding material.

4.1. Material grading.

The bedding material used for PPS is not a traditional bedding sand. It needs to be a no fines 2-3mm course sand or gravel. Alternately the material commonly known as quarter minus, an imperial measurement, which is a 4 to 6 mm crushed stone can be used. It is recommended that on large projects engineering specifications be obtained or at a minimum the manufacturer be consulted.

Table 3. Bedding material and jointing sand sieve analysis

Sieve size	Bedding material	Jointing sand
4.74mm	90-100	Not applicable
2.36mm	75-100	100
1.18	55-90	75-95
600 microns	-	35-59
300 microns	-	20-45
150 microns	-	5-15
75 microns	-	0-5

4.2. Bedding sand installation.

The bedding sand needs to be installed to a uniform 30 mm thickness with a +/-2 mm tolerance. The material needs to be lightly compacted using a vibrating plate compactor or non-vibrating heavy roller. It is important that once the bedding material has been installed and screeded that it not be disturbed.

5. Paver laying techniques.

The pavers can now be laid to the selected pattern.

5.1. Patterns.

The pattern of the paving needs to be decided based on what application the paving is being used for, the three main categories of patterns are:

- **Herringbone -** 45° and 90° herringbone.
- **Parquetry -** basket weave, half basket weave.
- **Stretcher -** stack bond and stretcher bond.

5.2. Setting out the area.

The area needs to be set out so that all string lines are 90° angles. It is imperative when using a square or rectangular paver that this be achieved.

5.3. Laying pavers.

The pavers are laid directly on the bedding material as in any other flexible paving system. It is important when laying the pavers that no paver be 2 mm higher than any adjacent paver. On completion of laying full pavers the cut pavers need to be installed. It is essential that when cutting pavers that all occupational health and safety requirements be strictly followed. It is also essential that the pavers be cut using a diamond blade saw.

6. Joint filling and post laying compaction.

6.1. Types of jointing sand

Due to the nature of Premier Hydropavers® the joints can be filled with a fine graded washed sand. (See Table 3)

6.2. Jointing procedure

The sand needs to be totally dry so it will flow into the joints more easily and not bridge between adjacent pavers. For ease of installation sand is recommended as the ideal jointing material as it creates better interlock, as allowing water to enter via the joints is not a priority.

6.3. Post laying compaction.

Once the joints have been filled, it is essential to compact the pavers using a vibrating plate with a rubber mat attachment. This process will ensure that all the joints are thoroughly filled, to create maximum interlock, and that the pavers are properly levelled and all lipping is eliminated. It is essential that during this process there is no jointing sand present on the paving.

This process may need to be repeated a number of times to ensure that the joints are properly filled.

7. Edge restraints.

On completion of the laying the perimeter of all paved areas should be provided with edge restraints to prevent lateral spread of the pavers and consequent loss of interlock. These should be adequate to support the intended loads and to prevent the escape of bedding course material from beneath the paved surface.

7.1. Types of edge restraints.

The design and size of this edge restraint is dependent on the traffic loads applied to the pavement. For vehicular traffic it is highly recommended that the edge restraint be concrete and preferably with some form of steel reinforcing. On pedestrian areas treated timber or galvanised steel may be appropriate.

7.2. Installation of edge restraints.

Due to the nature of the no fines material used in permeable paving systems it is recommended that the concrete edge restraint be installed before laying commences.

8. Maintenance.

The paving can be used immediately. Cleaning using high pressure cleaners and vacuum sweepers is not recommended for the first three months. During this time clean only with a broom or a leaf blower.

8.1. Periodical inspections.

The paving needs to be inspected at a minimum of twice a year for defects and spillages. Frequent sweeping and washing reduces the effect of weeds, dirt and grime and maintains the attractiveness of the paving.

8.2. Jointing sand maintenance.

The loss of jointing sand in flexible pavements is not uncommon. Sand can be lost via vacuum sweeping and wind or washed out by water movement. It will be necessary, if this occurs, to top up the jointing sand.

8.3. Use of chemicals.

Due to the nature of permeable paving systems it is highly recommended that only environmentally safe chemicals be used. The most common use of chemicals on paved areas is the spraying of weeds. Weeds on permeable paving systems should be hand removed or removed using steam.

8.4. Common stains.

There are many other common stains that occur on paved surfaces. Such as:

- Fungi, moulds and lichens - High pressure cleaning.
- Oil, bitumen and tar - Seek professional advice.
- Food stains - High pressure cleaning or detergents.
- Chewing gum - High pressure cleaning or carbon dioxide aerosol or dry ice.
- Tyre marks - Environmentally safe detergents.
- Dirt and grime - High pressure cleaning.
- Weeds - Hand removal or steam.
- Mortar stains - Seek professional advice.

Many of these stains can be removed by high pressure cleaning or using environmentally friendly detergents. If this is unsuccessful contact your supplier for professional advice.

9. Additional information.

If you require additional information with regards to any aspect of Permeable Paving Systems and Premier Hydropavers® please contact:

Premier Pavers and Stone

Phone: (03) 9248 2400.

Location: 287 Bay Road Cheltenham VIC 3192.

Email: sales@premierpavers.com.au

Website: www.hydropavers.com.au

10. References.

1 J.Knapton and K.C. Marvin. Design Manual 1. Clay Segmental Pavements.

A Design and Construction Guide for Sites Subjected to Vehicular and Pedestrian Traffic.1989.

2 Paver Note 1. Specifying and Laying Clay Pavers.
Clay Brick and Paver Institute.1983.

3 Shackel B. and Pearson A. Concrete Flag Pavements.
Design and Construction Guide. 2000

4 CMAA. Concrete Segmental Pavements. Detailing Guide.1997.

5 CMAA. Concrete Segmental Pavements. Design Guide for Residential Access ways and Roads. 1997.

6 Product Catalogue.

7 CMAA. PermPave. 2007.

11. About the Author.

Nicolaas (Nic) van Diemen is a **Qualified Landscape** and **Segmental Paving Expert.**

Nic has been actively involved in the landscape and segmental paving industry for the past forty years in the areas of design, construction and training. As a qualified landscape gardener he worked for some of Melbourne's leading landscape construction companies of the period as both a worker and foreman. He conducted his own landscape and paving construction business for many years, working for leading Melbourne architects and designers and was involved in all aspects of landscape design and construction as well as a broad range of segmental paving projects. In the early 1980s he became involved in the training of landscape apprentices. During this period he obtained his teaching qualification, studying landscape design at Royal Melbourne Institute of Technology and plant science at Burnley Horticultural College.

Nic lectured in Landscape Design and Construction at Holmesglen Institute of TAFE 1984 – 2009. He also lectured in Advance Certificate of Landscape Design and Construction -Melbourne University, Burnley Horticultural Campus 1987 –1992

In 1988 he developed the Clay Paviours Training Program in collaboration with the segmental paving industry and the Clay Brick and Paver Association. This program has since been updated to the Segmental Paviours Training Program. From 1988 until 2008 he was the principal lecturer of this program. He also taught this program in Japan in 1994. Additionally, he conducted Segmental Paving Training Programs for several overseas and local industry groups 1989 –2007.

He was the chairperson of the Segmental Paviours Training Program Consultative Committee, 2004 – 2009.

Nic was seconded in 1994 by Nubrik to conduct 2 three day training programs in Japan and has organised five segmental paving conferences conducted at Holmes-glen Institute, along with presenting papers at these conferences.

In 2005 Nic was awarded a fellowship in Permeable Paving Systems (PPS) by the International Specialised Skills Institute (ISSI). He completed his fellowship in 2006 studying PPS in Germany, England, Ireland, Holland and Jersey Island. He also attended and presented a paper at the 8th International Conference on Block Pavements, which included several papers on PPS in San Francisco USA in late 2006. The fellowship document was published in March 2009. (Abstract published on www.issinstitute.org.au) Nic has taken an active interest in the progress of PPS in Australia, particularly Melbourne, since that time and has given numerous presentations on PPS for the paving and landscaping industry.

Nic presented papers on PPS at Austral brick training program Melbourne 2007, Stone Expo Sydney 2008, and Landscape Victoria “Environmental Landscapes” Melbourne 2009.

He organised and presented Segmental Paving Seminars in Melbourne 1990, 1992, 1994, 1996, 2003, 2007 and in Japan (Tokyo & Kyushu) 1994. He also represented Holmesglen Institute of TAFE at ‘Pave Africa,’ the 7th International Concrete Segmental Paving Conference - 2003.

Nic was a judge for the Landscape Industries Association awards (Paving category) 1992 -2011 and Worldskills Competition, 1992 - 2009.

In 2010, Nic was awarded Life Membership of Landscape Victoria in recognition of his contribution to the industry and his work on segmental paving.