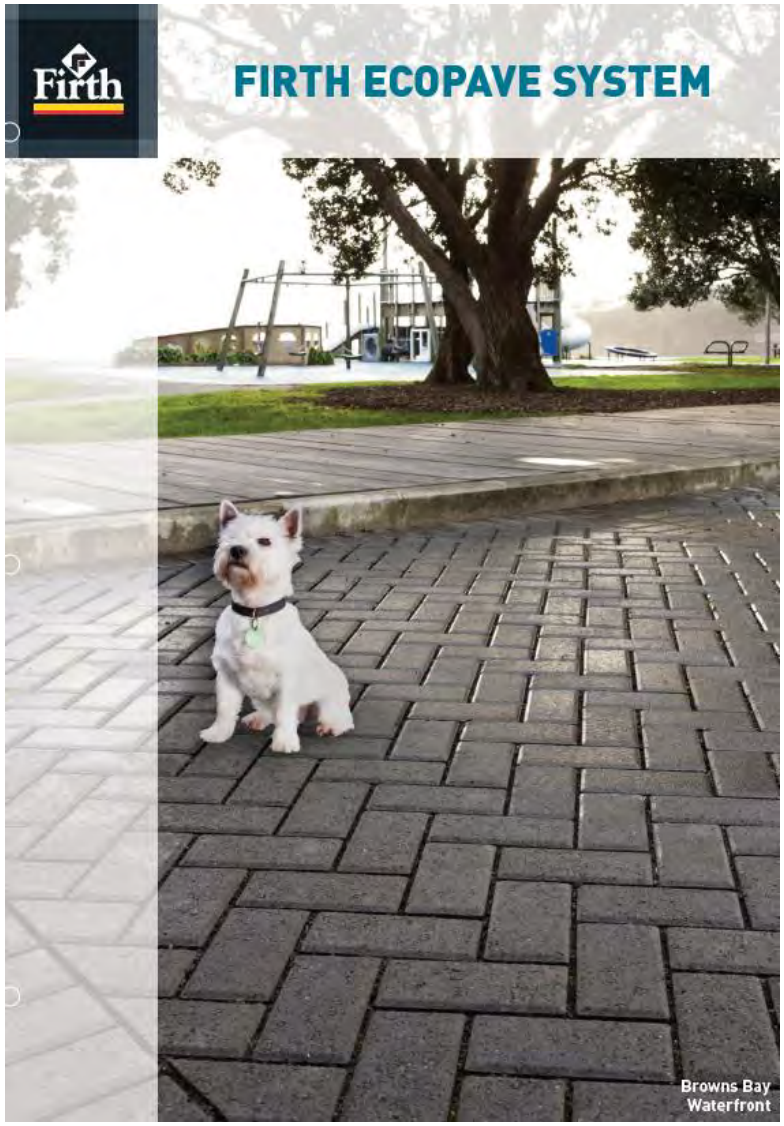
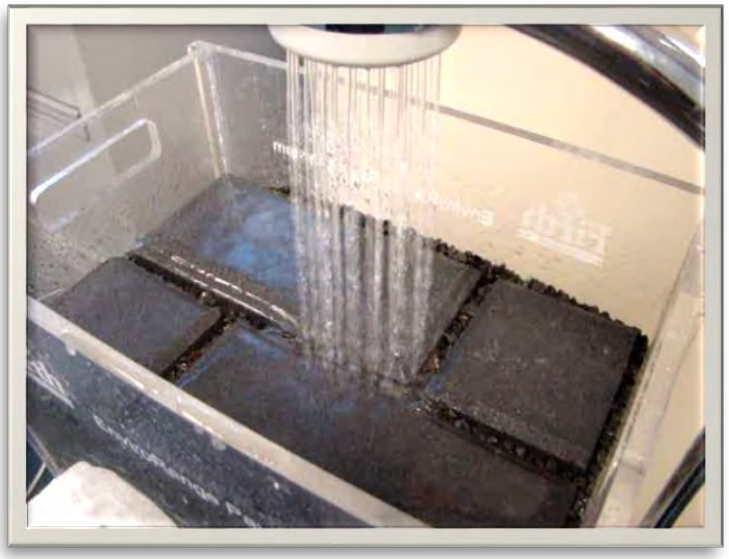
Permeable Paving



Firths Permeable Paving Systems

By
Stuart Girvan

November 2015



Permeable Paving

Firth EcoPave Range

- FlowPave 80mm]
  - H80 enlarged nib

- PorousPave® 80mm
  - Similar to No – Fines concrete

- GobiBlock®

- GrassPaver™

Brand Structure

Firth Products

EnviroRange

EcoPave

Permeable Paving

Advantages of the Firth EcoPave System

- **Reduce rainfall runoff** from hard surfaces, decreasing the demand on drainage systems.
- **Recharge natural ground** aquifers when using the infiltration system.
- Improved hydrological management of **storm water peak** flow by holding and releasing in a controlled manner. This process can also assist in **reducing the temperature** of the run off water before it reaches the rivers
- **May filter runoff water** by removing heavy metals such as Zinc and Copper through cationic exchange when using greywacke bas course aggregates.
- Reduce the need for **retention structures** (e.g. ground sumps, ponds or dams) and maximise land use by retaining water within the system.

Installation Guide

Installation Guide

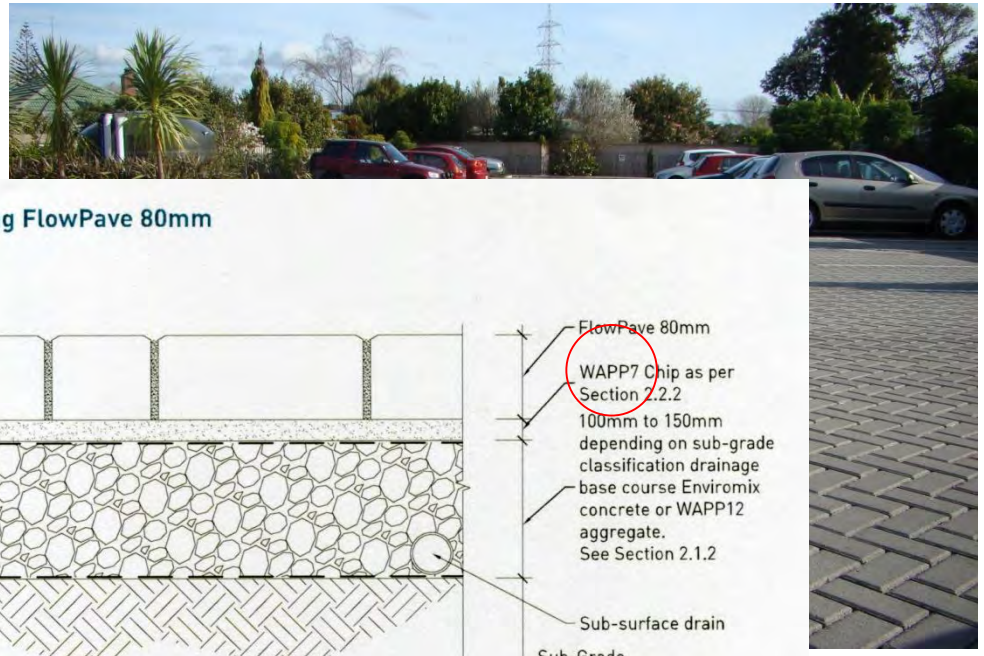
Introduction

Firths system at this stage is a single base course system for the residential market for:
Driveways
Walkway / patio
Light vehicular parking

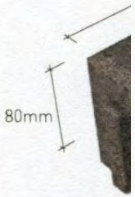
This guide is for the installation of the Firth EcoPave System, a permeable, concrete paving system and should be read in conjunction with the Firth EcoPave Brochure. This guide should be used in consultation with an engineer, architect or landscape architect in order to ensure compliance with council requirements and project conditions. Pavements should be designed in consultation with a qualified civil engineer and within the guidelines of NZS 3116:2002, Normal GAP (Graded All Passing) types of aggregate are not suitable as base course material and will lead to pavement failure if used.

Installation Guide

Permeable Surfaces Available



Firth FlowPave
Number per m²: 5(
Manufactured in 8(



1.2.4 Installation Cross section drawing FlowPave 80mm

Note: Weak Sub-Grade requires specific design

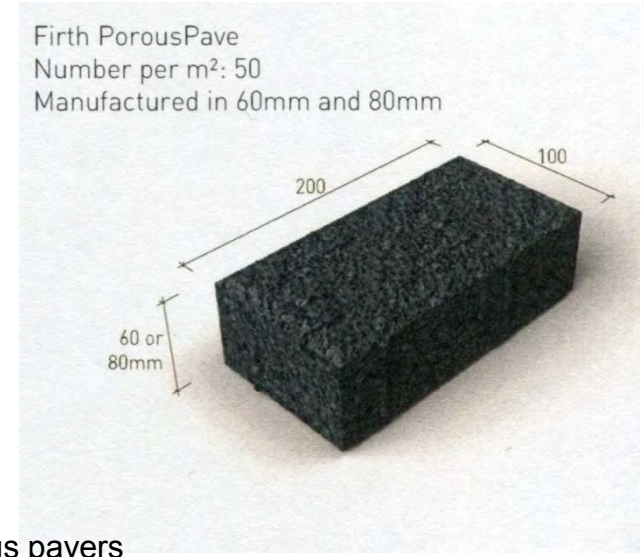
Solid pavers wit
Application: Ca
driveways, roads in town house developments

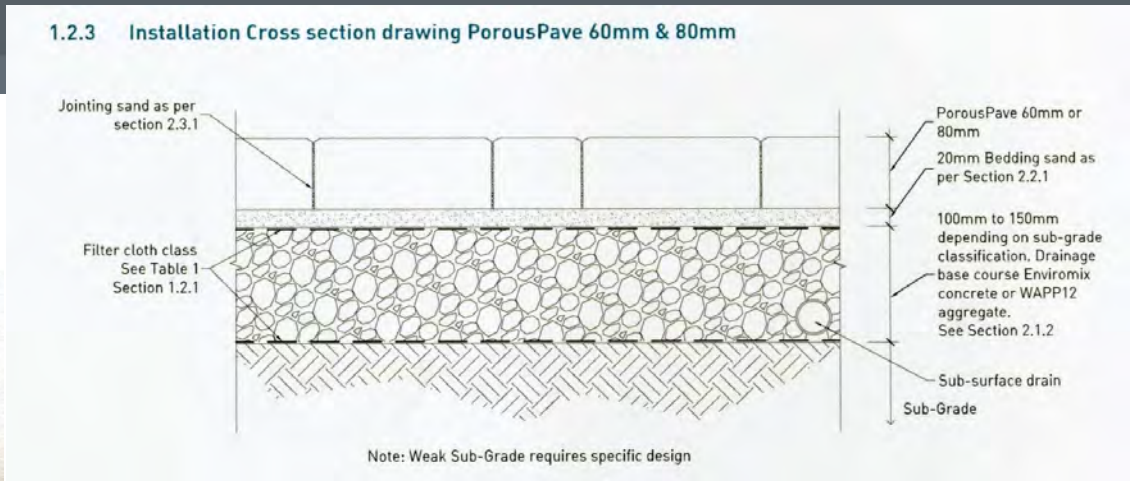
Laid on drainage chip with the same in the joints

Paver Compliance: NZS3116:2002
Table 1, application 4, Roads

Installation Guide

Permeable Surfaces Available



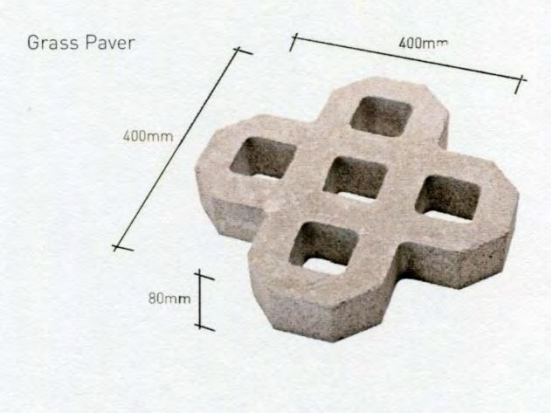


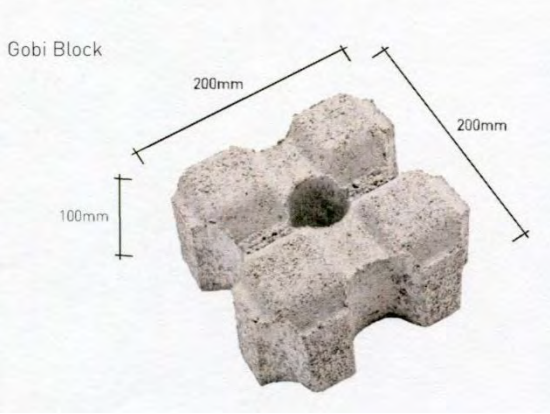
Porous pavers
(similar to a no fines Concrete)
Laid with bedding sand and joint sand

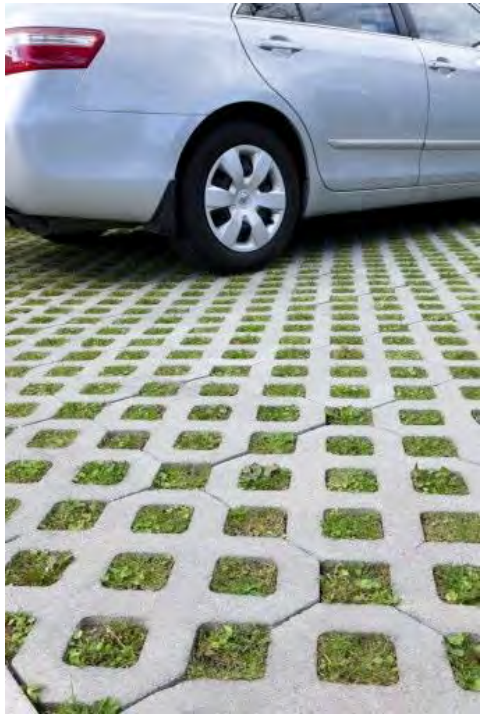
Application: Car parks, Driveways, roads in town house developments
Paver Compliance: NZS3116:2002
Table 1, application 4, Roads

Installation Guide

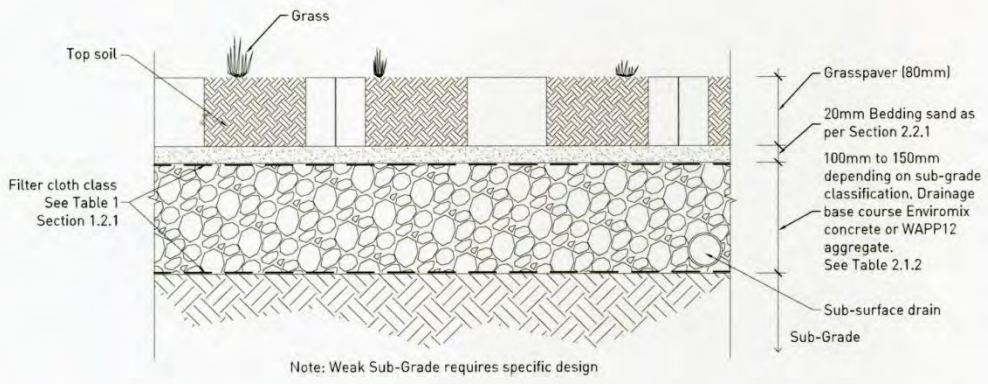
Permeable Surfaces Available







1.2.5 Installation Cross section drawing Grass Paver



Permeable Sub Base

Materials below the Permeable Surface

Permeable Sub Bases

Types of permeable Base Course:

1. No fines concrete.
2. Suitable drainage aggregate that will perform under loading when fully saturated. WAPP12

NB Permeable pavers need to be laid on a suitable permeable base course, not normal GAP type aggregate as the pavement will fail soon as the water gets into it. NB

Permeable Sub-Base

No – Fines Concrete

1. No fines Concrete Sub Base

Wrapping the no fines concrete sub-base with filter cloth will stop the migration of bedding and jointing sand into the no fines concrete. This also reduces sediment loading of the no fines concrete sub base from the surrounding sub-grade.

The water needs to be managed once it reaches the sub base. Can it permeate into the sub grade or is there a requirement for sub surface drainage to remove the water through a filter to clean the water further and then deposit it back into the storm water system?

Permeable Sub-Base

2. Drainage Aggregate Sub Base
   - If using more than one layer of sub base ensure that the overlying aggregate does not migrate into the one below as this will cause subsidence.
   - If possible get the supplier to wash the aggregate to remove most of the dust and dirt before delivery

Installation

Permeable aggregates behave differently when compacted:

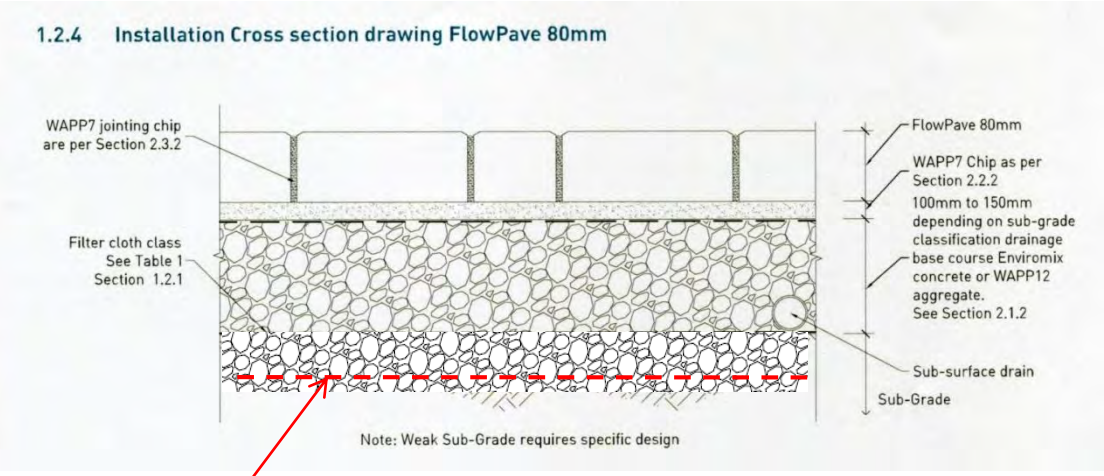
My experience is that mechanical rollers with and without vibration don’t work.

Installation

Plate compactors do work but too many passes and the top layer of the aggregate vibrates loose.

Installation

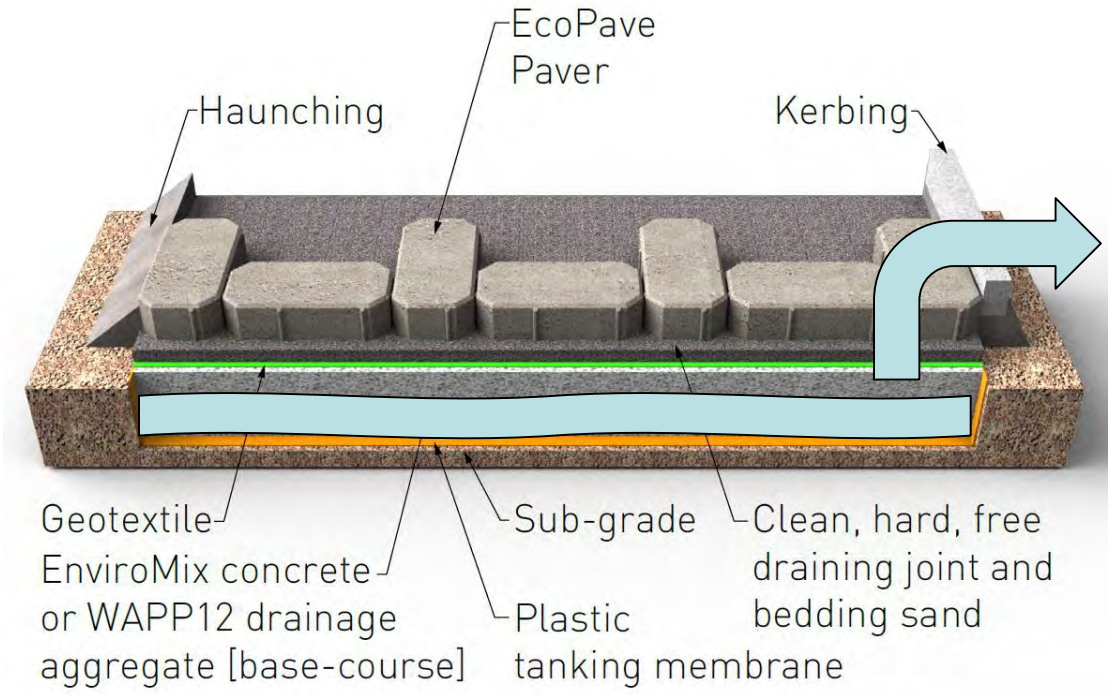
With soft sub grades an extra layer of GAP40 or GAP65 150mm-200mm needs to be laid on top off a suitable geogrid to provide a structural platform for the permeable base course to assist with the load capabilities



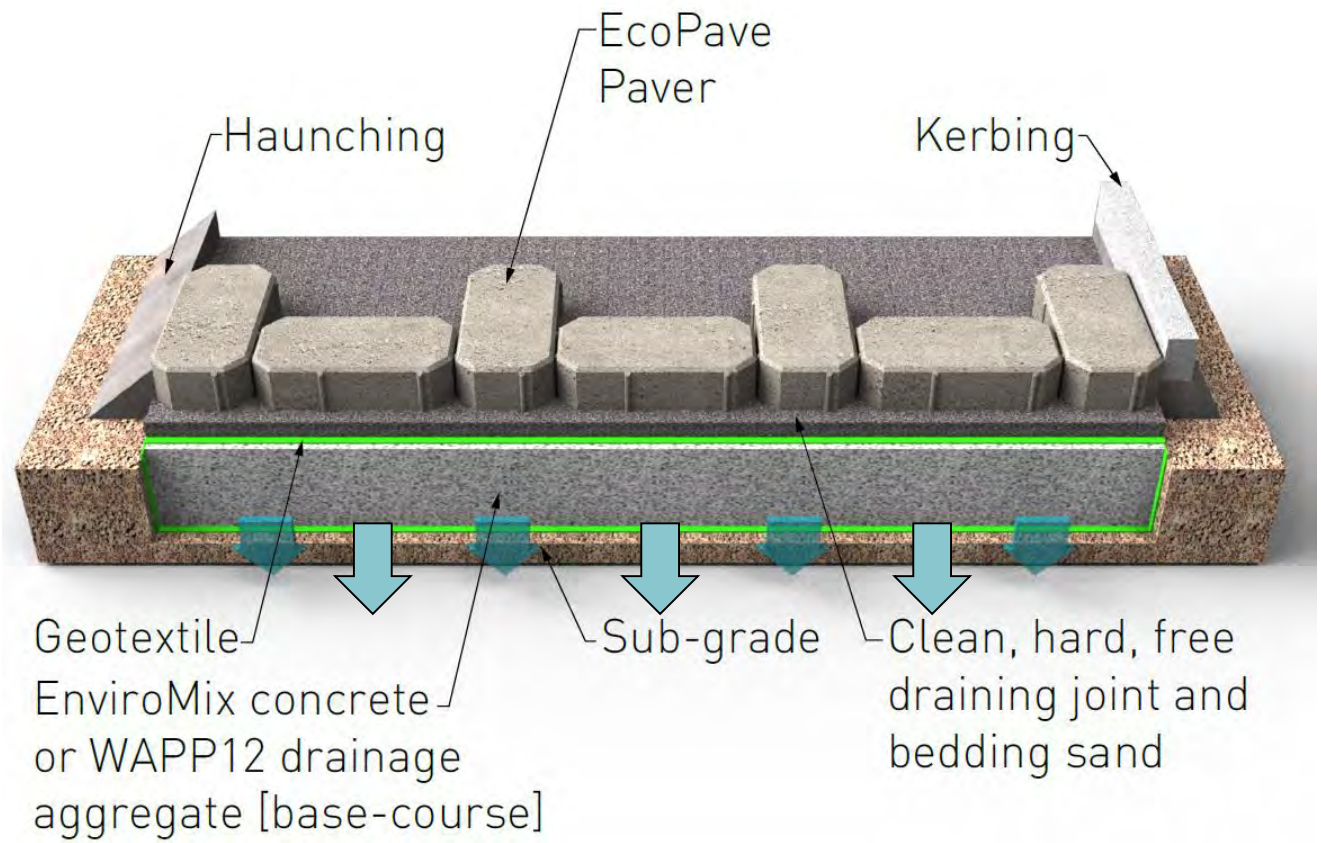
Biaxial Geogrid

Installation

- The sub base can be lined with heavy duty DPC and be used as a storage tank with the water pumped out to water the garden or flush toilets in residential applications.



Installation



Run off water can recharge the ground water into permeable sub grades like the pumice in Taupo or the beach sand at Browns Bay waterfront

Installation

Always lay paving up the slope. Maximum slope 4-5 degrees.
Pattern 45 degree herringbone in the direction of traffic

Installer Training

Firth provide installation training for landscapers and paving contractors, free of charge.

Installation

Timing

Plan the installation of the pavement till after any heavy earthmoving operations to avoid tracking mud into the system or take measures to protect it.

Installation

Location of the pavement depends on how much cleaning will be required and has to be carefully considered.

Testing

Infiltration tests

Infiltration test ASTM Modified Double Ring Infiltration Apparatus

Infiltration rate Porous Paver 80mm
+- 1200mm/hr

Infiltration test ASTM C 1701/C 1701M -09
Standard Test method for Infiltration Rate of Pervious Concrete

Infiltration rate 10mm Pervious Concrete
+- 7 000mm/hr

Projects

Te Atatu Medical Centre Flowpave 80mm on double layer of base course

Projects

Browns Bay Waterfront Parking Flowpave 80mm on double layer of base course

Projects

Placemakers Albany Porous Paver 80mm on double layer of base course

Projects

Drury Church Flowpave 80mm on WAPP12 base course

Pervious Concrete Trials

A Pervious Concrete Committee has been formed Involving the Concrete Placers Association, some concrete suppliers and CCANZ to promote pervious concrete in New Zealand.

Pervious Concrete Trials

Initial lab trials were done, then sample panels and then with the help from NSCC a trail footpath has been installed in Albany

Lab trials

Sample panels

Trial footpath

Pervious Concrete Trials

Have relied heavily on the ASTM standards and all the pervious concrete that's been laid in the USA.

Specifically: ACI 552R-10 Report on Pervious Concrete

Pervious Concrete Trials

Footpath Trial in Albany

Cleaning Permeable Surfaces

Cleaning Permeable Surfaces

- Infiltration rates of permeable paving decreases with time
- Regular cleaning prolongs life of infiltration rates
- Sweeping of pavers bi annually for smaller drive patio areas
- Use of regen sweep trucks on larger areas
- If infiltration rates badly compromised a wash and vacuum can be undertaken , involves removal and replacement of existing jointing material

Cleaning Permeable Surfaces

Cleaning Permeable Surfaces

Cleaning Permeable Surfaces

Cleaning Permeable Surfaces

Cleaning Permeable Surfaces

Cost and Benefit Assessment

DB Kettle Consulting Ltd

Cost and Benefit Assessment

2.8.4 Parking Areas

Rain gardens and/or porous parking are effective ways of managing parking areas to meet the SMAF1 and SMAF2 hydrology controls. Figure 2-8 shows how rain gardens and porous paving can be incorporated into a typical 2,000m^2 parking area.

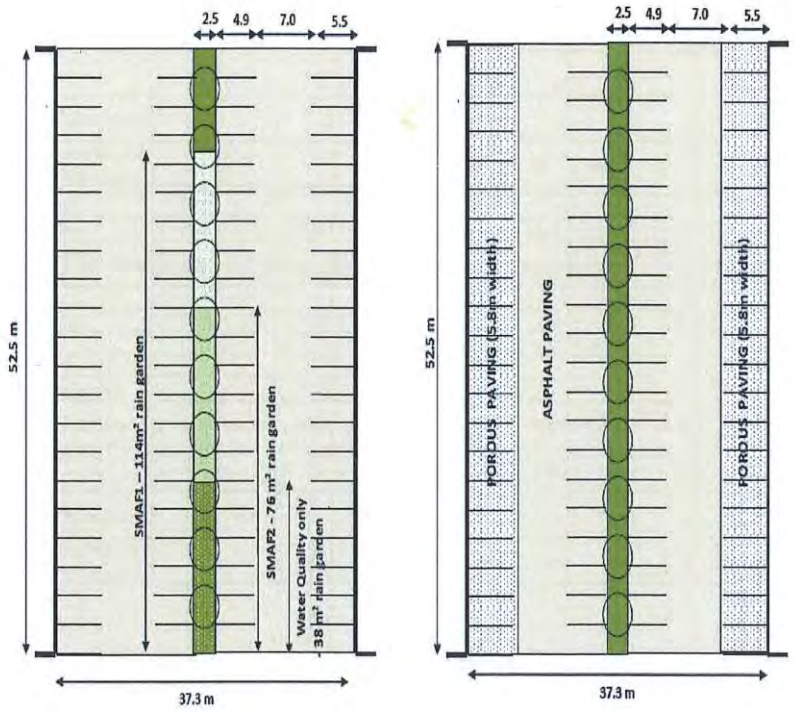


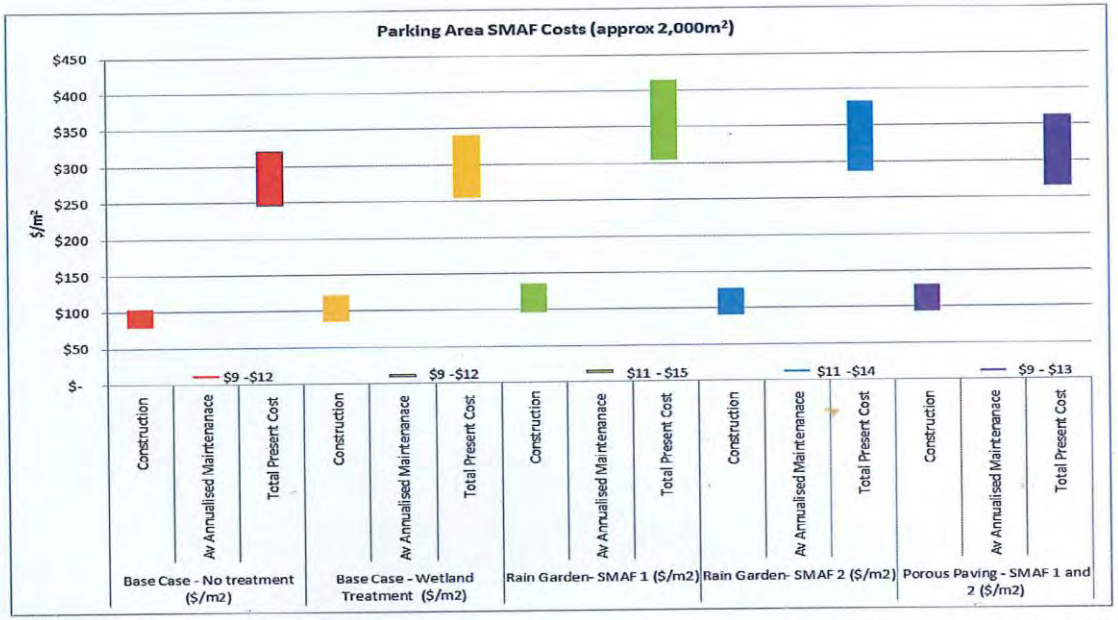
Figure 2-8 Schematic of Example Rain Garden and Porous Paving Parking Area (D&B Kettle Consulting Ltd 2013a)

Cost and Benefit Assessment

Table 2-8 Parking Area SMAF Costs

Parking Area	Base Case - No treatment		Base Case - Wetland Treatment		Rain Garden				Porous Paving	
					SMAF1		SMAF2		SMAF1 and SMAF2	
	Low	High	Low	High	Low	High	Low	High	Low	High
Construction										
Asphalt Pavement	$ 131,544	$ 168,084	$ 131,544	$ 168,084	$ 131,544	$ 168,084	$ 131,544	$ 168,084	$ 87,696	$ 112,056
Porous Pavement									$ 73,080	$ 109,620
Other	$ 20,340	$ 24,610	$ 20,340	$ 24,610	$ 20,340	$ 24,610	$ 20,340	$ 24,610	$ 20,340	$ 24,610
Landscaping										
- Vegetated (grass/landscaped)	$ 2,625	$ 11,156	$ 2,625	$ 11,156	$ 354	$ 1,504	$ 1,111	$ 4,721	$ 2,625	$ 11,156
- Rain Garden					$ 36,067	$ 73,135	$ 24,712	$ 50,423		
Sand Filter										
Wetland (25Ha Catchment)			$ 13,042	$ 33,604						
TOTAL CONSTRUCTION	**$ 154,509**	**$ 203,850**	**$ 167,551**	**$ 237,454**	**$ 188,305**	**$ 267,332**	**$ 177,706**	**$ 247,838**	**$ 183,741**	**$ 257,442**
- per m²	**$ 79**	**$ 104**	**$ 86**	**$ 121**	**$ 96**	**$ 137**	**$ 91**	**$ 127**	**$ 94**	**$ 131**
- Extra per m² (above wetland)					**$ 11**	**$ 15**	**$ 5**	**$ 5**	**$ 8**	**$ 10**
Percent increase from Base Case - Wetland Treatment					**12%**	**13%**	**6%**	**4%**	**10%**	**8%**
PRESENT COST CALCULATIONS										
Average Annualised Maintenance										
Asphalt Pavement	$ 15,785	$ 20,170	$ 15,785	$ 20,170	$ 15,785	$ 20,170	$ 15,785	$ 20,170	$ 10,524	$ 13,447
Porous Pavement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,347	$ 8,021
Other	$ 2,373	$ 3,033	$ 2,373	$ 3,033	$ 2,373	$ 3,033	$ 2,373	$ 3,033	$ 2,373	$ 3,033
Landscaping										
- Vegetated (grass/landscaped)	$ 92	$ 394	$ 92	$ 394	$ 12	$ 53	$ 39	$ 167	$ 92	$ 394
- Rain Garden	$ -	$ -	$ -	$ -	$ 4,088	$ 6,586	$ 2,725	$ 4,391	$ -	$ -
Sand Filter										
Wetlands (25Ha catchment)			$ 137	$ 284						
TOTAL Av. Annualised Maint.	**$ 18,250**	**$ 23,596**	**$ 18,388**	**$ 23,880**	**$ 22,259**	**$ 29,842**	**$ 20,923**	**$ 27,760**	**$ 18,336**	**$ 24,894**
- per m²	**$ 9**	**$ 12**	**$ 9**	**$ 12**	**$ 11**	**$ 15**	**$ 11**	**$ 14**	**$ 9**	**$ 13**
- Extra per m² (above wetland)					**$ 2**	**$ 3**	**$ 1**	**$ 2**	**-$ 0**	**$ 1**
- Percent increase from Base Case - Wetland Treatment					**21%**	**25%**	**11%**	**13%**	**0%**	**4%**
PRESENT COSTS										
Asphalt Pavement	$ 409,431	$ 523,161	$ 409,431	$ 523,161	$ 409,431	$ 523,161	$ 409,431	$ 523,161	$ 272,954	$ 348,774
Porous Pavement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 171,902	$ 257,853
Other	$ 69,218	$ 84,600	$ 69,218	$ 84,600	$ 69,218	$ 84,600	$ 69,218	$ 84,600	$ 69,218	$ 84,600
Landscaping										
- Vegetated grass	$ 4,725	$ 20,081	$ 4,725	$ 20,081	$ 637	$ 2,707	$ 2,000	$ 8,498	$ 4,725	$ 20,081
- Rain Garden	$ -	$ -	$ -	$ -	$ 116,633	$ 201,693	$ 78,422	$ 136,129	$ -	$ -
Sand Filter										
Wetland (25Ha Catchment)			$ 15,502	$ 38,484						
TOTAL Present Cost (2,000m²)	**$ 483,374**	**$ 627,843**	**$ 498,875**	**$ 666,326**	**$ 595,918**	**$ 812,161**	**$ 559,070**	**$ 752,388**	**$ 518,799**	**$ 711,308**
- per m²	**$ 247**	**$ 321**	**$ 255**	**$ 340**	**$ 304**	**$ 415**	**$ 285**	**$ 384**	**$ 265**	**$ 363**
- Extra per m² (above wetland)					**$ 50**	**$ 74**	**$ 31**	**$ 44**	**$ 10**	**$ 23**
- Percent increase from Base Case - Wetland Treatment					**19%**	**22%**	**12%**	**13%**	**4%**	**7%**

Cost and Benefit Assessment



Detention	x	✓	✓	✓	✓
Retention	x	x	✓	✓	✓

Figure 2-10 Parking Area SMAF Costs and Management Functions

Table 2-8 and Figure 2-10 show the following:

- For achieving SMAF 1 requirements, the extra construction cost above wetland treatment is similar for porous paving ($8 - $10/m^2) and rain gardens ($11 - $15/m^2). Porous paving and rain gardens provide both detention and retention, while wetlands provide detention only.
- Maintenance costs vary from $9- $12/m^2 per year for the two Base Case Scenarios (No Treatment and Wetland Treatment). For achieving SMAF 1 requirements, utilising porous paving ($9- $13/m^2) and rain gardens ($11 - $15/m^2) results in a slight increase in maintenance costs.
- Porous paving has a lower total present cost compared to rain gardens.

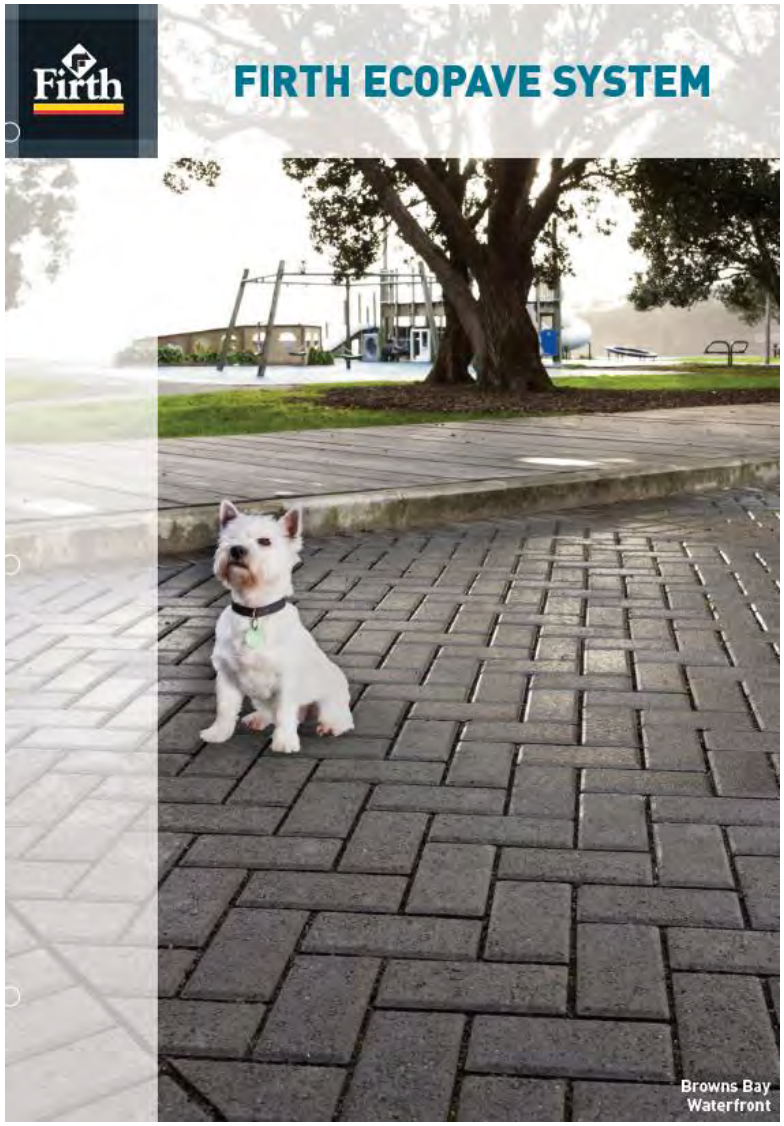
Permeability Rates

Flow Pave 80mm +- 3 500 mm/hr

Porous Pave 80mm +- 1 200 mm/hr

10mm Pervious Concrete +- 10 000 - 26 000 mm/hr
Dependant on compaction method

Permeable Paving



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