Mono Beany, A259

Beany Block, Newcastle

Drexus 100

Max-E Channel, Bedford

Mono Slot Drain, Derby

Drexus XL

Mini Beany, Conservation, Bedford

Birco 150, London

Why Choose Marshalls?

Marshalls plc is the UK's leading hard landscaping company. We have achieved this status through progressive product innovation and by demonstrating outstanding service levels to our customers. This privileged position will be sustained by continuous investment in our brand, our products, and our people.

This dedication to excellence is exemplified by Marshalls committment to developing a first class range of linear channel drainage products that fit even the most bespoke hydraulic system requirements.

Marshalls experience and expertise can ensure that the right system is selected, detailed, delivered and installed to give total peace of mind.

Marshalls pledges that all of the drainage products featured in this book comply with relevant industry standards, are manufactured to the highest standards, are fit for purpose and are designed to optimise savings in manufacture and use.

Marshalls' purchasing policy sets out the standards and ethics by which we conduct our business and operate our management systems to manage our suppliers.

The majority of our products are manufactured in the UK; where products are sourced from outside the UK an ethical risk assessment is completed and an appropriate action plan agreed - multi-stakeholder independent social audits are part of our best practice. Marshalls is a member of both the Ethical Trading Initiative and UN Global Compact.

Marshalls accepts legal compliance as an absolute minimum standard to which we work and, where no legislation is in place, we use industry best practice. Legal compliance is monitored through our independently audited management systems. Our Board is ultimately responsible for ensuring the business operates in a socially responsible way, including compliance with relevant legislation.

We're dedicated to creating spaces that make the world a better place for everybody – one pavement, one car park, and one city centre at a time.

Our vision is built upon four pillars: values by which our every decision is guided, no matter how big or small.

Demonstrating leadership.

We believe in driving the industry forward. It's an ambition we've been acting on for 120 years, thanks to our size, capability, range of products and unmatched market knowledge.

Delivering excellence.

We have very high standards. Our products have to be innovative, our people have to be the best, our workmanship has to be perfect. Only then can we deliver the quality we're renowned for, at every stage of the process.

Building trust.

Everyone at Marshalls acts with integrity, treating customers and their projects with care and respect. It means people trust us with their home, their business, their town. And it's how we foster relationships for the long-term.

Being sustainable.

We use the world to source our products, so we have a responsibility to look after it. It's something we have been committed to for over 120 years and has ensured our longevity. Whether it's creating stronger communities, preserving environments, or contributing to the UN Global Compact, our work is always sustainable.

Marshalls is a member of the Ethical Trading Initiative (ETI).

OHS 69609 EMS 56194 FM 00004 IMR 72571

Design Service & Project Support

Engineering Solutions

Marshall is committed to ensuring that the right system is selected, detailed, delivered and installed. The understanding that the right selection of linear drainage system is crucial to the function of any hard landscaped area therefore Marshalls Linear Drainage Team will work in partnership with the specifer, engineer and contractor, to become an integrated part of the design process, helping transform and deliver ideas into hydraulic designs matched to the individual project requirements to give total peace of mind.

"Our everyday goal is simple – Support the customer's performance and aesthetic design aspirations with a commercially driven, value added Design Support Service, excelling through Computer Aided Drawings, engineered solutions and technical advice."

Marshalls free, no-obligation Drainage Design Service encompasses the following services:

In-House Design Support Services

By use of our bespoke computer software the Design Team can plan realistic and rapid solutions to your drainage needs. The Design Team will:

- Work with the project team to ensure the client's expectation are met
- Operate with either electronic (CAD) or hard copy drawings
- Assist in the selection of the most appropriate system
- Provide hydraulic data to support the adequacy of the selected system
- Provide schedule and / or layouts of the components as appropriate
- Value Engineer design to drive down project costs

NEW Online Hydraulic Design Software

Marshalls bespoke software (the online design tool) can enable you to plan realistic, precise and cost effective solutions to your drainage needs, all at your fingertips through a simple step-by-step process.

The software uses the modified rational method as described in the Wallingford procedure to calculate appropriate runoff rates for your project. A simple procedure is followed to ensure selection of the correct Marshalls linear drainage system from a structural, aesthetic and hydraulic perspective.

Flexible input options enable the user to generate required rainfall events in terms of duration and return period whilst also having the capability to adjust for climate change. These features ensure that each Marshalls linear drainage design can be tailored to meet the requirements of a specific project.

The Online Design Tool will:

- Give access at all times from most web active devices
- Save designs to a personal online library within your account
- Give access to pre-designed templates for fast track designing
- Automatically update with additional or new product and technical data
- Calculate flow rates and capacity levels required

CPD Presentations and Training

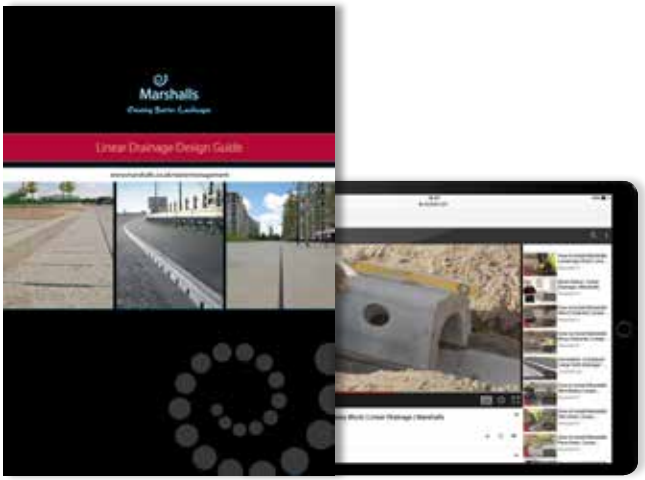
Marshalls Linear Drainage Team provides free of charge comprehensive and industry leading range of CPD (Continuous Professional Development) seminars to architects, engineers and contractors.

Marshalls CPD seminars cover a whole range of water management topics and solutions from permeable paving to linear and combined kerb and drainage systems.

Technical Design Guide

The fully comprehensive Marshalls Linear Drainage Design Guide draws from Marshalls experience in linear drainage, and aims to help the reader to understand more about this subject in a comprehensive and easy to understand way.

The guide, walks the reader through all the Product Range, the case for linear drainage, cost comparisons, the product selection process and design principles. The guide also provides technical information, offering advice on design, installation, materials and maintenance.



Further Technical documentation is also available;

- Microdrainage conduit files
- Computer Aided Design product drawings
- Technical product data and specification sheets
- Declaration of performances in accordance with BS EN 1433:2002
- Maintenance and cleaning regimes
- Online installation guides & videos.

MARSHALLS 360

360 Service Package

Our 360 Service Package provides comprehensive support including pre-construction appraisal, product sampling and CAD facilities. Marshalls Water Management and hydraulic engineering consultants are on hand at all stages of planning and construction to help ensure sound hydraulic design and sustainable performance of the drainage installation. To smooth project management our construction service teams employ state of the art traffic planning software for real time tracking and priority delivery schedules. All of this is underpinned with RIBA accredited training seminars for project teams. Visit marshalls.co.uk/360 to find out how your project can benefit.

For contact details see the further information page

BIM & Product innovation

Marshalls is an early adopter of Building Information Modelling (BIM) and has invested heavily in developing our people and skills to create the appropriate BIM objects and data that large commercial projects will soon demand. The company is continuously building a BIM object library that will be unrivalled in the Landscape sector and currently collaborates with relevant industry bodies to develop the training strategies, product data and software that will drive BIM adoption across the industry.

Bespoke Solutions

Detailed design features often make the difference between good and great. Marshalls is always delighted to take challenging briefs for bespoke landscape linear drainage features.

Liverpool Lime Street Station required a discreet drainage solution to follow the curvature of the architecture. Marshalls was able to develop a true radius slot drain to meet the clients requirements.

The client of the Welding Institute in Cambridge required a linear drainage solution for a multi story car park. Marshalls was able to recommend and supply Marshalls Birco Profil, a shallow steel channel designed for low construction heights whilst providing optimum drainage performance, reliable traffic safety and attractive design.

Marshalls DESIGN SPACE

Design Space

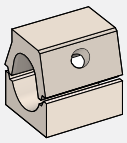
A bespoke London work space to inspire landscape design professionals. Bookable spaces for meetings, brainstorm sessions, or simply quiet space to think and create. Fully kitted to explore materials, colours and textures, BIM Models, technical data and social media platforms all on screen.

Extra events are a regular programme of seminars, notable speakers, and CPD. Open Space for big ideas, Personal Space for quiet contemplation, Inner Space for imagination.

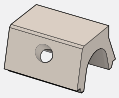
Product Range Combined Kerb & Drainage

Beany® Block

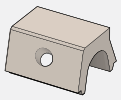
Combined Kerb & Drainage System



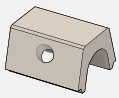
HB Straight Backed



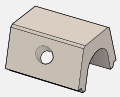
HB Straight Backed Low Hole



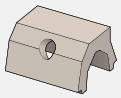
HB Symmetrical



Symmetrical Low Hole



45° Splayed



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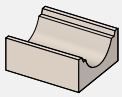

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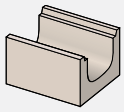

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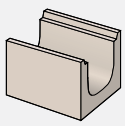

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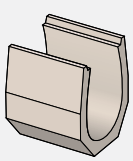
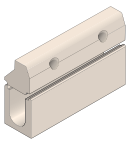
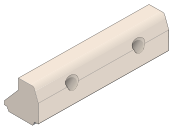


Mini Beany®

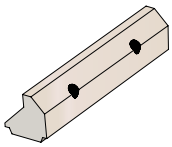
Combined Kerb & Drainage System



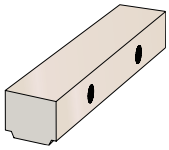
1m Half Battered Top



1m 45° Splayed Top



1m Conservation 205 x 255 profile



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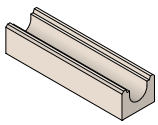

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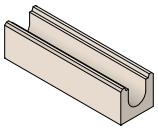

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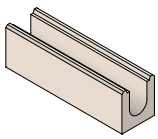

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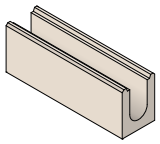


Mono Beany®

Combined Kerb & Drainage System

HB Mono 321 1m

HB Mono 502 1m

SP Mono 321 1m

SP Mono 502 1m

HB Mono 321 0.5m

HB Mono 502 0.5m

SP Mono 321 0.5m

SP Mono 502 0.5m

Bridge Beany®

Combined Kerb & Drainage System

45° Splayed 500 x 150 x 100mm

45° Splayed 500 x 175 x 100mm

45° Splayed 500 x 275 x 100mm

45° Splayed 500 x 350 x 100mm

45° Splayed 500 x 450 x 100mm

HB 500 x 150 x 100mm

HB 500 x 175 x 100mm

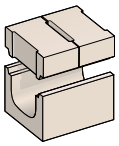
HB 500 x 275 x 100mm

HB 500 x 350 x 100mm

HB 500 x 450 x 100mm

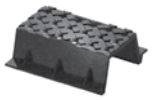
Max-E-Channel

Concrete Drainage System



Reinforced Concrete E600

Cast Iron F900



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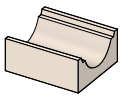

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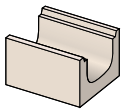

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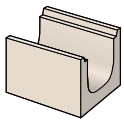

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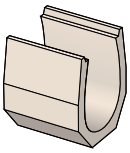
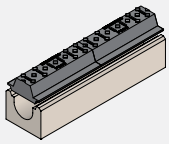
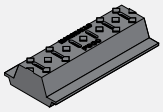


Traffic Drain

Grate Drainage System



Top Unit



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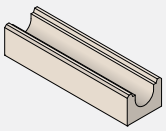

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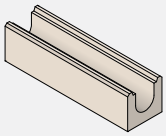

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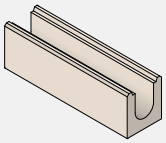

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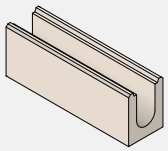
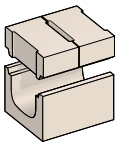


Product Range Channel Drainage

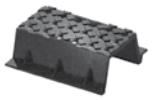
Max-E-Channel

Concrete Drainage System



Reinforced Concrete E600

Cast Iron F900



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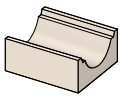

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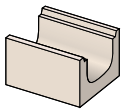

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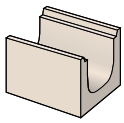

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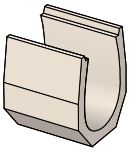
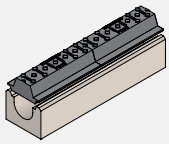


Traffic Drain

Grate Drainage System



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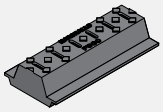

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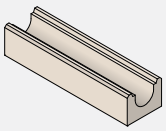

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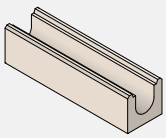

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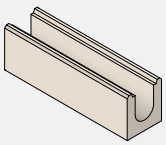

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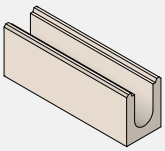
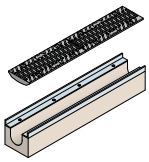


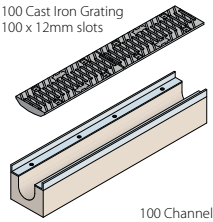
Birco

Grate Drainage System



Birco 100

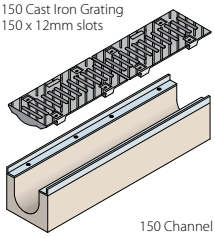
100 Cast Iron Grating
100 x 12mm slots



100 Channel

Birco 150

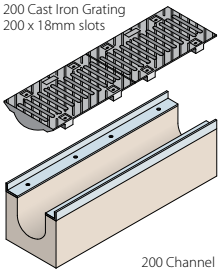
150 Cast Iron Grating
150 x 12mm slots



150 Channel

Birco 200

200 Cast Iron Grating
200 x 18mm slots



200 Channel

Birco 300$_{AS}$

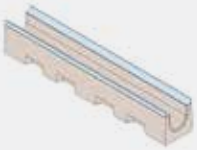
300 Cast Iron Grating
125 x 20mm slots

300 Channel

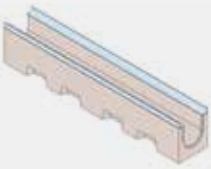
Drexus 100

Grate Drainage System

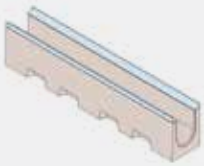
0/0 Channel



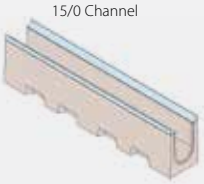
5/0 Channel



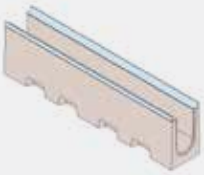
10/0 Channel



15/0 Channel



20/0 Channel



Drexus Pave Drain

Concrete Drainage System

Natural Stone Top

Concrete Top

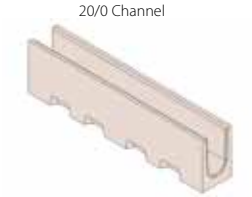
0/0 Channel

5/0 Channel

10/0 Channel

15/0 Channel

20/0 Channel



Drexus Slot Drain

Slot Drainage System

Mono Slot Top

Duo Slot Top

Offset Duo Slot Top

0/0 Channel

5/0 Channel

10/0 Channel

15/0 Channel

20/0 Channel

Drexus XL

Concrete Drainage System

325 Channel

425 Channel

525 Channel

675 Channel

825 Channel

The Case for Linear Drainage

Introduction

The growing demand for more cost-effective and less complicated drainage systems has led to modern linear drainage becoming the preferred choice amongst specifiers and contractors alike.

Marshalls' unique linear drainage systems combine the clear-cut advantages of linear drainage over traditional point drainage, with the benefits of a high quality, robust concrete system.

Surface water interception

- More efficient at intercepting running water
- Ponding is reduced or eliminated as is streaming water across a site

Shallow depth of construction

- Inherently shallow construction required
- Savings due to reduced excavation
- Reduces construction time, offering further savings
- Less conflict with existing underground services
- Reduced quantities of spoil to be disposed of

Ease of design

- Performs more efficiently with just the use of concrete channels, grates, outfalls and reduced amounts of pipework.
- Only requires shallow depth construction
- Limited number of components required
- Does not require complex crossfalls to be incorporated
- Design of crossfalls and longitudinal falls of adjacent hard landscaping is straightforward
- Improved end user performance

Ease of installation

- Channel line and level can be set out with ease
- Crossfalls are less complex to set out or construct compared with point drainage
- Expensive construction time saved due to shallow construction
- On-site errors are easier to avoid
- Unlike other options, Marshalls' systems do not require temporary ballast (e.g. Sand) during installation
- Inherently strong and robust concrete reduces on-site damage

Significant cost savings by reducing carrier pipes

- Many schemes can utilise the inherent ability of a channel or combined kerb and drainage system to act not just as the traditional gully in point drainage, but also as the carrier pipe in storing and transporting surface water.
- Any carrier pipes will be at a shallower depth with resultant cost savings
- Fewer expensive manholes required
- Less spoil to be removed from site
- Improved health and safety on site through reduced need for deep excavation work

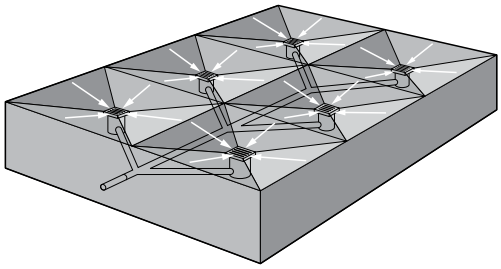


Fig. 1 Typical point drainage system, illustrating the need for complex crossfalls with attendant implications for design, installation and cost

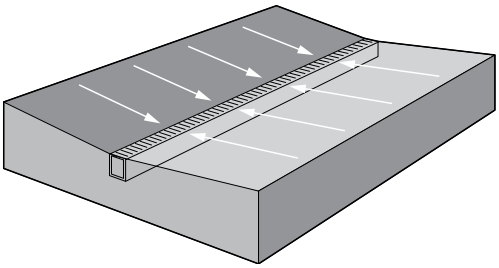


Fig. 2 Typical equivalent linear drainage system

Storage of surface water

Linear drainage can utilise the storage capability of its channels to good effect where there are limitations placed on the total outflow of the scheme. This temporary storage facility has been utilised to:

- Attenuate peak flows
- Avoid or reduce costs of balancing ponds or reservoirs
- Reduce pipework sizes at outfalls

Reduced maintenance

- Easier and less costly to maintain than other forms of surface water drainage systems
- Easy to access along the whole length of the linear drainage system via removable gratings or regular access points
- Blockages will not completely disrupt the whole system and can be dealt with easily
- Inherently strong and robust precast concrete systems resistant to the effects of freeze thaw and de-icing salts

Aesthetics

- Wide choice of decorative metal gratings or textured and coloured top blocks to enhance the aesthetics of a scheme
- Straight lines of linear drainage can be incorporated into the overall design

Control of spillage

- Allows total control of unwanted liquids in an emergency

End user comfort

- Eliminates false falls and consequent 'roller coaster' effect for vehicular traffic associated with point drainage
- Level surface offers greater comfort to pedestrians & road users

Selection Process

Linear Drainage Product Selection Procedure

The following pages describe the procedure for choosing the most appropriate Marshalls linear drainage system for a particular application.

Marshalls' comprehensive range of drainage systems can be split into four categories;

1. **Combined Kerb and Drainage systems specifically designed for kerbside use;**
   - Beany® Block
   - Mini Beany®
   - Mono Beany®
   - Bridge Beany®

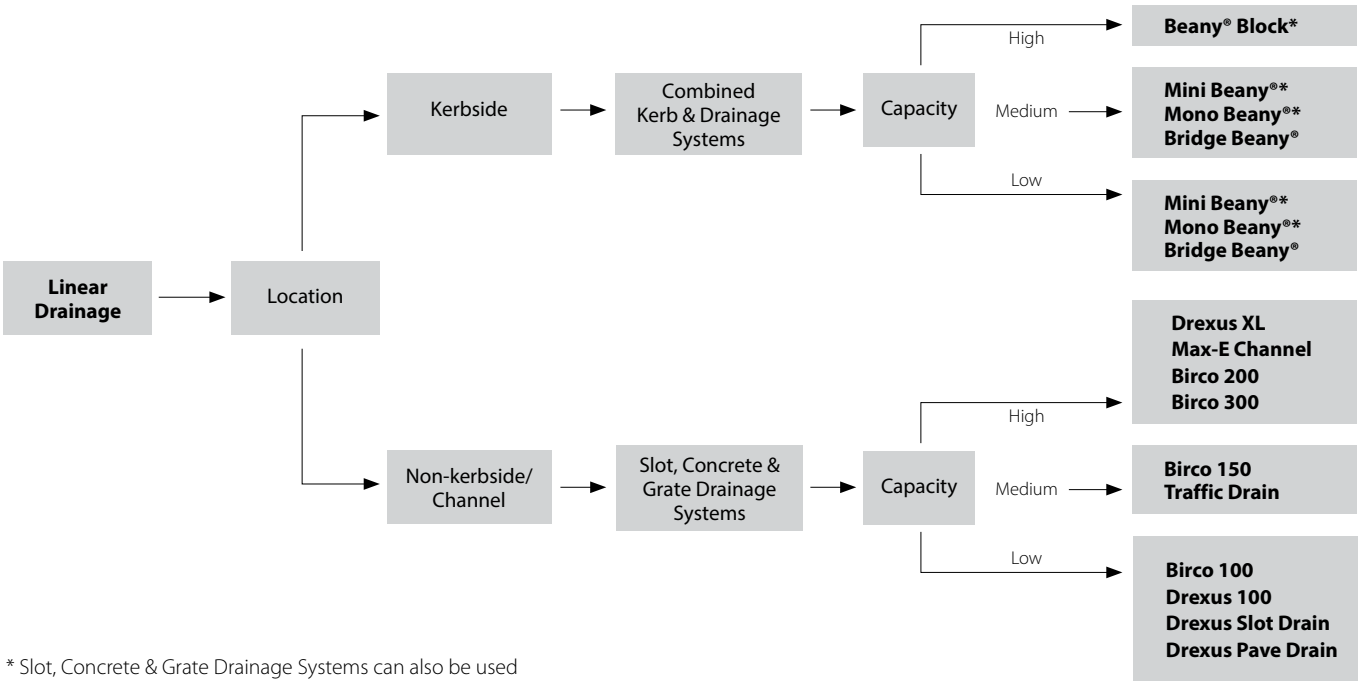
2. **Slot Drainage Systems designed primarily (though not exclusively) for non-kerbside use;**
   - Drexus Slot Drain Duo & Mono

3. **Grate Drainage Systems designed primarily (though not exclusively) for non-kerbside use;**
   - Birco
   - Drexus 100
   - Traffic Drain

4. **Concrete Drainage Systems designed primarily (though not exclusively) for non-kerbside use;**
   - Max-E Channel
   - Drexus Pave Drain
   - Drexus XL

The position of outfall, the area to be drained, topography and rainfall intensity will each affect the final decision as to which is the most appropriate system. However, there are two fundamental factors which, more than any other, determine which system is most appropriate;

- Location(i.e. kerbside or non-kerbside)
- Capacity



* Slot, Concrete & Grate Drainage Systems can also be used in kerbside locations. Where this is the case follow the design procedure for non-kerbside/ channel drainage

Fig. 3 General Principles for Selecting the Appropriate System

Selection Process

Channel Drainage Systems

Seven channel linear drainage systems are available from Marshalls, designed primarily (though not exclusively) for non-kerbside applications;

- Max-E-Channel
- Birco
- Drexus 100
- Drexus Pave Drain
- Drexus Slot Drain
- Traffic Drain
- Drexus XL

Selection Procedure

The choice of channel drainage system will often be determined by site parameters, such as size of area to be drained, existing levels and length of drainage runs. The following steps should be followed to establish the most appropriate Marshalls channel.

Step 1

Determine the location of the channel drainage system within the drained area.

Step 2

Determine the length of run of the channel.

Step 3

If the channel length is approx 60m, refer to Birco 100, Drexus 100, Drexus Pave Drain or Drexus Slot Drain. (See note 1).

Step 4

If the channel length is well in excess of 60m, refer to the Max-E-Channel range and Drexus XL. Choose either a large capacity system with few outfalls or a medium capacity system with more outfalls (See note 2).

Step 5

Determine the load classification of the channel system's application and specify the appropriate grating or top unit (See note 3).

In addition to the above, the following factors should also be considered:

Location of Existing Main Drainage

- If the location of the existing drainage system is fixed, it will determine outfall locations and optimum design of the linear drainage system may not be possible

Outfall Pipe Capacity

- Whatever linear drainage system is used, the outfall pipework must be designed to accommodate the peak discharge from the system
- Consider the available working width & depths for the site where runs are proposed taking into account the chosen system dimensions & launch detail(s)

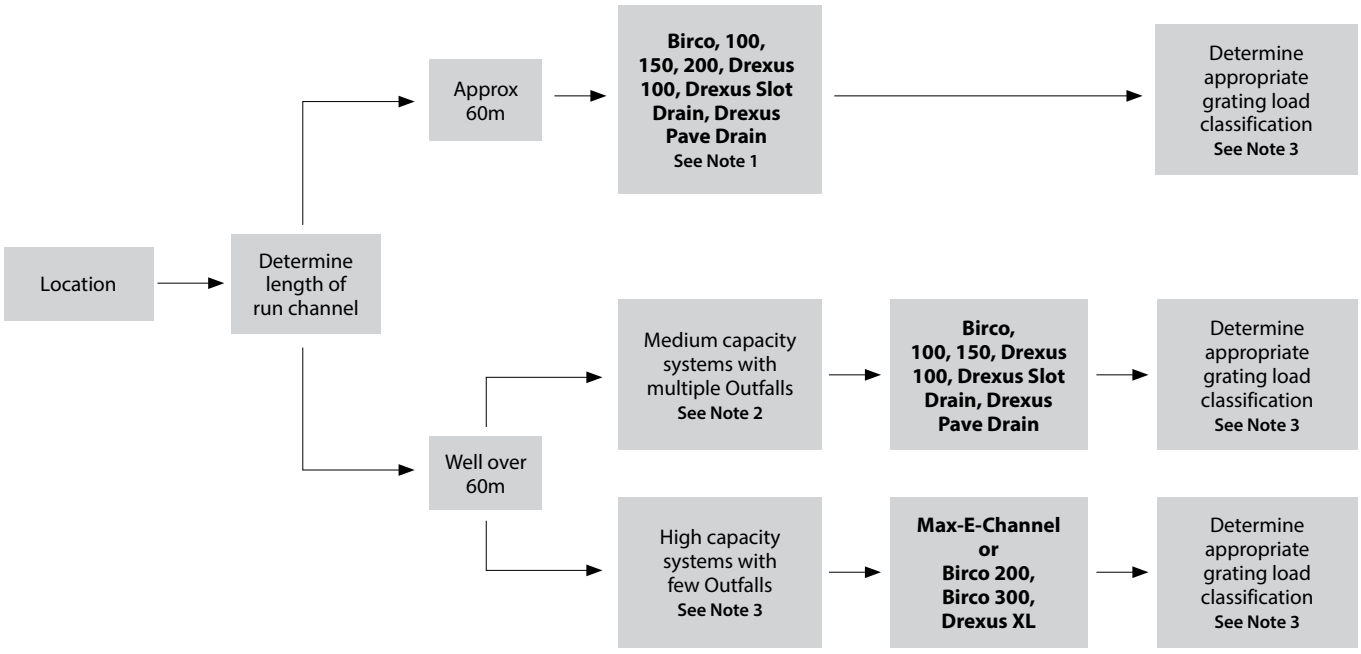


Fig 5. Summary of General Principles for Selecting an Appropriate Marshalls' Channel System

Notes

1) Generally, where the linear drainage channel length is in the order of 60m, one centrally located outfall will be sufficient and a medium capacity system such as Drexus 100, Drexus Slot Drain, Drexus Pave Drain or Birco 100 can be used.

Example
A relatively small paved area of dimensions 50 x 50m can be easily drained by a 100mm wide channel system such as Drexus 100, Drexus Slot Drain, Drexus Pave Drain or Birco 100. One centrally located outfall to suit the existing main drainage system will be sufficient.

2) Where linear drainage channel runs are well in excess of 60m, say 200m, then there is a choice of 2 options;

Option 1 - a high capacity system (Max-E-Channel or Drexus XL) with few outfalls or, alternatively;

Option 2 - a medium capacity system (eg Birco 150) with multiple outfalls

Example
For a paved area of dimensions 200 x 150m, then the options are as follows;

Option 1

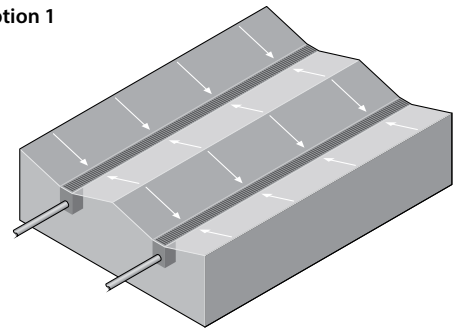


Fig. 6 High Capacity System with Few Outfalls

This example shows Marshalls' Max-E Channel or Drexus XL, draining the area with only one outfall at the end of the channel run. Less carrier pipes are used, resulting in even greater cost savings. There will also be less excavation with this design.

Option 2

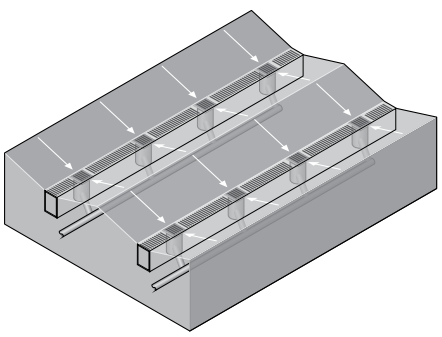


Fig.7 Medium Capacity System with Multiple Outfalls

This example shows typically two Birco 100 or Drexus 100, Drexus Slot Drain, Drexus Pave Drain runs utilising in-built fall or transition channels, with four outfalls discharging into a carrier pipe system. This is a highly cost-effective solution and would result in considerable savings compared to an alternative point drainage solution.

3) The loading classifications, as defined in BS EN 1433: 2002 'Drainage channels for vehicular and pedestrian areas - classification, design and testing requirements, marking and quality control, are as follows;

Class A15	Areas which can only be used by pedestrians and pedal cyclists
Class B125	Footways, pedestrian areas and compatible areas, private car parks or parking decks
Class C250	Kerbside and non-trafficked areas of hard shoulder that extend to a maximum of 0.5m into the trafficked area
Class D400	Carriageways of roads, hard shoulders and parking areas for all vehicles
Class E600	Areas subject to high wheel loads e.g. ports and docksides, warehousing and distribution.
Class F900	Areas subject to especially high wheel loads e.g. aircraft pavements

Design Principles

Introduction

The basis of hydraulic design of any linear drainage system is fundamentally like any other engineering analysis; an assessment is made of the required performance level that the element has to achieve and this is compared to the element's ability to accommodate this. In the case of linear drainage, how much water (peak run-off) will be flowing down the channel compared to the maximum stated flow capacity of the channel for the given conditions without causing any problems such as flooding.

There are therefore two elements to any linear drainage design; a determination of the peak run-off or maximum flow along and out of the channel and a determination of the system's maximum capacity.

Peak Run-Off

The determination of peak run-off will depend upon many considerations including;

- Size and location of the drained area
- Use and application of the drained area
- Chosen or calculated rainfall intensity

Whilst several methods of calculating the peak storm water run-off exist, there are two which [Marshalls recommend] should be considered when designing linear drainage systems;

- The Simple Area Run-Off Method
- The Modified Rational Method (often referred to as The Wallingford Procedure)

The Simple Area Run-Off Method

In the Simple Area Run-Off Method, it is assumed that the whole of the drained area contributes to the peak flow, that the rainfall intensity is uniform over the whole area and additionally that a value for the rainfall intensity is actually assumed. Therefore the assumed value for rainfall intensity is directly proportional to the peak run-off. A balance is often made between cost and the level of performance required but it is generally accepted that this method will yield conservative results.

The peak run-off formula used in this method is:-

$Q = A \times i/3600$, where

Q is the peak storm water run-off (in litres per second)

A is the drained area (in square metres)

"i" is the rainfall intensity (in millimetres per hour)

Some typical values assumed for rainfall intensity are given below. Engineers and designers must choose carefully and give due consideration to the performance level required;

- 75mm/hr (0.021 l/m^2/s) Areas where the consequences of flooding are serious such as where roof drainage [or entrances to buildings] is involved
- 50mm/hr (0.014 l/m^2/s) Car parks, pedestrian areas, roads or highways
- 40mm/hr (0.011 l/m^2/s) Service yards
- 30mm/hr (0.008 l/m^2/s) Large storage areas such as ports

In addition, this method of peak run-off determination should be limited to use when designing relatively small drained areas (less than 10,000m^2) and when designing relatively short runs of linear drainage (less than 200m).

The Modified Rational Method

The Modified Rational Method (often referred to as The Wallingford Procedure) is considered more accurate for larger schemes with longer drainage runs. Whilst the method generally assumes that the whole drained area contributes to the peak run-off, it uses typical storm profiles based upon actual data and takes into account actual geographical rainfall variations. In this way, the critical rainfall intensity for a given set of parameters and conditions can be calculated. The only decision that a designer makes is to choose a storm return period. Again several factors will influence this choice but periods of between 1 in one year to 1 in two years are typical for designing the linear drainage systems for most applications with only more onerous designs considering a 1 in five years return period. Reference can be made to BS EN 752 for advice on the choice of return period and the Modified Rational Method document advises "time of entry" for chosen return period.

Maximum System Capacity

Analysis of water flow along a linear drainage system where water continuously enters the system laterally is complex and differs in some respects to flow in circular pipes. It is usual to assume that flow in pipes is uniform or steady as the "flow in" equates to the "flow out" and that as the parameters along the system will generally remain unchanged, the flow is essentially unaltered. For these conditions, flow capacity has been determined from traditional methods such as the Colebrook-White formulae.

Where continuous lateral inflow is involved and particularly where large flows for large drained areas are concerned, a steady flow state may not be achieved and an alternative to steady state flow capacity determination may need to be considered.

Recent research work carried out at HR Wallingford has considered this aspect of Marshalls' linear drainage systems. The principle of spatially variable flow was established where, particularly for shallow gradients, the position of peak depth and hence the critical location moves from the assumed location at the outfall upstream towards the head of the run. The research work confirmed that for Marshalls' Beany Block system, where flow-capacities have traditionally been calculated using Colebrook-White, for all practical applications the capacities quoted were realistic and accurate. However, Colebrook-White gave very conservative figures for shallow gradients or flat applications and more cost-effective designs can be completed using data derived from the HR Wallingford work. The theory and practical application of flat channel flow is confirmed in TRL Report 602.

Flow data contained in the Marshalls Drainage Design Guide are derived from both HR Wallingford research and from traditional methods. Each system's data will indicate its source.

In addition to flow capacity figures, velocity data is also included. The velocity data has been determined by dividing the appropriate flow capacity by the full cross section area for the section under consideration. For Colebrook-White derived flows, this is accurate; for HR Wallingford derived flows this is ***conservative***.

Design Capacities
When using inbuilt fall Channels exclusively or in combination with flat invert Channels, drainage capacities should be calculated at the nearest upstream prime invert depth Channel.

Other Considerations
There are other aspects of linear drainage design beyond the factors given above. These include:

Maintenance
All surface water collection and transport systems will require maintenance to ensure efficient performance. Where linear drainage is designed for shallow gradients due care must be taken in the design for the effects of silting. Many systems are kept free from silting by the action of fast flow, but HR Wallingford's research confirmed that velocities flows as low as 0.4m/s "caused silt to move".

Existing Drainage
The location of existing drainage systems may often determine the location of the linear drainage outfall. This may or may not coincide with the most cost effective or efficient linear drainage design.

Ground Levels
Existing ground levels will determine low points and gradients, particularly so for roads and highways. This can mean that outfall locations are not determined by the hydraulic design. Where the channel longitudinal gradients varies, an equivalent uniform gradient may be derived from the HA advice note HA37. Specific advice on the application of this for Marshalls' linear drainage or combined kerb and drainage systems is available upon request.

Cross Falls and Drained Widths
Generally, cross falls should be between 1 in 40 to 1 in 80 whilst the maximum drained distance to any linear drainage should typically not exceed 50m.

Outfalls
As indicated the location of outfalls is sometimes not determined by the hydraulic design. Where the choice of outfall location is within the designer's control, and particularly where long drainage runs are being designed, the capacity of the outfall pipe work can sometimes limit the efficiency of the system. Capacity figures for Marshalls' outfalls are given in the appropriate sections. These figures are based upon theoretical but conservative calculations. Details are available upon request.

The Simple Way To Design Linear Drainage Systems

By use of Marshalls bespoke software the online design tool can enable you to plan realistic, precise and cost effective value engineered solutions to your drainage needs, all at your fingertips through a sample step-by-step process.

For more information visit:
www.commercialtoolbox/linear-drainage/details

Design Principles

Drainage Arrangements

Due to the manufacturing flexibility available to Marshalls, we are able to offer several of our linear drainage and combined kerb and drainage systems with pre-sloped or inbuilt fall channels or transition units.

The inherent flexibility of inbuilt fall and transition base systems gives the designer a number of options to increase the flow capacity of the drainage run as circumstances dictate:

- Constant depth invert channels can be laid flat, or to a slope to increase the flow and discharge capacity (Figs. 8 & 9 opposite).
- Channels with progressively deeper inverts can be introduced towards the outfall end forming a stepped construction. Again the slope will increase flow and discharge capacity (Figs. 10 & 11 opposite).
- Channels with inbuilt/transition falls can be used (Fig. 12 opposite).

Inbuilt falls

Drexus Pave Drain, Drexus Slot Drain and Drexus 100 and Birco are all available with either inbuilt or transition falls. Inbuilt fall or transition Channels increase drainage discharge capacity by improving flow rates and thereby increasing the overall discharge capacity of the system. Channels with inbuilt falls or transitions have benefits in a number of specific applications:

- In flat areas, such as supermarket car parks, where pavement falls must be minimised to prevent "runaway trolley" syndrome
- Adjacent to buildings where architectural detail dictates that pavement level is parallel to roof level
- To maintain a level pavement adjacent to internal flooring in warehouse areas
- Where insufficient fall is present, inbuilt fall or transition Channels allow the creation of an artificial valley with either a gully at the centre or at each end of a drainage run (Figs. 13 & 14 opposite)

Inbuilt fall Channels are designed as a 20 Channel set (20 linear metres) but are manufactured individually and can be ordered in any permutation. They can be laid in virtually any given length in combination with constant depth invert Channels (Fig. 16 opposite). Inbuilt fall channels may also be laid to a gradient to increase the invert slope and flow capacity.

Transition Channels are designed as a 4 Channel set (4 linear metres) but are manufactured individually and can be ordered in any permutation. They can be laid in virtually any given length in combination with constant depth invert Channels (Fig. 16 opposite). Inbuilt fall channels may also be laid to a gradient to increase the invert slope and flow capacity.

Prime incremental depth

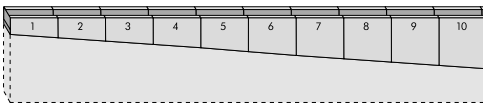
A set of 20 No. inbuilt fall channels take the system from the shallowest to the deepest constant depth channel in increments. For most of the Birco systems (100 and 150), the increment is 10mm per metre long channel (1%). For Birco 200, the increment is 5mm per metre long channel (0.5%). These increments correspond to the various constant depth or invert channels "prime depths" of 0/0, 5/0, 10/0, 15/0 and 20/0 every 5 linear metres (Fig. 16 opposite).

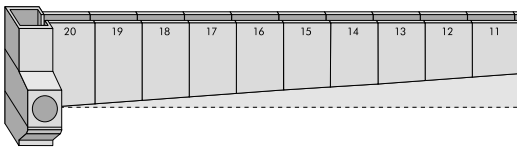
Inbuilt fall Channels are available as follows:

Channel Type	Fall	Type	Units Per Set
Birco 100	1%	10 mm/1000 mm channel	20 no.
Birco 150	1%	10 mm/1000 mm channel	20 no.
Birco 200	0.5%	5 mm/1000 mm channel	20 no.

Transition Channels are availabel as follows:

Channel Type	Fall	Type	Units Per Set
Drexus 100	2.5%	25mm/1000mm channel	4 no.
Drexus Pave Drain	2.5%	25mm/1000mm channel	4 no.
Drexus Slot Drain	2.5%	25mm/1000mm channel	4 no.





Note: Drawings show exaggerated fall for illustrative purposes only (not to scale)

Fig.8
Constant depth invert Channels, laid to level ground

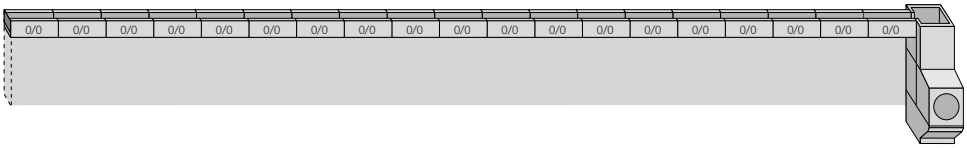


Fig.9
Constant depth invert Channels, laid on sloping ground

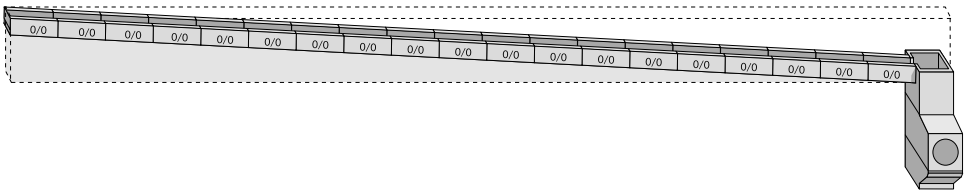


Fig.10
Channels laid to a stepped construction laid to level ground

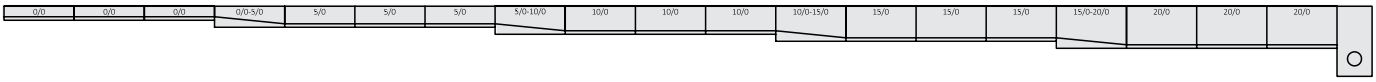


Fig.11
Stepped constant depth channels laid on sloping ground

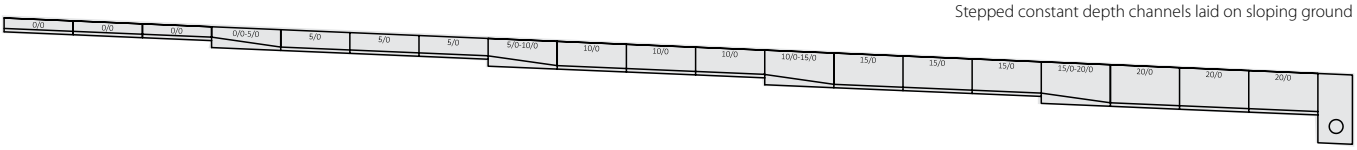


Fig.12
Inbuilt fall Channels, laid on level ground

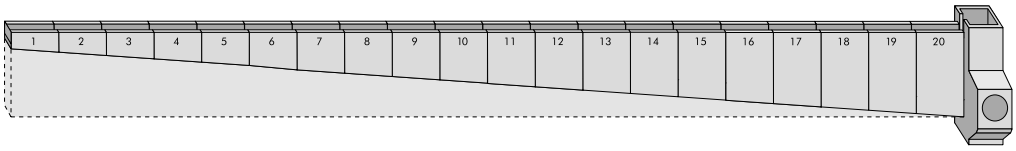


Fig.13
Artificial valley with Outfall at the centre, laid on level ground

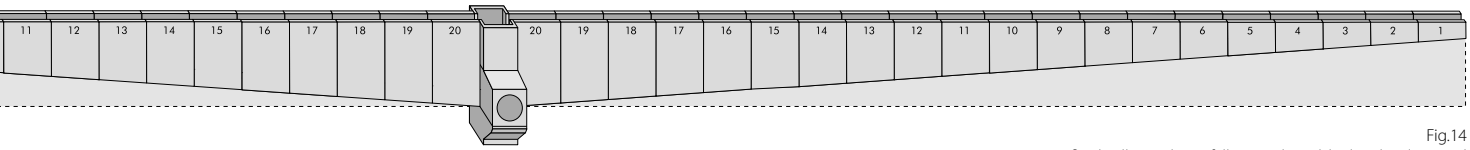


Fig.14
Artificial valley with Outfalls at each end, laid on level ground

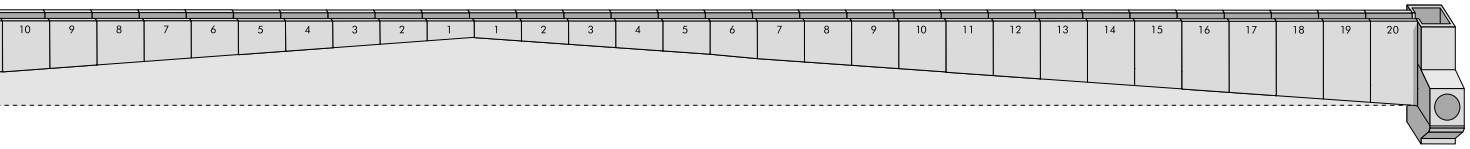


Fig.15
Combination of constant depth invert Channels and inbuilt fall Channels

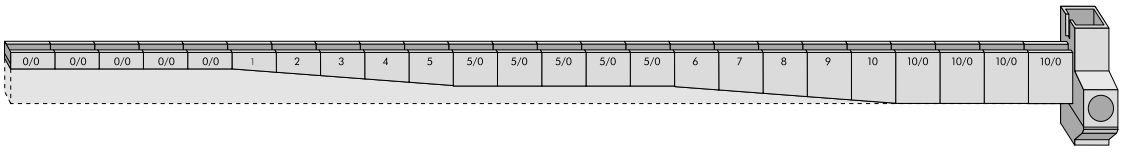
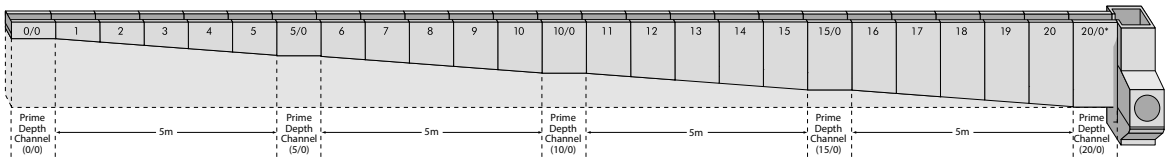


Fig.16
5 prime depth Channels laid with a full set of inbuilt fall Channels



*Not available for Birco 200

General Construction

Manual Handling

As a substance, cured concrete is non-hazardous; however it is heavy, hard and abrasive. Manual handling of these products therefore has associated hazards. Only individuals who have received training in kinetic handling techniques should be allowed to handle these products. Gloves should be worn when handling concrete products to avoid cuts, abrasions and/or skin irritations.

Marshalls advises that the majority of their drainage components be installed using mechanical handling equipment. Techniques using mechanical handling equipment, such as vacuum machines, have been proven to eliminate manual handling on many sites. Overall project savings have been shown through the benefits of easier, more efficient and less wasteful installation. Suitable equipment is available from Probst Handling and Laying Systems.

A DVD clearly showing the principles and advantages of using mechanical handling equipment and techniques for the installation of Beany Block is available by contacting the Marshalls Drainage Design Team.

Inclement weather

Installation operations should be discontinued if weather conditions are such that the performance of the inspection chamber may be jeopardised.

Installation should not be undertaken when the temperature is below 3°C on a falling thermometer and below 1°C on a rising thermometer.

COSHH

All relevant health and safety information, including COSHH data sheets, can be obtained from Marshalls Advisory Services or Drainage Design Team.

Protection

All necessary Personal Protective Equipment (PPE) should be worn on site, as the site rules dictate. Goggles, ear protection, dust masks and protective footwear must always be worn whenever cutting operations are undertaken.

Cast Iron

Cast Iron

Throughout this Design Guide reference is made to cast iron as a generic material.

Cast iron is available as either 'grey' iron (flake graphite) or 'ductile' iron (spheroidal graphite). We do not believe that, for the product's intended use, the material type will affect performance. However, if you wish to know the material type this is given in the specific product data sheet.

The coating applied to our cast iron is a temporary bitumen based coating that will become dull and lose its gloss over a period of time. It is not intended to protect the casting in use and would be expected to break down over a short period of time, either through weathering, or by being worn off when trafficked. As this happens the product would be expected to show signs of surface oxidation.

From the perspective of long term structural performance, the application of such coatings is not intended to serve any purpose; the corrosion mechanism of cast iron is very different to that of steel and is not detrimental to structural performance.

Both grey and ductile iron contain high quantities of silicon, which upon oxidation converts to silica (alongside the iron oxide) producing a tough non-porous homogenous surface coating. In addition, there is a slight reduction in volume, causing this coating to bind tightly onto the surface which effectively protects the iron and prevents further oxidation.

If the area is regularly trafficked, the grates will fairly quickly polish up to a dark colour.

If the area is not regularly trafficked and where aesthetics are important, then galvanised steel, stainless steel or powder coated cast iron gratings (all options that are available) should be considered.

Design Service

Drainage Design Support

Marshall is committed to ensuring that the right system is selected, detailed, delivered and installed. The understanding that the right selection of linear drainage system is crucial to the function of any hard landscaped area reinforced the need for us to share our knowledge with you. We do not underestimate the importance of the hydraulic design matched to the individual project requirements to give total peace of mind. We offer design support from conception to completion with experienced personnel and proven procedures.

To ensure specification of the correct system and components, we offer a free, no-obligation Drainage Design Service. By use of our bespoke computer software the design team can plan realistic and rapid solutions to your drainage needs.

The Design Team will:-

- Work with the project team to ensure the client's expectation are met
- Operate with either electronic (CAD) or hard copy drawings
- Assist in the selection of the most appropriate system
- Provide hydraulic data to support the adequacy of the selected system
- Provide schedule and/or layouts of the components as appropriate
- Give general advice based on a wealth of knowledge

A team of field based Drainage Engineers is also available to support our sales team and offer you technical advice on site or in your office.

NEW Online Hydraulic Design Software

Marshalls bespoke software (the online design tool) can enable you to plan realistic, precise and cost effective solutions to your drainage needs, all at your fingertips through a simple step-by-step process.

The software uses the modified rational method as described in the Wallingford procedure to calculate appropriate runoff rates for your project. A simple procedure is followed to ensure selection of the correct Marshalls linear drainage system from a structural, aesthetic and hydraulic perspective.

Further Infromation

The following further information is available:-

Technical Support, Product Data Sheets and COSHH	**Marshalls Advisory Service** **Tel: 0370 4112233** **Fax: 01422 312943** **e-mail: advisoryservice @marshalls.co.uk**
Free Design Service	**Drainage Design Team** **Tel: 0345 30 20 708** **e-mail: design.team@marshalls.co.uk**
Sales Office: Quotes and Orders	**Tel: 0345 3020400** **e-mail: wmsales@marshalls.co.uk**
Contract Information: Appendix 5/5 for Combined Kerb and Drainage systems Appendix 5/6 for Linear and Drainage systems Appendix 5/3 for Slot Drainage systems Method of Measurement Contract Schedule	

References & Further Reading

1. BS EN 1433:2002 - Drainage channels for vehicular and pedestrian areas – classification, design, and testing requirements, marking and evaluation of conformity

2. BS EN 206-1:2000 – Concrete. Specification, performance, production and conformity

3. BS 8500-2:2002 - Concrete Complementary British Standard to BS EN 206-1

4. BS EN 998-2 : 2003 - Specification for Mortar for Masonry

5. BS 7263-3 : 2001 - Precast concrete flags, kerbs, channels, edgings and quadrants

6. BS EN ISO 1461: 1999 - Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

7. BS EN 752-1:1996 - Drain and sewer systems outside buildings. Generalities and definitions

8. BS EN 752-2:1997 - Drain and sewer systems outside buildings. Performance requirements

9. BS EN 752-3:1997 - Drain and sewer systems outside buildings. Planning

10. BS EN 752-4:1998 - Drain and sewer systems outside buildings. Hydraulic design and environmental considerations

11. TRRL Laboratory Report 602 - Drainage of level or nearly level roads

12. Highways Agency's Design Manual for Roads and Bridges
HA 37 - Hydraulic Design of Road-edge Surface Water Channels
HA 102 - Spacing of Road Gullies
HA 33 - Surface and Sub-surface Drainage Systems For Highways
HA 105/04 - Sumpless Gullies

13. Highways Agency's Manual of Contract Documents for Highway Works
Specification for Highway Works
Notes for Guidance on the Specification for Highway Works
Highway Construction Details

14. HR Wallingford WP5 - The Wallingford Procedure for the design and analysis of urban storm drainage 1981

15. HR Wallingford WP6 - Wallingford Procedure for Europe: Best Practice Guide to Urban Drainage Modelling CD ROM 2001

16. HR Wallingford SR 581 - Hydraulic Capacity of Drainage Channels with Lateral Inflow 2001

17. HR Wallingford SR 606 - Hydraulic Design of Paved Areas 2002

18. Design of Linear Drainage by Dr. M Naqvi, Thomas Telford publishing 2003

19. The Building Regulations 2002 - Approved Document H3, Section 2, 'Drainage of Paved Areas'

20. Building Standards (Scotland) Regulations 1990, Technical Standard M 'Drainage and Sanitary Facilities'

21. Sewers for Adoption – 7th Edition

22. Sewers for Scotland - 2nd Edition