

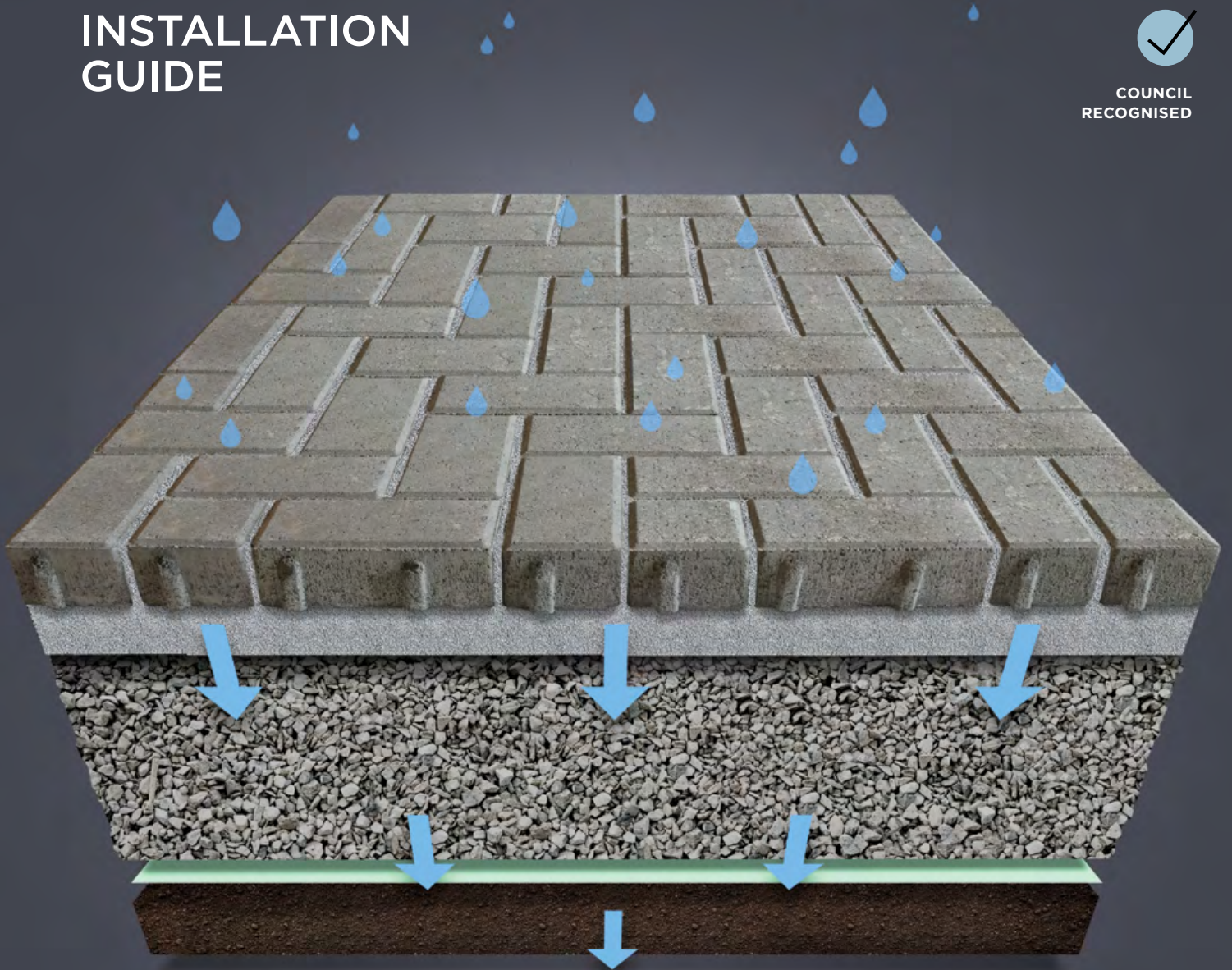
+Firth EcoPave®

Permeable Paving

INSTALLATION GUIDE



COUNCIL
RECOGNISED



The Firth EcoPave® range will assist in the management of rain and stormwater runoff.



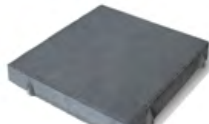
Firth FlowPave



Firth FlowPave Set



Firth PorousPave®



Firth Patio Paver



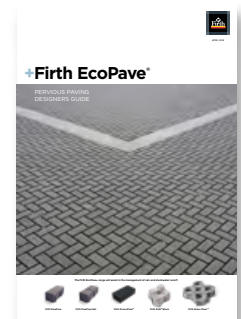
Firth Gobi® Block



Firth Grass Paver



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FIRTH ECOPAVE RANGE INSTALLATION GUIDE

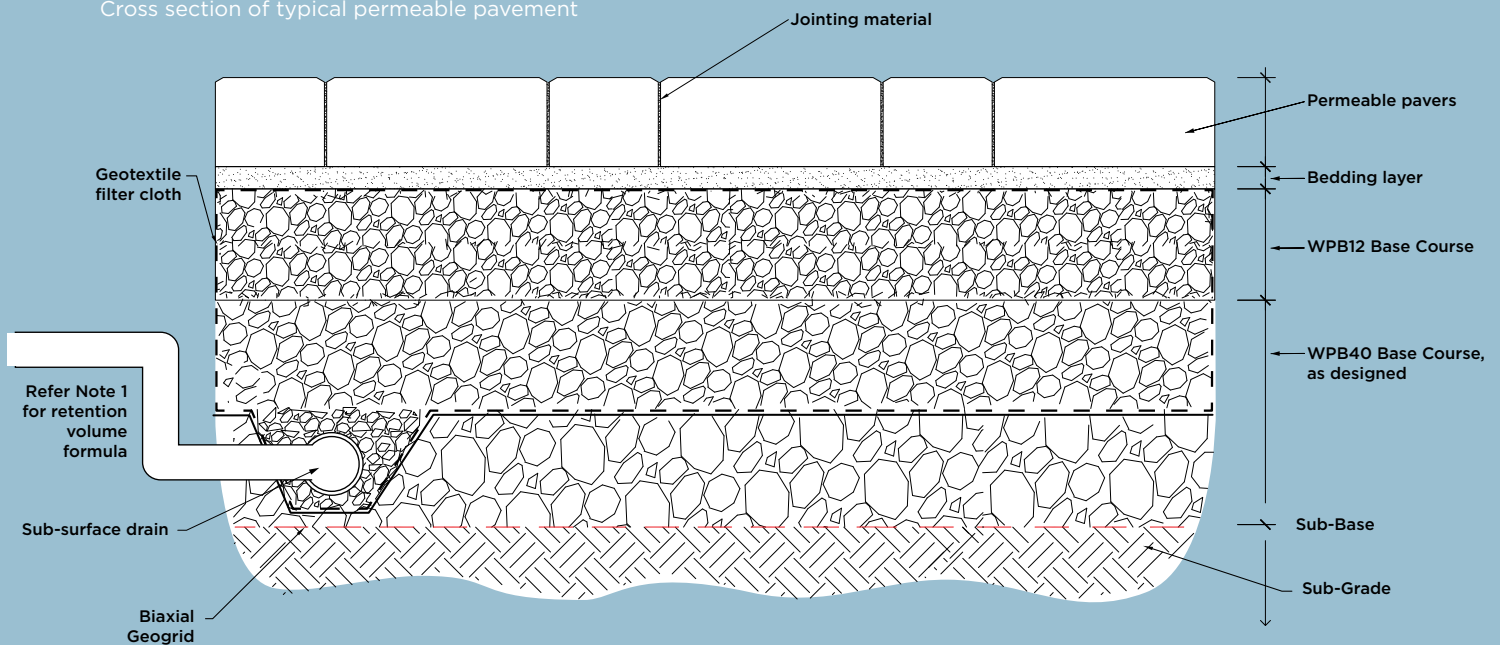
- > Complies with Auckland GD01 “Passive” Design
- > Slopes up to 7deg (or 12% or 1:8.5)

1.0 INTRODUCTION

THIS GUIDE IS FOR THE INSTALLATION OF THE FIRTH ECOPAVE® RANGE, WHICH ARE PERMEABLE, POROUS OR PERVIOUS CONCRETE PAVING SYSTEMS. THIS GUIDE SHOULD BE USED IN CONSULTATION WITH AN ENGINEER, ARCHITECT OR LANDSCAPE ARCHITECT IN ORDER TO ENSURE COMPLIANCE WITH COUNCIL REQUIREMENTS AND PROJECT CONDITIONS. PAVEMENTS SHOULD BE DESIGNED IN CONSULTATION WITH A QUALIFIED CIVIL ENGINEER AND WITHIN THE GUIDELINES OF NZS 3116:2002, WITH DUE CONSIDERATION OF THE LIKELY MOISTURE SENSITIVITY OF THE SUB-GRADE AND THE NEED FOR FILTER FABRICS. NORMAL GAP TYPES OF AGGREGATE ARE NOT SUITABLE AS BASE COURSE MATERIAL AND WILL LEAD TO PAVEMENT FAILURE IF USED.

1.1 TERMINOLOGY

Cross section of typical permeable pavement



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m² h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

Bedding Layer – Permeable pavers are bedded on a 20mm layer of either sand or chip depending on the type of permeable paver used.

Base course – The structural drainage layer underneath the bedding layer, which can be either drainage aggregate or a no-fines concrete. This layer is also referred to as “storage medium” as it can act as a storage tank once the storm water run off has dissipated into it.

Sub-Base – GAP40 or GAP65 to create a stable base in low CBR.

Sub-grade – The undisturbed soil at the bottom of the pavement system. The strength of this influences the thickness of structural support layer of the base course.

Sub-surface drain – A drainage system which allows water to enter it so it can be directed out of the base course. Assists with removing water in impermeable clay sub-grades and can be designed to reduce the stormwater peak flow.

Filter cloth – Normally a non-woven geotextile which is a polypropylene fabric which allows water to pass through it and prevents the bedding sand from migrating into the sub-base drainage aggregates. Also assists in stopping contamination of the sub base drainage aggregates when surrounded by clay soil.

WPB40 – A layer of aggregate which may be required as per design (check your requirements), which allows a higher amount of storage water.

1.2 System Choices

1.2.1 Table 1 - Application, Unit Type choice and indicative base course thickness

Note: Base course thicknesses are indicative only and are provided to give an example of typical construction. This table does not replace the use of engineering advice.

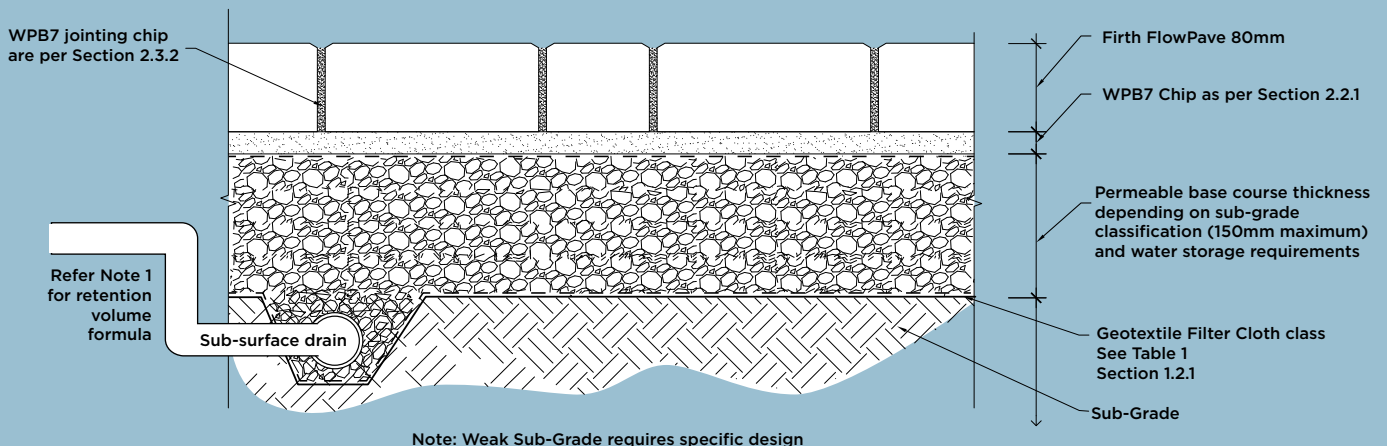
LOADING CONDITION	SUB GRADE CLASSIFICATION (SOAKED)			TYPE OF FIRTH PAVER
	WEAK CBR 5	MEDIUM CBR 10	STRONG CBR 15	
Residential Pedestrian Patio / Pathway Geotextile Filter Cloth	100mm Class C	100mm Class B	100mm Class A	PorousPave® 80mm FlowPave 80mm FlowPave Set 80mm Grass Paver 80mm
Residential Light Traffic Single Unit Residential Driveways Geotextile Filter Cloth	150mm (maximum) Class D	125mm Class C	100mm Class B	PorousPave® 80mm FlowPave 80mm FlowPave Set 80mm Grass Paver 80mm* Gobi® Block 100mm*
Residential Light to Medium Traffic Multi Unit Residential Driveways Geotextile Filter Cloth	Specific Design	150mm (maximum) Class D	125mm Class C	PorousPave® 80mm FlowPave 80mm FlowPave Set 80mm
Public Footpath Low and High Impact Geotextile Filter Cloth	100mm Class D	100mm Class C	100mm Class B	Commercial Grade PorousPave 80mm FlowPave 80mm FlowPave Set 80mm

Notes:

- For small jobs NZS3116:2002 suggests the following sub-grade assessment test which may be sufficient. Weather conditions can however significantly influence the test. The test should therefore be carried out under wet ground conditions:
 - Weak - Walking leaves a strong foot imprint.
 - Medium - Heel pressure leaves an imprint.
 - Strong - No imprints.
- For moisture sensitive soils (the soaked and unsoaked CBRs are significantly different i.e. clays). The thickness of the base course should be increased by at least 50mm above the values provided in the table above (to a maximum of 150mm).
- Where soils are known to be expansive (large volume change in wet and dry states), engineering advice should be sought. A solution sometimes adopted is to provide an impermeable liner above the expansive material.
- Greater base course thickness than indicated above may sometimes be required for water storage or hydraulic requirements.
- Specific design is required where soaked CBR is less than 5. However, a solution often used in very soft sub-grades is to provide a 150-200mm layer of GAP40 below the drainage base course with a biaxial geogrid at the interface between subgrade and GAP40. See installation guide for more detail.
 - * Firth Gobi® and Firth Grass Pavers™ are suited to residential parking areas for light vehicles such as campervans, caravans and boats.
- Slopes greater than 12% require specific design.

To determine the on-site sub-grade CBR value use the Scala Penetrometer Test as per NZS 4402:1986

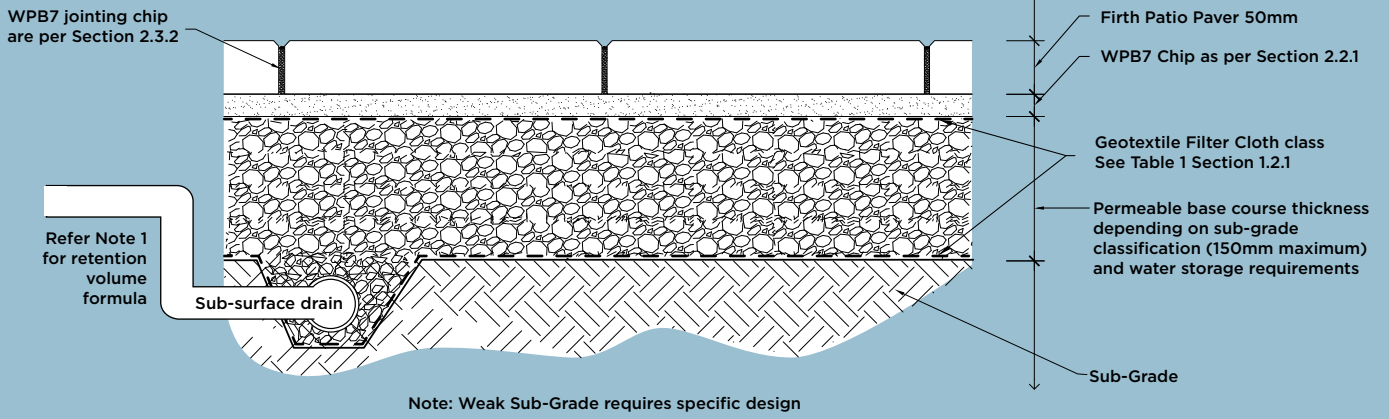
1.2.2 Installation Cross section drawing Firth FlowPave and FlowPave Set 80mm



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m² h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

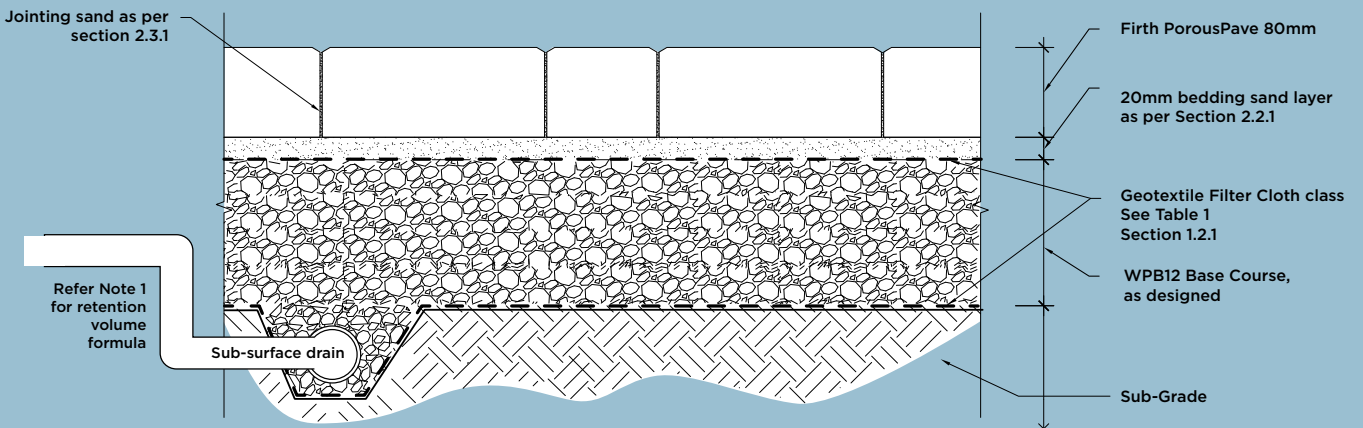
1.2.3 Installation Cross section drawing Firth Patio Paver 50mm



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

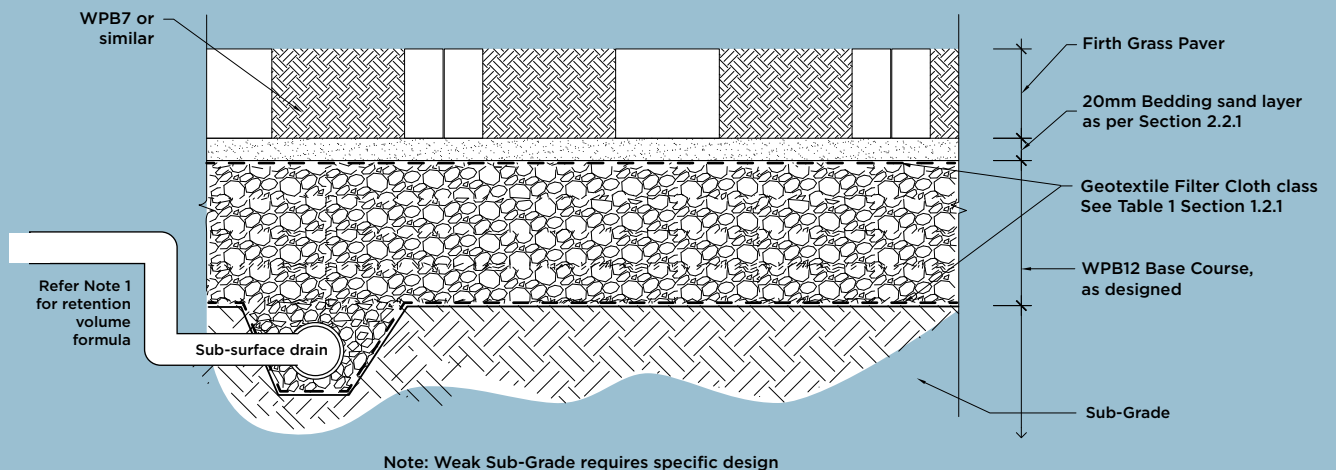
1.2.4 Installation Cross section drawing Firth PorousPave 80mm



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

1.2.5 Installation Cross section drawing Firth Grass Paver 80mm (for occasional parking / light vehicles)

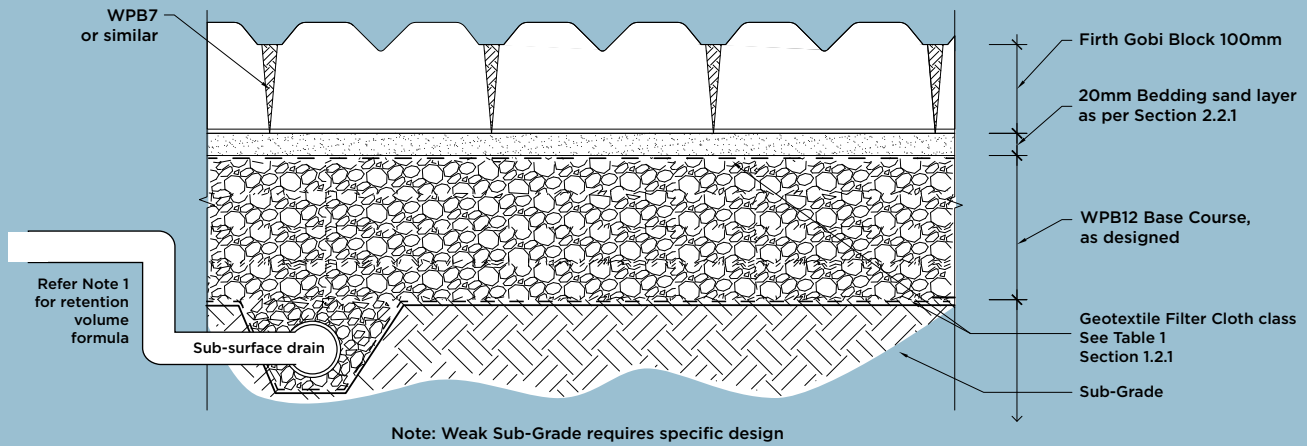


Firth Grass Paver 80mm

Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

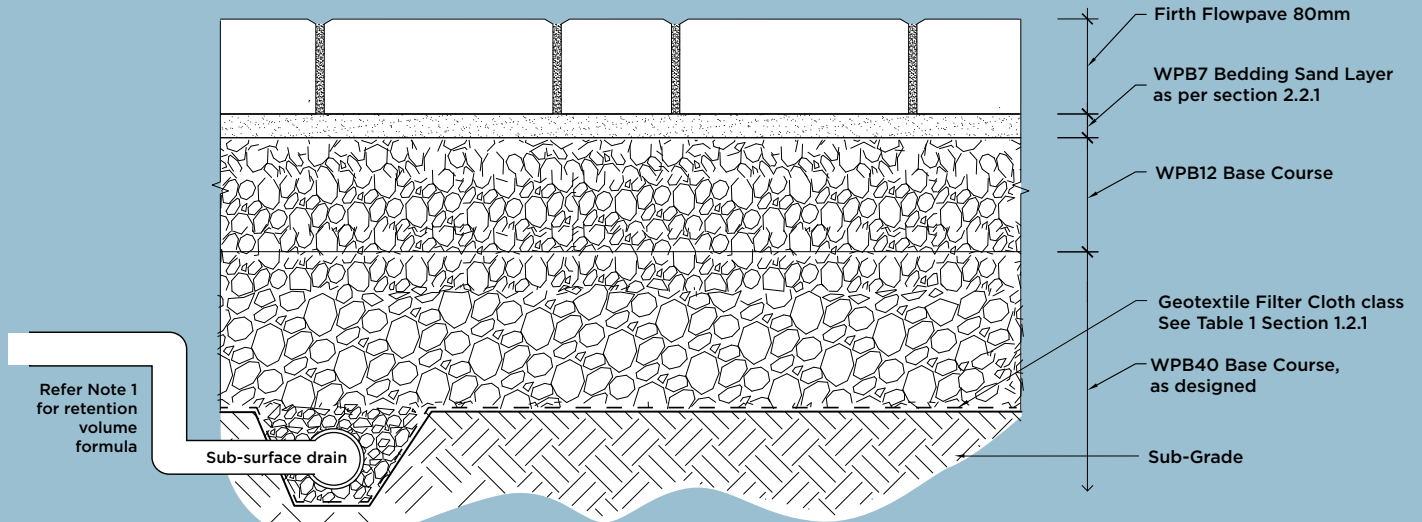
1.2.6 Installation Cross section drawing Firth Gobi® Block 100mm (for occasional parking / light vehicles)



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

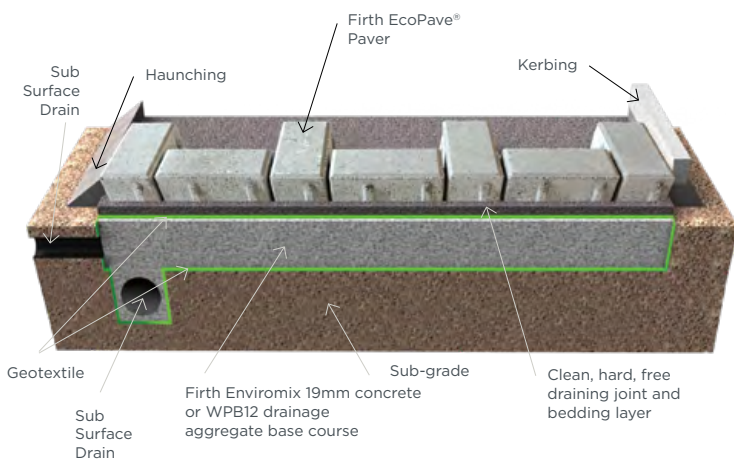
1.2.7 Installation Cross section drawing Firth FlowPave 80mm - Extra Retention System



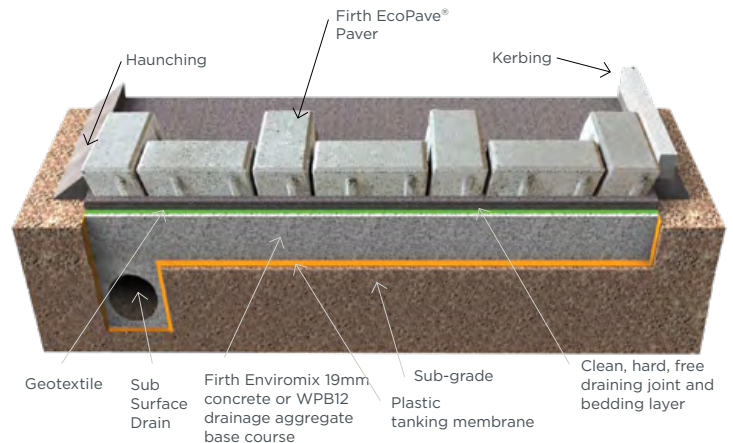
Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course

1.3 Infiltration Sub-Grade Method Detention System



1.4 Storage Tank Base Course Method Retention System



By installing a heavy duty plastic tanking membrane around the sub-base you can create a storage tank of runoff water underneath your permeable pavers. With the installation of a cesspit and a pump, this water can be pumped out and used to flush toilets or water the garden.

2.0 CONSTRUCTION MATERIALS

2.1 Base Course Material [storage media]

The base course material shall be either Firth Enviromix 19mm concrete or Winstones drainage aggregate “WPB12” or “WPB40” as designed.

2.1.1 Firth Enviromix 19mm Concrete 19mm

Firth Enviromix 19mm concrete will store approximately 220lt./m³, or, when laid 100mm thick, it will store approximately 22lt./m².

2.1.2 Winstones Base Course Drainage Aggregate “WPB12” 2-12mm

Table 2 - “WPB12” grading envelope

SIEVE SIZE (MM)	WPB12	
	UPPER LIMIT	LOWER LIMIT
19.0mm	100	100
13.2mm	95	100
9.5mm	75	90
6.7mm	50	75
4.75mm	30	50
2.36mm	0	10

Specific Requirements

- > The material shall produce less than 10% fines under a load of 120kN when tested in accordance with NZS 4407:1991 Test 3.10.
- > The material shall contain no deleterious material such as organic or clay material.
- > The broken face content shall be not less than 70% by weight and have 2 or more broken faces when tested in accordance with NZS 4407:1991 Test 3.14.

WPB12 will store approximately 300litres/m³, or when laid 100mm thick, will store approximately 30litres/m²

Table 2.1 - “WPB40” grading envelope

WPB40	37.5	26.5	19	13.2	9.5	6.7	4.75	2.36	1.180
MAX	100	87	76	66	58	50	44	0	-
MIN	100	84	71	59	50	42	36	0	-

2.2 Bedding Material

The bedding material can either be sand or aggregate chip depending on which type of permeable paver is chosen. See cross-section drawings for specific types of pavers.

2.2.1 Bedding Sand

The bedding sand shall comply with NZS3116:2002 Table 4 Sand category III residential, residential driveways and public footpaths.

Table 4 - Grading limits for bedding sand

BS SIEVE SIZE	PERCENTAGE BY MASS PASSING		
	SAND CATEGORY I	SAND CATEGORY II	SAND CATEGORY III
5.00 mm	90 to 100	89 to 100	89 to 100
2.36 mm	75 to 100	65 to 100	65 to 100
1.18 mm	55 to 90	45 to 100	45 to 100
600 Qm	35 to 65	25 to 80	25 to 80
300 Qm	10 to 45	5 to 48	5 to 48
150 Qm	0 to 10	0 to 15	0 to 15
75 Qm	0 to 1.5	0 to 3	0 to 5 ⁽¹⁾

Note: ⁽¹⁾ For residential pedestrian applications a 0 - 10% range can be used.

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Specific Requirements

- > The material shall contain no deleterious materials such as clay or organic material, nor contain more than 2.5% of light weight particles as determined by NZS 3111:1986.

2.2.2 Bedding Chip

Winstones “WPB7” or alternative shall comply with the following grading and requirements.

Table 3 - WPB7 grading envelope

SIEVE SIZE (MM)	WPB7	
	UPPER LIMIT	LOWER LIMIT
19.0mm		
13.2mm		
9.5mm	100	100
6.7mm	100	90
4.75mm	55	25
2.36mm	3	0

Specific Requirements

- > The material shall produce less than 10% fines under a load of 120kN when tested in accordance with NZS 4407:1991 Test 3.10.
- > The material shall contain no deleterious material such as organic or clay material.
- > The broken face content shall be not less than 70% by weight and have 2 or more broken faces when tested in accordance with NZS 4407:1991 Test 3.14.

2.3 Jointing Material

The jointing material can either be a sand or an aggregate chip depending on which type of permeable paver is chosen.

2.3.1 Jointing Sand

The joint sand shall conform to NZS 3116:2002 Table 5 Other.

Table 5 - Grading limits for joint sand

SIEVE SIZE	ROADS & INDUSTRIAL PAVEMENTS PER CENT PASSING	OTHER PER CENT PASSING
2.36 mm	100	100
1.18 mm	75-90	75-100
600 Qm	55-80	55-100
300 Qm	20-40	15-60
150 Qm	5-15	3-30
75 Qm	0-5	0-5

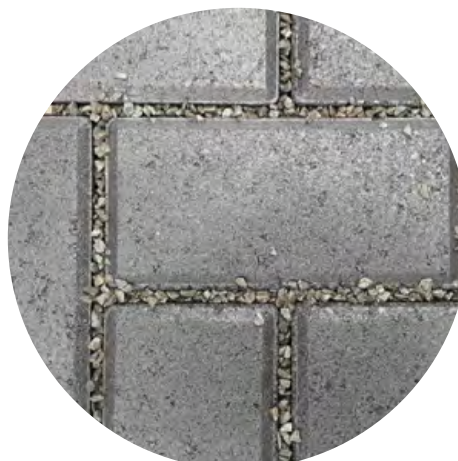
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Specific Requirements

- > The material shall contain no deleterious materials such as clay or organic material, nor contain more than 2.5% of light-weight particles as determined by NZS 3111:1986.

2.3.2 Jointing Chip “WPB7” 2-7mm drainage chip

This jointing chip is the same aggregate as the bedding chip in Section 2.2.2, Table 3. The Firth FlowPave 80mm uses this jointing chip.



2.4 Table 4 – Characteristics Table of Greywacke WPB7 and WPB12

PROPERTY		STANDARD	TEST METHOD	RESULT
SOURCE	Solid Density	NS4407:1991	Test 3.7.2	2.72t/m ³
	Abrasion Resistance (Los Angeles Test)	NS4407:1991	Test 3.12	-11%
	Weathering Quality	NZS3111:1986	Test 15	AA
	Crushing Resistance	NZS3111:1986	Test 14	450≥
PRODUCTION	Permeability	Volume 2, Section 10.6 “Method of soil laboratory testing” by K.H. Head		k = 7.0 ⁻³ m/s
	Broken Face Content	NZS4407:1991	Test 3.14	100%
	Cleaness Value	NZS3111:1986	Test 13	70≥
OTHER	Maximum Dry Density	NZS4402:1986	Test 4.2.2	WPB12-1.65 t/m ³
				WPB7-1.60 t/m ³
	Minimum Dry Density	NZS4402:1986	Test 4.1.1	WPB12-1.45 t/m ³
				WPB7-1.45 t/m ³
Total Voids % (From Maximum Dry Density Data)				>40%

2.5 Firth EcoPave® Permeable Pavers

Permeable pavers shall comply with NZS3116:2002 Table 1 for breaking loads, dimensional tolerance, abrasion and slip resistance.

2.6 Base course Thickness and Geotextile Filter Cloth Classification

See Table 1 in sect 1.2.1. Sub-grades weaker than a CBR of 5 will require specific design.

2.7 Geotextile Filter cloth

Non woven Polypropylene Geotextile fabric type set out as in Table 1 in sect 1.2.1.

2.8 Geogrid (Subgrade reinforcement)

For pavement construction using geogrids over very soft subgrade (CBR below 5) it is recommended not to use vibrating compaction equipment. This is to reduce the possibility of “livening” of the soft subgrade and pumping of soil particles up into the basecourse before sufficient interlock has been achieved with geogrid.

If the subgrade is livened as a result of over-compaction and (or) excessive water, roading construction should be put on hold to allow constructed work to set up before proceeding with subsequent layers.

The first layer thickness should be 150 to 200mm thick. Truck loads of sub-base shall be tipped into stockpiles on the sub grade and not tipped directly on geogrids. The sub-base stockpiles should be spread by mechanical plant such as loader with an opening bucket or excavator bucket. The first layer should be carefully static rolled with a small number of passes using a light roller to create a grid/aggregate interlock. If pavement was designed for multi layers of geogrids, all additional layers should be also carefully static rolled a small number of passes.

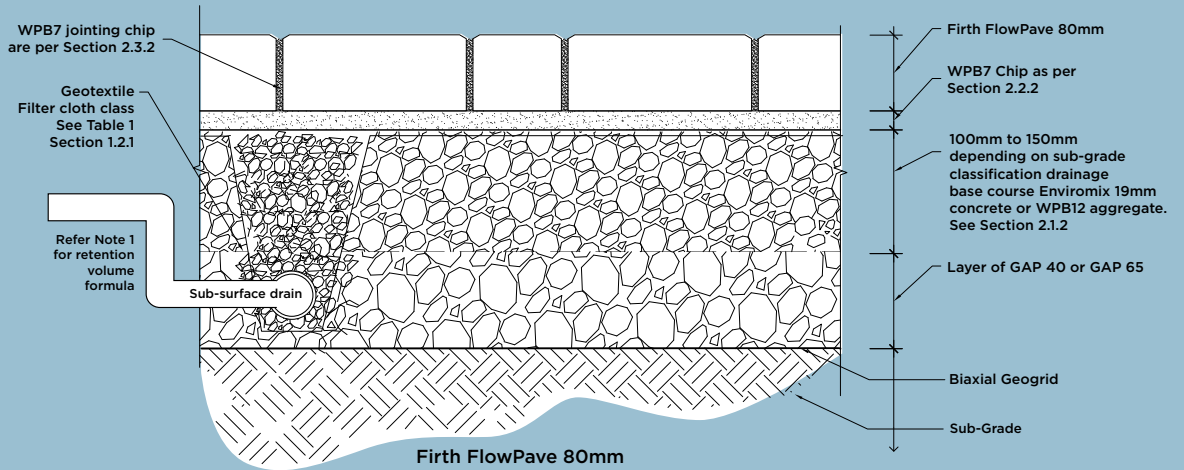
If construction is taking place in wet conditions and pumping is likely, a layer of geotextile should be placed beneath layer of geogrid.

Considering the fact that tri-axial geogrids have triangular apertures they may be placed on the subgrade either parallel to the road centre line or in the transverse direction. The width of overlap between adjacent rolls is dependent upon grading and thick ness of sub-base and the stiffness of the subgrade. The minimum overlap shall be 300mm and maximum shall be 600mm or as specified by the engineer. Overlaps must be maintained during the filling operation. This is generally achieved by placing small heaps of fill locally over the overlaps ahead of the main filling operation. No traffic or site plant shall be permitted to travel on the geogrids prior to placing sub-base aggregate.

Compaction of unbound materials for sub-base and road bases shall normally be carried out in accordance with specifications for sub-base aggregate. Compaction of other fills shall be carried out in accordance with specifications for earthworks construction.

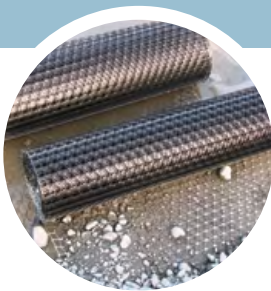
3.1 Installation Cross Section Drawing for weak subgrade Firth FlowPave 80mm

Standard roading drainage practices should be followed, particularly maintaining the ground water level a minimum of 600mm below the sub-grade level.



Note 1: retention volume formula = $a \times h \times 0.3$

a = area of paving m^2 h = height between bottom of overflow outlet and base of form base course 0.3 = porosity of perm base course



With soft sub-grades an extra layer of GAP40 or GAP65 150mm-200mm needs to be laid on top of a suitable geogrid to provide a structural platform for the permeable base course to assist with the load capabilities.

3.0 PLANNING AND PREPARATION

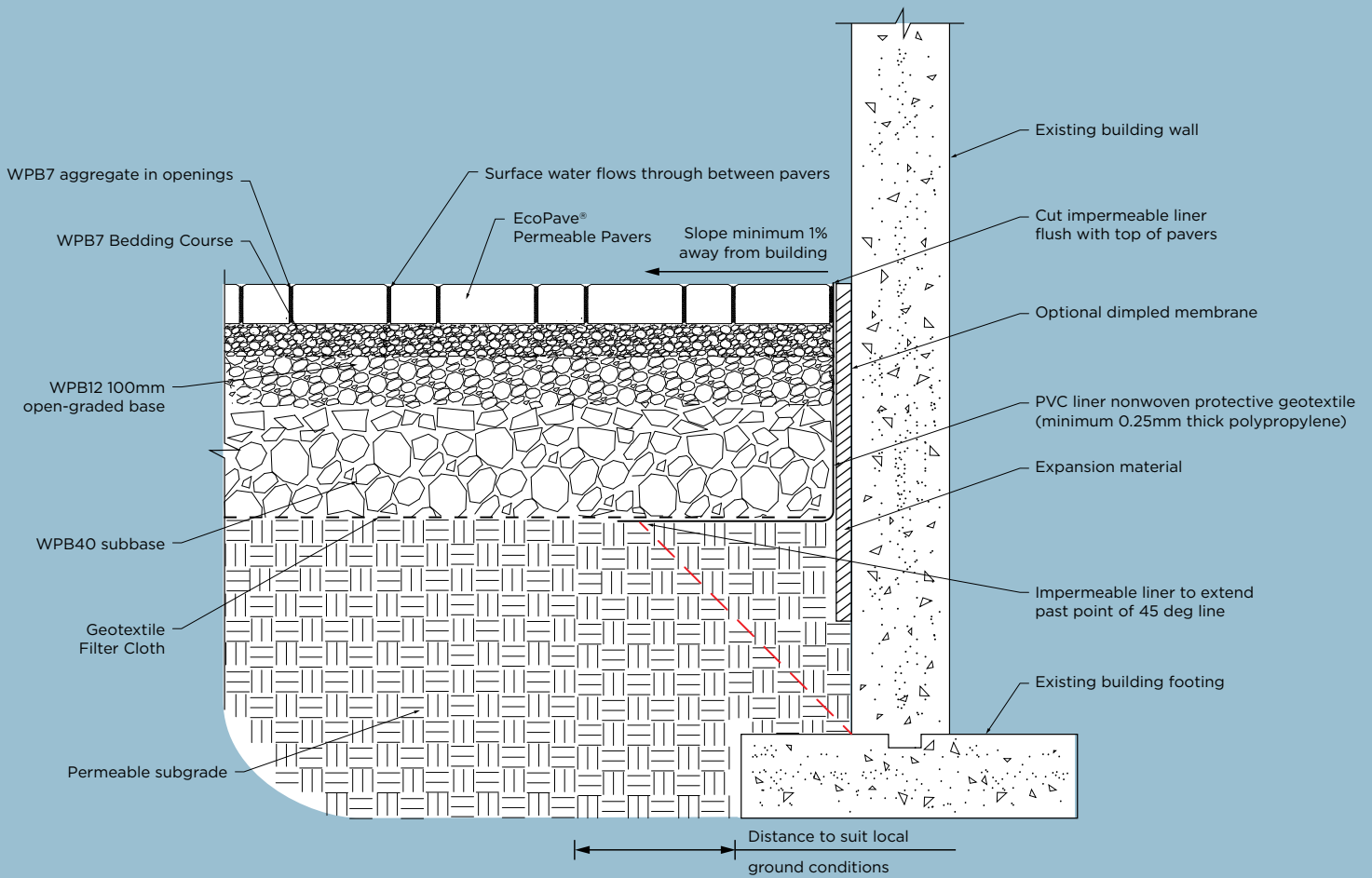
Before commencing installation, assess the nature of the project. In particular, consider how the paving will be laid in conventional terms, and how the Firth EcoPave® Range System will manage rain, stormwater & runoff. On large surfaces it may be necessary to get the system hydrologically engineered to ensure the pavement can manage the required runoff capacity from a water management point of view. Ensure that each of the following is understood & completed prior to the actual start of the job.

- 3.1 Locate and mark the area to be paved.
- 3.2 Verify the location, type and elevations of edging around the perimeter.
- 3.3 Excavate ensuring that the sub-base foundation is appropriate for the amount of traffic it will be subjected to. The required excavation depth for either the Detention or Infiltration system will need to be calculated based on a combination of Table 1 and the amount of water the system is expected to store (refer to section 2, for the storage capacity of the chosen base material i.e. Winstone's drainage aggregate or Firth's Enviromix 19mm concrete). Ensure the sub-grade (soil) is compacted to the specified density and moisture content.

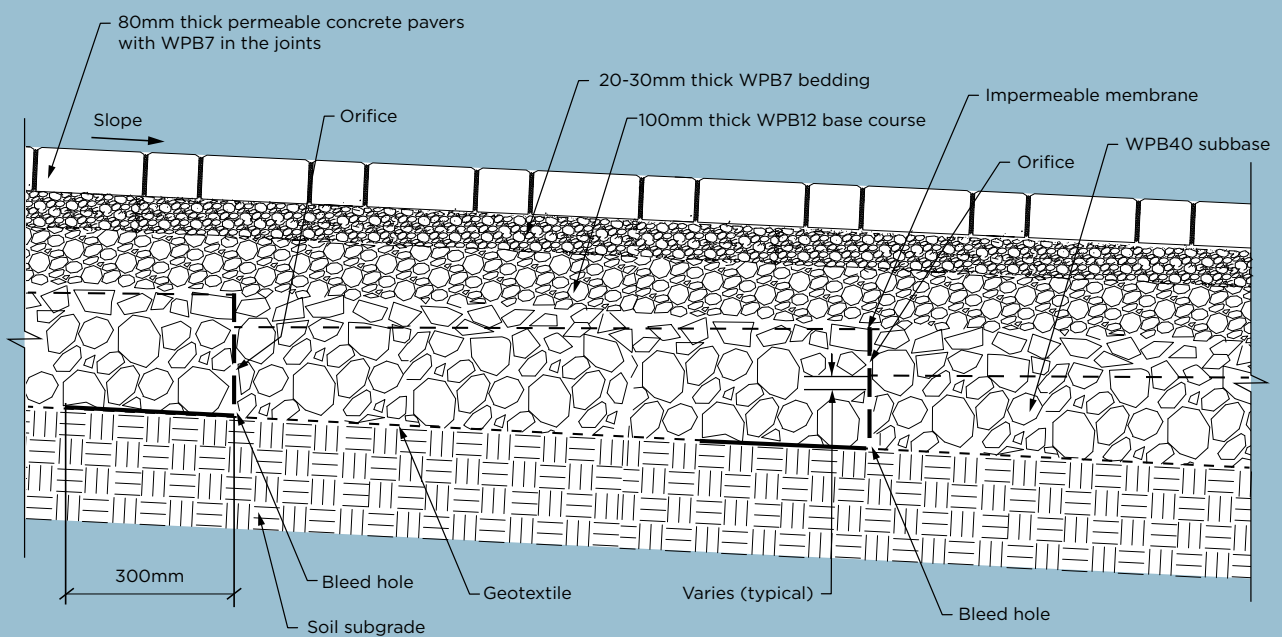
Note: Compaction of the soil sub-grade should be to a minimum of 5% CBR for pedestrian areas and residential driveways, and a minimum of 10% CBR for vehicular areas. Stabilisation of the soil and/or base material may be necessary with weak or saturated soils, or when subject to high wheel loads. Compaction will reduce the permeability of soils. These conditions may require the use of drains in open graded bases). On site sub-grade CBR can be determined by Scala Penetrometer Test as per NZS 4402:1986.
- 3.4 Once excavation is complete, ensure that the sub-grade is free from standing water, uniform and even. There should be no organic material or debris on the site prior to the start of the job.
- 3.5 Where necessary, it is acceptable to apply bedding sand immediately on top of the sub-grade [prior to applying the geotextile] in order to even out any undulations/holes on the surface of the sub-grade.
- 3.6 The site is now ready for installation.

Note: A sloping site will have less storage capacity than a level site as water will resurface at the lowest point. This can be overcome by encouraging cross flow (through the installation of weirs) or concentrating storage capacity at the lowest point of the design. Alternatively, a drainage coil can be incorporated into the design allowing water to disperse to another drainage system.

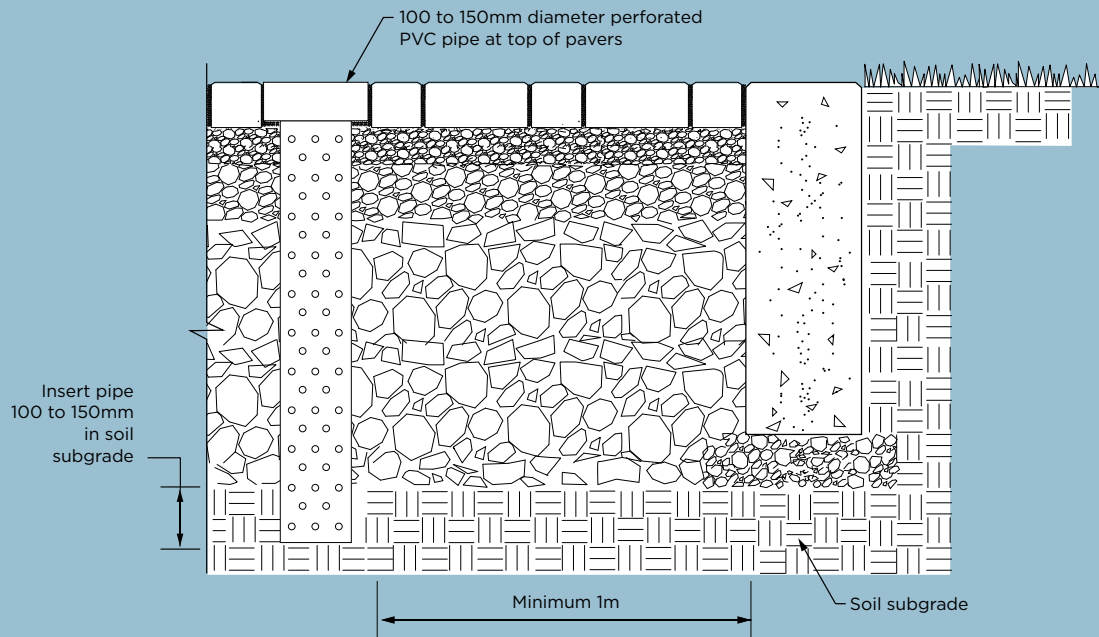
3.7 EXAMPLE FOUNDATION WALL PROTECTION FROM WATER INFILTRATION



3.8 EXAMPLE OF WATER FLOW BARRIERS / CHECK DAMS WITH GEOMEMBRANE



3.9 OBSERVATION WELL IN PERMEABLE PAVEMENT AT THE LOWEST SUBGRADE ELEVATION



4.0 INSTALLATION

- 4.1** Lay the geotextile on the bottom of the excavation, ensure that there is sufficient geotextile available to go up each side of the excavation and approximately 30cm onto the top of the sub base. Note: The geotextile must encapsulate the storage medium on all sides.
- 4.2** Carefully install the base course (ie. Winstones WPB12 drainage aggregate or Firth Enviromix 19mm concrete) on top of the geotextile. Install enough aggregate/concrete to ensure the pavers will sit at the correct height once they have been installed on the bedding layer. Vibrating plate compactors must be used to consolidate the aggregate. Static or vibrating rollers are not effective.
- 4.3** The elevation of the compacted surface should not deviate more than 38mm over a 3m straightedge.
- 4.4** Lay geotextile filter fabric over the top of the base course and lap with fabric coming up the sides to completely encapsulate the base course material with an overlap of 200mm.
- 4.5** Install bedding sand or WPB7 chip and pavers, ensuring haunching or kerbing is adequate to retain the bedding sand and pavers. The pavement should be protected from contamination from surrounding construction and avoid getting clay and dirt into the system. Dirty run off into the permeable pavement will clog it and render it inoperable.
- 4.6** All pavers shall be installed as per NZS 3116:2002. However, upon completing the laying of pavers, follow this procedure:
1. Compact paving (as per NZS 3116:2002). Spread jointing material (sand or WPB7) into joints and sweep all excess material off the surface. DO NOT compact the Firth PorousPave® pavers with sand on the surface (the sand will break down and partially fill the voids and reduce the permeability of the paving system). Compact paving for a second time.
 2. A final top up of jointing sand can be achieved by washing sand into the joints of Firth PorousPaver® pavers.
- 4.7** Any contamination of the paving should be removed using low pressure water blasting followed by resanding of the joints.
- 4.8** All pavers to within 1m of the laying face must be left fully compacted at the completion of each day.
- 4.9** The final surface elevations shall not deviate more than 38mm under a 3m long straightedge.
- 4.10** The surface elevation of pavers shall be a minimum of 5mm above adjacent drainage inlets, concrete collars or channels.
- 4.11** Prior to first use, ensure that any residual sand/chip is swept/washed off of the surface.

5.0 FIRTH ECOPAVE RANGE MAINTENANCE PLAN

5.1 For small “In Lot” installations (such as driveways)

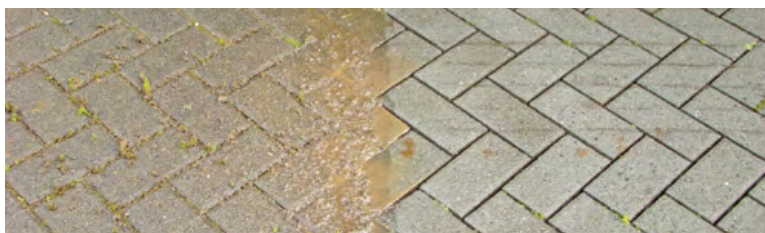
1. End of first year and every ten years – top up joint chip or sand between pavers.
2. Organic sediment (leaves, pine needles etc). In locations where the leaves drop on the pavement, regular cleaning/blowing of leaves to stop organic sediment decomposing on the surface and joints. This is the most important activity in maintaining your permeable pavement.
3. Every year – general cleaning/weed/moss control with a Rotary head cleaner or hosing.
4. Assume no corrective maintenance to uplift and dispose of bedding sand and geotextile due to low contamination levels.

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5.2 For Larger installations (such as parking lots of +- 1000m²)

1. End of first year and every five years alternating with 10 year corrective maintenance – top up joint chip or sand between pavers.
2. Every year – general inspection.
3. Every year – general cleaning/weed/moss control. (Rotary head cleaning system).
4. Every ten years – check the permeability of the system. (Firth offer a free service for testing) If the water stands for 1hr or has a permeability rate of less than 250mm/hr proceed with the corrective maintenance which involves the extraction of joint chip or sand and replacement using Hydrovac cleaning system.



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6.0 INSTALLATION SURROUNDING/COVERING TREE ROOT ZONES

The Firth EcoPave® Range is, in some circumstances, suitable for installation immediately adjacent to trees and tree root zones.

Permeable paving installed properly will contribute significantly to the long-term sustainability of the tree. Any installation that will cover a tree root zone should be designed in conjunction with an engineer.

Please note the following specific requirements:

1. The tree root zone should not be excavated [ie. the roots should be preserved]. Note: this pertains only to installations surrounding trees and designed to specifically preserve the tree root zone.
2. Providing the following conditions can be met:
 - < The topsoil is not prone to settling/subsiding and
 - < The maximum weight of vehicles is limited [ie. residential light traffic/single unit residential driveways].

Then in some circumstances it is acceptable to install the Firth EcoPave® Range on top of the existing top soil. However it is recommended that the advice of an engineer be sought.

Whenever installing any of the Firth EcoPave® Range pavers on/around tree roots use WPB7 instead of Firth EnviroMix 19mm. This will be beneficial in that it will:

- < Provide a more flexible surface.
- < Maintain permeability from the surface to the tree root zone.
- < Reduce the need for compaction [which affects permeability].
- < Reduce the need for excavation of the root zone.

7.0 MORE INFORMATION

For more information on the Firth EcoPave® Range, including the name and location of product suppliers and permeable paving installation contractors, or to obtain free training please contact the Firth Team on **0800 800 576**.



8.0 FREQUENTLY ASKED QUESTIONS

What's the difference between the Firth FlowPave 80mm paver and the Firth PorousPave® 80mm paver?

The Firth FlowPave paver is a solid unit with enlarged spacer nibs (7mm) which widen the joints between the pavers to allow the runoff water to permeate through the joints. The Firth PorousPave® paver is like a no-fines concrete made with an aggregate chip which allows runoff water to permeate through the actual paver itself.

What's the difference between the installation of the Firth FlowPave 80mm and the Firth PorousPave® 80mm?

The Firth FlowPave paver uses a chip for both the bedding and jointing material. The Firth PorousPave® paver uses sand for both the bedding and jointing material. Both pavers have either a suitable drainage aggregate or Firth Enviromix 19mm concrete sub-base.

How does the drainage aggregate in the base course clean the run off water?

Through a process called Cation Exchange Capacity (CEC). This is the tendency of media to attract/hold onto positively charged ions (cations). In terms of water quality treatment from stormwater runoff, a high CEC would indicate a good potential to absorb heavy metals or nutrients that might be carried in runoff.

What kind of aggregates can I use for the base course?

Specifically designed drainage aggregates that are structurally sound when fully saturated/submerged with water. Normal GAP types of aggregate are not suitable and will lead to pavement failure.

How long does it take before the system clogs up?

It's difficult to be specific due to every location being different and dependant if it's located in the right position and how much sediment there is in the runoff. The location of where the permeable pavement is installed plays an important role with the sediment loading and hence life span of the system. Areas that will be subject to organic loading (leaves from trees) should be carefully considered together with a sweeping (without vacuum) regime. Other locations which will have a high clay content in the runoff should be avoided.

In 2016, a study was undertaken in the Auckland region to test the long term permeability performance of installed pavements and the effectiveness of surface cleaning. The method used for the surface cleaning was a wash and vacuum using the Hydrovac EcoPave Cleaning system, which works through the application of small water jets to dislodge the sediments followed by a vacuum suction, the tested areas recorded post clean permeability rates up to or greater than the as built minimum of 1,200mm/hour.

Permeable pavements have a very high permeability and are approximately tenfold the requirement to allow for sediment loading to achieve longevity. Research has shown that with some sediment loading and NO cleaning the Firth FlowPave system will last many years (See "Development and Assessment of a Permeable Paving System for Stormwater Quality Management" by Navin Weeraratne, degree of Master of Engineering in Environmental Engineering, The University of Auckland August 2004).

How can I test the permeability of my pavement system?

One of the test methods is ASTM C1701/C 1701M -09 "Standard Test Method for Infiltration Rate of In Place Pervious Concrete" is simple and easy to conduct in on-site locations.

9.0 REFERENCES

firth.co.nz/residential/ecopave/flowpave

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Smith, David R. Permeable Interlocking Concrete Pavements, 2nd Edition. Interlocking Concrete Pavement Institute (ICPI). 2001.

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Further information

"Permeable pavement performance for use in active roadways in Auckland, New Zealand" by Elizabeth A. Fassman, PhD and Samuel David Blackburn, ME Auckland University.

EPA United States Environmental Protection Agency "Surface Infiltration Rates of Permeable Surface" six month update (Nov 2009 through April 2010).

"Field Monitoring and Software Development for Permeable Paving Stormwater Solution" Sam Blackburn, Masters degree, Dept of Civil and Environmental Engineering, University Of Auckland 2006/07.

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"Optimisation of the particulate and dissolved matter retention capacity of permeable concrete block paving with infiltration pores by using different material in the infiltration pores" Diploma Thesis by P Meyer University of Essen.

"Field Survey of Permeable Pavement Surface Infiltration Rates" by Eban Z Bean, William F Hunt and David A. Bidelspach Journal of Irrigation and Drainage Engineering ASCE.

"A Guide To Permeable Interlocking Concrete Pavements" MA56 November 2010, Concrete Masonry Association of Australia.



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