Lowland Path Construction Guide

paths for all

FOR A HAPPIER, HEALTHIER SCOTLAND

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
nature.scot

FOR A HAPPIER,
HEALTHIER SCOTLAND

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
nature.scot

Paths for All is a partnership organisation, for a full list of our current partners please visit our website www.pathsforall.org.uk
Paths for All Partnership is a registered Scottish charity No: SC025535 and a Company Limited by Guarantee No: 168554 incorporated 19 September 1996 at Companies House, Edinburgh,
Registered Office:
Office 8, Forrester Lodge, Tullibody Road, Alloa FK10 2HU.

Scottish Natural Heritage (SNH) is the government's adviser on all aspects of nature and landscape across Scotland. Our role is to help people understand, value and enjoy Scotland's nature now and in the future. For more information, visit our website at www.nature.scot

Design: jonodesign.co.uk

Contents

Photography

Pages 4, 6 & 127 copyright © JONO Design.

Page 83 copyright © Tensar.

Page 107 copyright © Sustrans.

Page 115 copyright © Paving Expert.

All other photographs copyright © Paths for All.

1 Introduction

For most people, you know you have been on a good path when you can look up and enjoy the view and not what is beneath your feet, when you don't arrive back home with your wellies and the dog covered in mud, and when you can find your way easily without getting anxious or lost. Usually this does not happen by chance. Paths need careful planning, constructing, and signposting and most important of all, they need looking after to keep them in good shape.

From doing simple maintenance to building a bridge, choosing a suitable path surface to finding a suitable contractor there is a lot to learn and sometimes some difficult choices to make. These pages are designed to help you develop some path 'know how', whatever level you are working at. There is advice and training available, National Path Demonstration Sites to visit, a lot of tried and tested ideas and designs to make use of and some information about how legislation underpins how paths are planned and managed.

This good practice guide has been fully revised and updated from the original "Lowland Path Construction - A Guide to Good Practice" which was published in 2001.

The guide considers all aspects of lowland path development and management and looks at the different stages of path construction projects – planning, design, construction and maintenance. The guide provides information to help make lowland path management decisions across Scotland from urban areas to rural places. It will also help in making

informed decisions about long term management of path networks – for example in response to potential climate change.

There are four chapters that follow in the guide:

The guide is mainly aimed at professionals, such as Access Officers. There is a degree of technical information included but our aim was to produce a guide that can be used with the minimum of technical knowledge. We hope that people from community path groups who have limited experience of lowland path development and management will also find the guide useful.

The information has been structured to allow easy navigation to the appropriate level of detail. For example, experienced path managers may be looking for information on a particular path design, whereas those new to this topic may benefit from understanding the principles of lowland path management.

This guide was produced by Paths for All with support from Scottish Natural Heritage.

The guidance in this guide is not standards. The guide has been compiled using the best information available to Paths for All at the time of publication. It is intended as a general guide to the topics and should not be viewed as a substitute for professional advice in specific project cases.

The guide contains clickable text to help navigate through the guidance and to link to other relevant resource as follows:

- green text will go to another location in the guide when clicked
- blue text will go to an online resource when clicked.

2 Path Planning

Before starting work on designing or constructing a path, you need to think about the existing paths in your area and ensure you understand how to go about developing a path or network.

This chapter contains introductory information about:

2.1 Getting to know your paths

The aim of this section is to help you to identify where people are already going, where they want to go, and how different routes within a network can be made to meet the needs of everyone.

Before deciding to build a new path or upgrade an existing one, spend some time getting to know the paths in your area. Try to find out who already uses them, how many people use them, and who might want to in the future.

The Core Paths Plan for your area will show the core paths and ‘wider access network’. Your local authority or national park access officer should also have a record of the consultations done as part of the core path planning process, so ask for copies of any maps that they may have which show existing paths as well as the aspirational routes.

To get a better picture, you could try conducting a local survey and asking where people go for a walk, ride or cycle, as well as their aspirations for where they might want to go (use a map to allow people to draw their routes).

Once you have gathered some information, transfer it to a map so that you can visualise the network on the ground. You will build up a picture of whole paths and 'links' or gaps, which you can then describe in terms of the physical characteristics of the area; who owns the land; any path construction or maintenance work that has been done in the past; existing infrastructure, such as car parks, bridges and signs, and any features associated with the path, such as viewpoints, buildings or wildlife. This is the Green Level survey and compiles all the available information about each path. It is not necessary to put together a complete inventory before going further, but the more information that you can find, the easier it will be to anticipate issues further down the line.

Gaps and links

Whilst gathering this information you will be able to identify gaps and links in the network. You may discover that some old routes have been lost (either by lack of use or development) or find that there is a strong need for new links to improve the accessibility of certain parts of the network. Think carefully about the network as a whole and look for any 'weak points', where problems at a single point could have implications for other links. For example, a river crossing might be necessary, but if the bridge site is prone to flooding it could cut off the other parts of the network, if they are only accessible by the bridge. Where possible try to identify alternatives so that your network can stay open, even partially, if the worst does happen.

Constraints of terrain and local circumstances

When it comes to paths, it is clear that one size does not fit all – every path has its own set of circumstances that influence the way it is used and how it needs to be managed, and how it fits in to the local landscape. It is really important to understand all the constraints that may affect the path before setting out.

Things to consider:

Landscape

How do the paths fit in to the local landscape and are there any special features that need to be avoided or protected? What landscape features could enhance the character of the paths, or provide interest to path users? For example, it may be dangerous to site a path along the top of an exposed cliff, but the view is one of the main attractions that users want, you may need to design the route to give safe opportunities to appreciate the view by providing defined viewpoints.

Terrain

Will the paths need any specific works to negotiate slopes or physical features? Can you change the route's alignment to avoid steep slopes, or provide alternatives? For example, if an existing desire line goes directly to the top of a local hill, decide whether building steps is the best option, or if the path could take a less direct route, with shallower gradients.

Climate change

Will the path or network be able to withstand the predicted changes to the climate? Are there any adaptations that might be needed in the future? For example, the area may be susceptible to coastal erosion that is predicted to worsen with climate change, so designing the network to allow for 'managed retreat' may be preferable to costly investment that cannot be protected.

Land ownership and management

Can you work positively with the land managers and are there any land management operations on or near the path that might affect how it is built, used or managed? For example, a local farmer may be prepared to offer ground for a new path if it will help to reduce problems with people disturbing livestock.

User needs

Are there any outdoor activities that are particularly popular in your area that would affect the design or management of the paths? For example, is the network in an area of high horse ownership or are there livery stable 'hot spots', you need to take this into account.

Identifying opportunities

It is easy to get stuck on detail, so taking a broader view of your local paths as a network should help you to identify opportunities to address the constraints you have acknowledged, and find ways of making the paths interesting and easy to use for everyone.

Involving people

This is where it makes sense to get the views of other people in your local area. Community engagement is a really important part of any planning exercise, and can make the difference between success and failure. Take the time to work out what you want to ask, and find out whether there are other people undertaking consultation processes around the same time – consultation fatigue is becoming a problem for both local people and those trying to get people's opinions.

If you work for an organisation there may already be procedures and processes in place that will guide how you involve people in the planning. In general, the earlier you can gather people's views and the more you understand about people's needs (and take them into account), the more likely you are to gain their support.

Some of the more important information you may want to collect includes:

- what activities people currently take part in (e.g. walking, cycling, riding)
- where people currently go to take part (e.g. draw lines on a local map)
- where people want to go (e.g. draw lines on a local map)
- what activities people want to take part in, but cannot due to lack of suitable facilities
- where barriers exist that cause problems for people to access the route (e.g. wet or muddy spots, narrow or overgrown, steep slopes, steps, stiles, cross drains, etc.).

2.2 Planning for paths

Before getting too heavily involved in the design and construction of your path network it is worth considering a few key issues that will affect your overall management approach. This section is designed to give you an overview and point you towards more specific information. Even if you have been involved with paths for many years, it is still useful to take a 'strategic look' at the network from the outset.

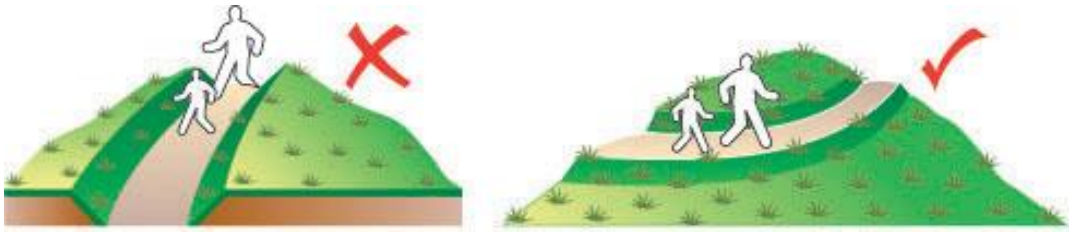
The long-term task of keeping your paths in a 'fit for purpose' condition should be at the centre of your thinking. Planning and designing your paths with this in mind and you should be able to minimise the overall costs of providing a path network. By taking account of the whole life costs of the path you might decide to use a low-cost specification that requires regular maintenance or it might be necessary to spend most of your overall budget on a high cost specification and low maintenance option.

The following sections cover a range of issues that you need to consider at the early stages of any path project, and the different types of survey used to gather information about paths or networks, which will help to make important decisions:

2.2.1 Location

A good location for a path can make a difference in many ways – whether the network can cope with changing weather patterns and use, or even whether people will want to use the path at all. When looking at options for where to put new paths, or how to replace or upgrade existing ones, think about the considerations in the following table.

Location considerations	
Surrounding land use	check whether there are any land management activities that could cause a problem for some or all users consider whether land management activities could have a physical impact on the path – cattle can damage paths by poaching the surface; woodland plantations provide shelter but windblown trees could be a hazard look at the local authority's Local Plan for development to see if there are planned developments – there may be opportunities to include new or better paths within planning proposals
Landscape	make sure the proposals do not adversely affect the character of the local landscape – ensure that paths follow landscape features rather than cut through them or go straight over the top, e.g. take the path around the side of a hill, rather than up and over it so that the path will not be seen (e.g. as in the following image) check whether there are any particular features of interest that could enhance the path – viewpoints and vistas provide opportunities for interpretation, as well as a good location for a resting place
Path corridor	negotiating a narrow strip of land for just the line of the path might not give you enough scope to account for design problems or space for different users – fitting a path within a wider corridor gives better opportunities for management and can help to prevent conflict between different user groups and improve the people's experience of the path



Making the path fit the landscape.

2.2.2 Meeting users' needs

People who are using paths for different activities may need particular features to be present, or absent, so knowing who is likely to use the path is very important. People on wheels, such as cyclists, wheelchair users and those pushing buggies / prams appreciate gentle gradients, smooth hard surfaces and prefer not to have to negotiate steps or cross drains. Horses are less comfortable on those smooth hard surfaces but gates need to be wide enough to allow a horse and rider through without the need to dismount.

Try to put yourself in the position of a particular user group and consider what would make the paths more attractive and easier to use. The fundamental principle that you should adopt is the 'least restrictive option'. This is often used to design paths for people with disabilities (the Equality Act (2010) places an obligation to make 'reasonable adjustments' in public spaces), but the approach should be seen as good practice for all user groups – this means that you

identify all the potential 'barriers' and seek ways to minimise their impact for different user groups. There may be compromises or conflicts in the needs of different user groups and you may have to make a judgement about whether some of the barriers are too difficult to overcome. In some cases, it may actually be better to look for an alternative route or provide specific path for different user groups that provides a high-quality experience for each group, rather than ending up with one poorly designed path which only partially meets everyone's needs. You may find that, at a later date you need to provide a justification for your decisions, so it is worthwhile recording what factors you have taken into account during the projects planning and design stages.

You may also need to think about the likely levels of participation, and how the various adaptations could have mutual benefits between user groups. For example, in areas where there are very few horse riders it may be sufficient to leave space for horses to ride alongside the constructed path, which would allow a higher specification of path surface to be used on the main path to accommodate people on foot and wheels. However, this may not be sufficient if there is frequent use by horses and one path surface built to accommodate everyone might be necessary.

You can find out more about shared use paths here Shared Use Paths in Scotland and there is detailed good practice guidance on 'Countryside For All' from the Fieldfare Trust.

Cyclists, wheelchair user and walker sharing a path.

Path width

There are various conventions of path width and the main considerations are who is likely to be using the path and how much room is available along the route corridor. It is usual to specify a minimum width of 1.5m for paths in rural areas, but most shared use paths are at least 2m wide. In urban areas, 2.5m - 3m wide is commonly specified for shared use paths to accommodate the likely higher usage. The choice of path surface may dictate the width, to enable access for construction plant, and you need to consider whether maintenance operations (such as grass cutting) will affect the minimum width of the path. For natural surfaces, it is common to cut a swathe of at least 2m, but this may depend on the landscape setting and expected use.

2.2.3 Moving the ground

The construction of any path will need to take account of the topography and the first choice in adapting to the topography is careful route alignment – avoiding unnecessary rises and falls is good for most users and also eases construction. Where it is not possible to keep the path within an acceptable gradient, you may need to undertake earthworks to reduce steep gradients. The scale of the earthworks will potentially have a large impact on the cost of constructing the path, so the design of any earthworks is very important.

Variations in topography that affect the construction of a path are:

- **cross slopes** - where a path has to cut across a hillside
- **longitudinal slopes** - where a path follows the shape of the land.

Cross slopes

In order to produce a path of adequate width across a slope it will be necessary to form a level 'bench'. This can be done either by cutting a 'bench' into the slope or by building up to the level with a suitable well graded fill material. The angle of the cut slope is important for stability of the path and is dependent on the strength of the soil and underlying substrate (e.g. glacial till or rock).

Longitudinal slopes

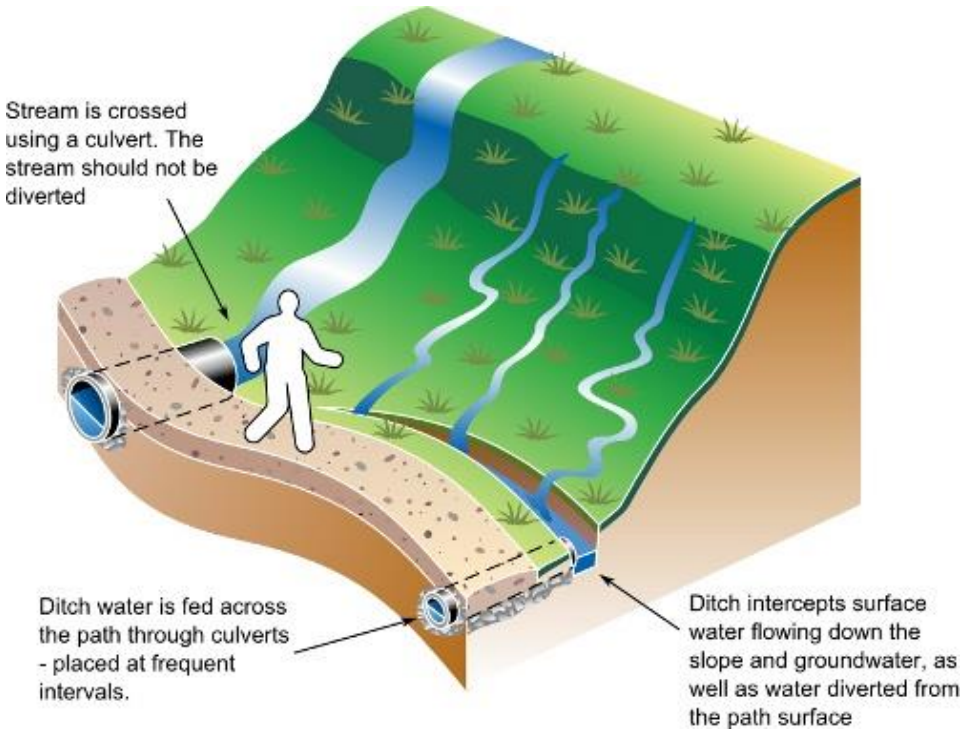
The amount of work required to deal with short longitudinal slopes depends on the maximum gradient of the path specification. As part of the early stages of path planning try to select a route around high and low areas to avoid or minimise earthworks and disturbance. However, you may still need to deal with steep slopes and undulations, where the path traverses ground with hollows and hummocks.

2.2.4 Keeping water off the path

One of the most important aspects of managing lowland paths is dealing with water. Whether this is rain falling directly onto the path, surface water from adjacent land or groundwater seeping onto the path from below, water has the capacity to cause damage to paths and misery for users.

Wherever possible, water should be kept away from the path by intercepting it before it reaches the surface and diverting it away so that it does not cause problems elsewhere. Take a careful look at the topography (the shape of the ground) and watch or work out where the water is likely to drain. Bear in mind that water will always look for the easiest, if not shortest, route across the ground. You may need to intercept water from springs or surface flow.

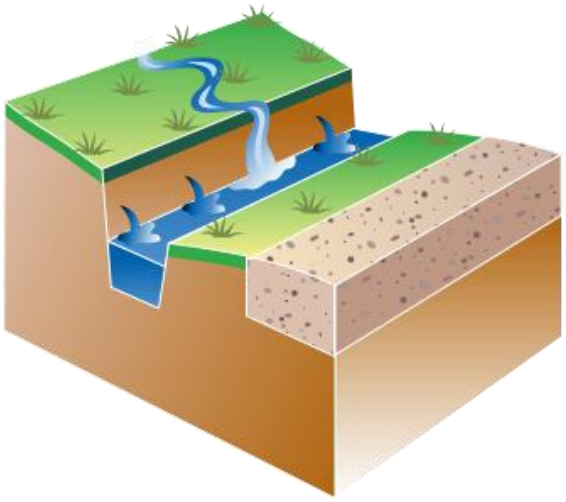
The shape of the path surface can be used to 'shed' water and is one of the most important points to consider before installing any drainage features into the surface. You can use a camber, which provides a sloping surface with raised centre to drain water to either side of the path or a crossfall, which is a level surface that slopes to one side. On very narrow paths, you can add a short dip in the surface to reverse the direction of the gradient (called grade reversal) to force water off the path.



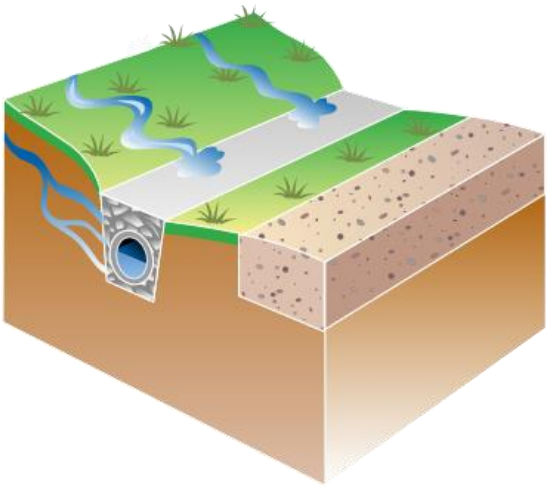
Intercepting surface water approaching a path.

You can intercept and divert surface and ground water away from the path using:

- a **ditch** - an open channel



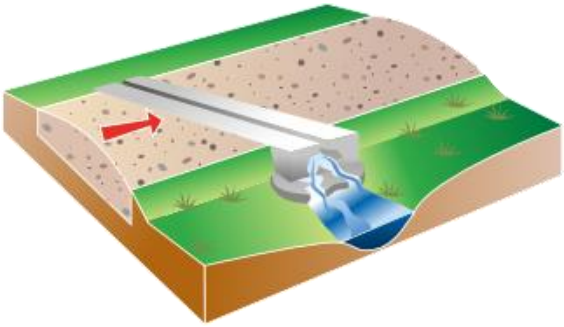
- a **French drain** (or filter drain) - a channel filled with stone and a pipe



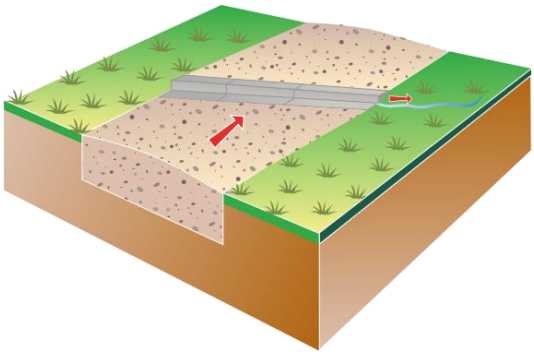
There are pros and cons of open ditches and French drains, and you will need to think about your local circumstances before deciding which to use. For example, ditches can look more natural and are easier to maintain. French drains, on the other hand, can be hidden from view, do not attract litter and prevent open water hazards. However, if a French drain becomes blocked it may require complete excavation and replacement. If you decide to use French drains, an added complication is that tree roots will grow towards the flowing water and will quickly damage any permeable liner and block pipes. When thinking about the positioning of open ditches or closed drains bear in mind that excavation works close to trees can damage their roots and in the long term may cause a tree to die.

Cut-off drains, water bars, culverts and cross drains may be needed to divert the water off or across the path, as follows:

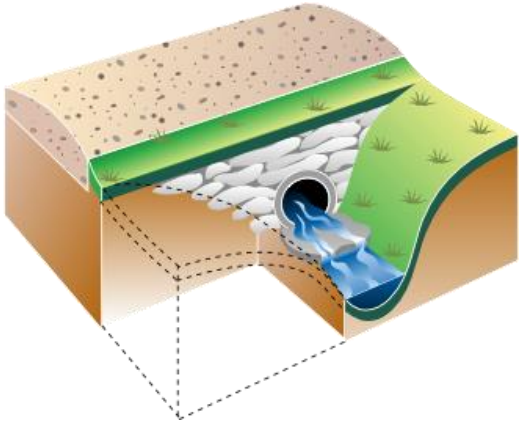
- a **cut-off drain** can catch surface water flowing down, or drain water across, the path



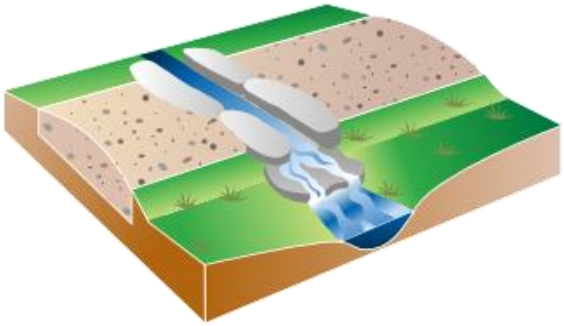
- a **water bar** intercepts flowing water on the path surface but adds a step, creating a barrier and trip hazard across the path



- a **culvert** allows water to drain under the path



- a **cross drain** allows water to cross the path but introduces an open gap in the surface, creating a barrier and trip hazard



These features need to be correctly positioned so that once the water has been removed it should not be allowed back on to the path. This may mean that ditches need to be dug to divert the water away from the path, with a soakaway to help disperse it into the ground.

In some cases, you may be able to run ditches or pipes to existing burns to discharge the water from along the path. Take care not to change the overall drainage pattern – your ditches and drains should allow the water to pass through the path and resume its original flow. Diverting all collected water into a burn could cause problems downstream, such as flooding.

If there is an existing drainage system, such as agricultural land drains, you may be able to make improvements or repairs, with the landowner's agreement, rather than starting from scratch. Take care not to damage existing drains and check that, if you want to divert surface water into the existing system, there is enough spare capacity to cope with the extra water.

Where a path has to cross a watercourse – a stream, river or drainage channel – you will need to construct a culvert or bridge. You will need to check with your local Scottish Environment Protection Agency (SEPA) office regarding the Water Environment (Controlled Activities) (Scotland) Regulations (2011) as work within a watercourse may be restricted or prohibited. These regulations are often simply referred to as the CAR regulations.

Bridges can be costly, but will allow a much greater volume of water to pass unrestricted along the watercourse. They are essential for any sizeable burn or river. Planning, designing and constructing a bridge is a potentially complex subject, and is beyond the scope of this Guide. For more information about planning, designing and building small-span bridges see the Path Bridges Guide.

Culverts are generally a pipe or pipes laid in the bed of a small burn with stone headwalls to retain the material laid over the pipe and hide the pipe ends. Pipe culverts are cheap, in comparison with bridges, and easy to install, but will have a greater effect on a watercourse than a bridge, so size is critical.

In order to design an appropriate drainage system, you will need to work out the potential surface run-off that your system might need to cope with. There are lots of 'factors' to take into account, such as the area being drained, slopes, the permeability of the underlying soil, rainfall intensity and duration. There are complex calculations that you can perform if you want to have an accurate estimate of the amount of water likely to be flowing during a storm.

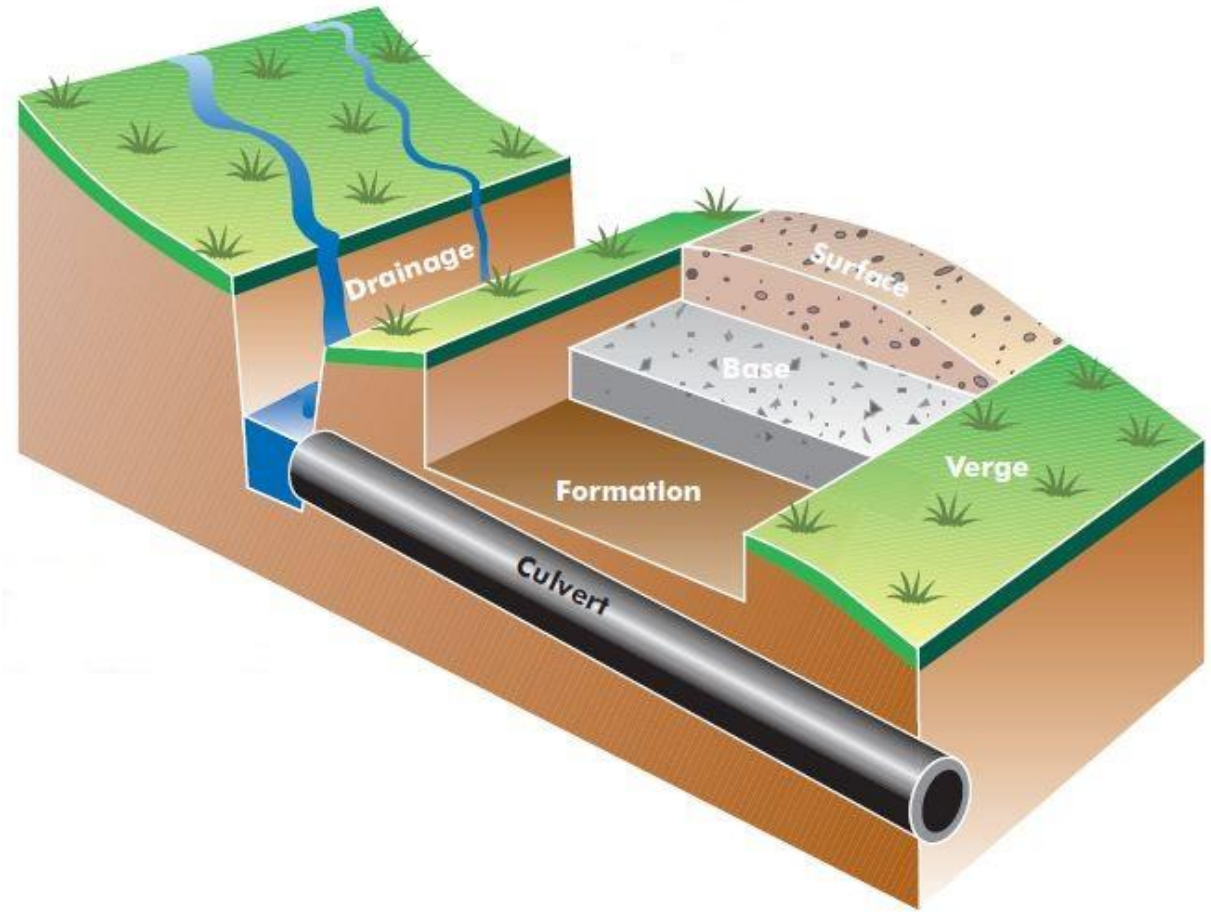
Accessibility and water

Choosing drainage features to install in to the path surface, such as water bars and cross drains, will create a barrier for most users on a path. This makes access for most users more difficult or not possible, particularly people with restricted mobility and on wheels e.g. wheelchair user. This means that grade reversals, closed cut-off drains and piped culverts are better options for keeping water off the path as they provide a continuous surface. Steep cambers or cross falls, whether natural or man-made, can also create problems for many people.

When planning a route, remember to look at the overall accessibility of the path and install drainage features that are appropriate to the situation – if the terrain limits what is technically feasible, select drainage features that match the accessibility.

2.2.5 Path structure

A constructed lowland path is made up of different layers to form a surfaced structure capable of use by a range of non-vehicle traffic. Each layer has a particular purpose in creating a path suited to its location and potential users.



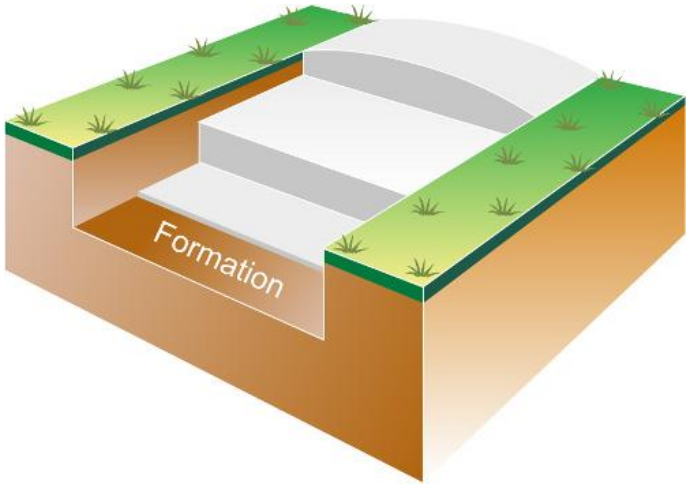
Path structure and drainage cross section.

The following sections explain each layer:

- Formation
- Geotextiles and geogrids
- Base
- Surface
- Edges

Formation

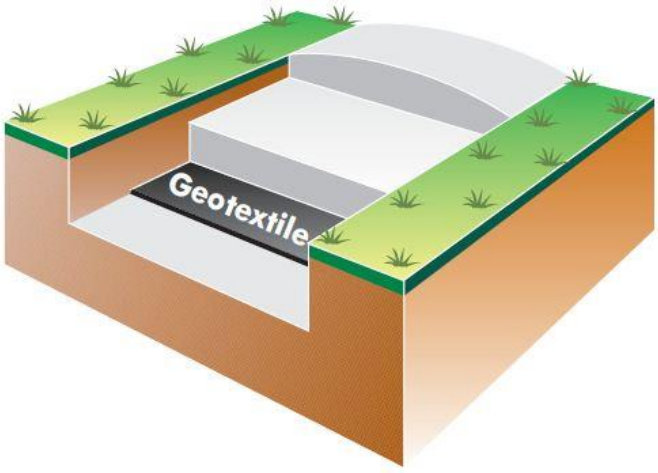
The formation layer is the prepared ground on which the path is constructed. Depending on ground conditions and the proposed construction, the work required to produce the formation layer can be anything from just clearing vegetation, through to excavation of a formation tray. The depth of formation layer will partly depend on the depth and strength of the soil and the anticipated traffic. You may also need to undertake some earthworks to reduce gradients or to make space for a formation layer across a slope.



Formation layer.

Geotextiles and geogrids

Geotextiles and geogrids are man-made ground engineering products made of different grades and strengths of synthetic materials. They are either used individually or in combination (called a geocomposite) to separate the base from the formation layer and to reinforce the base layer on a weak soil. A geogrid will also protect the formation layer from the movement of machinery when a path's base is built - the continuous movement of heavy machines, transporting materials on to site, over the same ground can cause damage to a soils profile e.g. compaction, wheel rutting.



Geotextile in location.

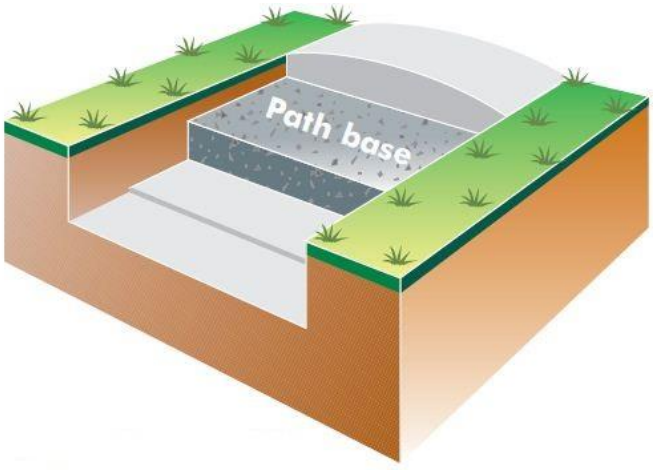
For most light use paths, if the formation layer is well drained and reasonable hard, a geotextile sheet and geogrid will not be required. You can use a simple field heel test to check

the strength of the soil before deciding whether or not to include these materials in the path's structure.

In the longer term, the inclusion of a geotextile sheet and geogrid can be beneficial to the durability of a path. They are a low-cost addition that will not vastly affect the path construction price.

Base

The base layer is the main 'load bearing' layer of the path. It is also referred to as the 'sub base' layer. A base layer is made up of one or more layers of well graded granular stone comprising a wide size distribution from large stones down to fine particles (dust). The larger stones interlock to provide most of the strength. The smaller stones and 'fines' fill in the gaps between the larger stone to help 'bind' the base layer together into a strong solid mass once it is compacted. The base layer should evenly spread the weight of users from the surface layer above to the formation layer below. A well constructed base layer will prevent settlement, rutting or cracking.



Path base in location.

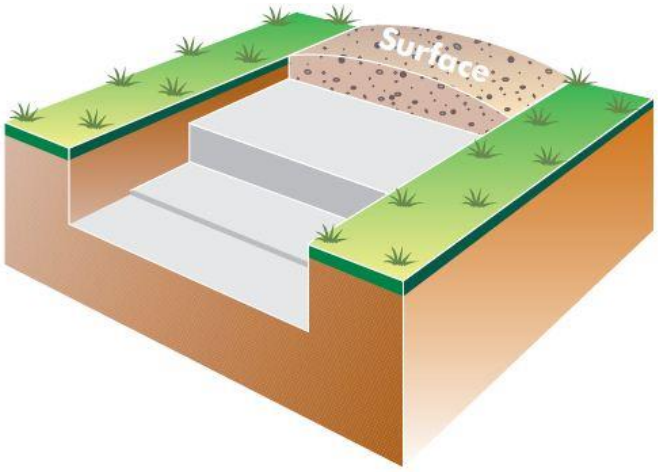
The deeper a path's base layer is, the stronger it will be. Specifying the base layer depth requires four factors to be considered, as set out in the table below.

Base layer factor	Considerations
path users	the types, frequency and loads they will impose
formation strength	the load bearing capacity of the ground on which the path is being laid
maximum aggregate size	the depth of base layer needs to be at least twice the size of the largest stones used to allow the stone particles to interlock properly
composition of the aggregate	some rock types or recycled materials will require additional thickness or layers to provide the required strength

The path's base layer will also regulate any surface imperfections left in the formation layer. A smooth, even and well compacted base layer is essential for a high-quality surface.

Surface

The surface layer is the most important part of the path from the users' point of view. It is the only part of the path with which they will make contact, but it also needs to transfer their weight to the base layer below. The surface layer is therefore critical to both the usability and appearance of the path.



Path surface in location.

When choosing a path surface, the following factors should be considered:

- durability
- maintenance requirements
- smoothness
- appearance
- sustainability.

Consider what the users will want in terms of smoothness and all-weather usability and then consider this in relation to durability, maintenance implications and appearance when choosing a suitable surface. The sustainability issue of where materials are sourced is increasingly important, to ensure that path networks have minimal ecological and carbon footprints.

The budget usually has the greatest effect on surface choice. Aim to obtain sufficient funds to provide a path specification suitable to the location and needs of users, rather than specifying the path according to how much funding is available. If funds are restricted, consider first reducing the length of the constructed path rather than using a cheaper, less durable and less suitable surface type.

Surface types

Path surfaces fall into five main types: natural, unbound, semi-bound, bound and porous. The main types of surface and the pros and cons of each are outlined in this section.

Not all path surfaces are suitable for everyone and every location. Unbound surfaces tend to get heavily marked by horses, particularly during or after wet weather. Wheeled users such as cyclists, wheelchair and mobility scooters normally prefer a smoother surface like bound surfaces. Horse riders on the other hand feel safer on softer natural surfaces with more grip and like to avoid loose stones that can damage the horse's hooves. Providing a constructed

unbound, semi-bound or bound surface with a parallel natural grass path for horse riders might be a better approach, rather than looking for a surface material suitable for everyone.

Natural surfaces

In some situations, a path may not require a formal surface. The existing vegetation may be appropriate for the expected users and setting, especially in rural areas. Mowing a strip of grass regularly will help to define the path and improve the strength and wearing quality of the grass. Short grass will be easier for wheeled users. The addition of drainage works may further improve the surface by removing muddy areas and puddles. With high volumes of use, natural surfaces will be susceptible to rapid wear and tear which requires careful maintenance and management to prevent deterioration beyond comfortable use.

Mown grass path.

Unbound surfaces

An unbound surface is generally made of well graded aggregate. It relies purely on the friction between the different sized stone particles to bind them together for strength and durability. Generally, the aggregate is very fine and particle sizes range from 4mm, 5mm or 6mm to dust. Common unbound surface types are whin dust, limestone and granite dust, depending on the local geology. Coarser aggregates can be used to provide more surface texture. Because stone particles are not bound together, these surfaces are very susceptible to being washed out by water, so careful surface drainage is required.

The simplest unbound surface is the path's base layer itself. This can be blinded with whin dust or granite dust in order to fill up any voids and bind together loose stone. This method is very economical as it requires the minimum amount of material. However, use and weather will quickly expose the stone surface below, which will require regular patching and compacting.

Whin dust and granite dust can be laid on top of the base layer (usually about 25mm thick) and compacted. This will provide a reasonably smooth, even surface suitable for a variety of users. However, as whin dust is not free draining, frost heave and heavy rain can turn the surface to mush, making it unusable in winter or wet weather. Granite dust is free draining and less susceptible to frost heave.

Whin dust path.

Semi-bound surfaces

Semi-bound surfaces are based on locally available sources of natural or recycled aggregates and industrial waste by-products. These surfaces can be composed of many different combined materials such as limestone, shale waste or granite waste and screened road planings. They generally contain significant quantities of fine particles, which when wetted, start to 'set', and then 'harden' when dry, although not to the same extent as a bound surface. Newly laid surfaces can be loose, but will 'harden' to the point of becoming impermeable after a period of continuous use.

Semi-bound surfaces are often thought of as an intermediate between short-life unbound surfaces and long-life bound surfaces. However, the whole life costs of semi-bound surfaces may exceed those of a bound surface equivalent.

Toptrec path.

Bound surfaces

A bound surface is a combined layer of well graded aggregate glued together by a binder, such as bitumen. This top layer is called the 'surface course', a term used in road and pavement construction. Bound surfaces are much more durable than an unbound or semi-bound surface as the binder will prevent the aggregate being washed or worn away quickly. Bound surfaces will therefore be more suitable for steeper slope gradients and all year round use. It should be noted, however, that choosing a bound surface doesn't mean that drainage

provision can be reduced, as flooding may still damage the surface. It is also essential to protect a bound surface from weed growth either by using a suitable geotextile or residual weed killer. If a bound surface is what you require, seek specialist advice from competent surfacing contractors.

Impermeable bound surfaces used for most path applications fall into three categories: surface dressing, bituminous macadam (Bitmac) and hot rolled asphalt.

Surface dressing

Surface dressing involves spraying a thin layer of bitumen emulsion over an existing bound surface or a newly laid base layer, followed by rolling-in a layer of washed stone chippings. The objective of a surface dressing is to create a stable mosaic of stone chippings that are securely attached to the surface by the bitumen emulsion. The result is a sealed surface that protects against water ingress into the base layer below, and, in the case of resurfacing treatment, slows down the deterioration of the path to prolong its life and restores surface texture. Because the surface dressing is a very thin layer it is liable to crack if the path's base layer surface is uneven or poorly prepared.

Surface dressing provides the appearance of loose stone but creates a non-slip surface for users, even horses. The finished look of these surface treatments will depend on the colour of the aggregate used. Loose stone chippings must be swept from the finished surface as they can cause a slip hazard. The time period available for surface dressing is very narrow and the summer months are only really suitable. There can be a high risk of surface failure when temperatures are low.

Tar spray and chip path.

Bituminous macadam (Bitmac)

Bitmac is a combined mixture of well graded aggregate and a bitumen binder. It can be laid to various depths and is commonly used in road and pavement construction. The most common type of bitmac used in path construction is Dense Bituminous Macadam (DBM). Bitmac is very strong and durable. If laid correctly, the surface can last for 20 years or more without repairs being required. The smooth finish is very attractive to wheeled users, but frost and ice can make these surfaces treacherous in winter, so salt application may be required. Leaf litter can also cause problems, so overhanging trees may need to be cut back and leaf clearance included in the maintenance schedule.

Bitmac path.

Hot rolled asphalt

Hot rolled asphalt is a combination of a bitumen binder and fine, well graded aggregate. When it cools it sets to a strong flexible 'concrete'. It is very smooth and totally impermeable. Texture is achieved by rolling in chips after laying. Asphalt is more difficult to lay than bitmac and requires a skilled surfacing contractor. However, asphalt is more flexible and tends to deform rather than break apart if the path's base layer settles.

Porous surfaces

The issue of Sustainable Drainage Systems (SUDS) cannot be ignored, particularly in urban situations where a smooth surface is required. If surface water can be dispersed 'at source' it will reduce the need for systems to store and drain storm water.

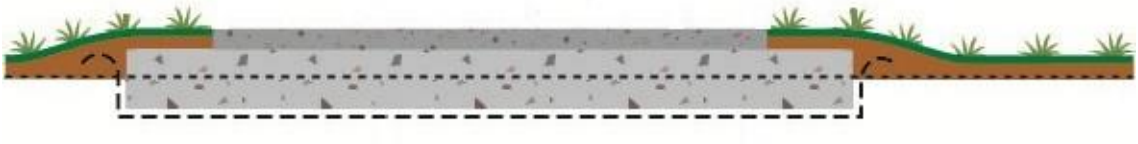
In order to produce a porous surface, the path's base layer also needs special preparation – it must be free draining, uniformly graded aggregate with no fine content, relying on the spaces between particles to allow water to pass through. However, the base layer needs to be constructed above the water table to avoid becoming waterlogged, and therefore ineffective.

Two techniques that give a similar durable finish to bound surfaces are porous asphalt and resin-bound aggregate. Both surface types need to be laid by specialist contractors and use hot bitumen or UV resin respectively to bind the surface layer together.

Reinforced grass or gravel systems can also be used to construct a porous surface, using interlocking plastic cellular pavers to provide structural strength.

Edges

It is essential to support path edges to prevent lateral spread of the base layer and to protect the edges of the surface layer. Ideally the base layer is wider than the finished surface layer, with landscaped turfs providing a soft edge. This method increases the formation layer width and disturbance, so may not be suitable for some sensitive areas. However, it does give extra support to the path edges, and, can be very beneficial where path usage is high and the route is occasionally accessed by vehicles for maintenance purposes.



Edging on a partly excavated formation tray

In sensitive areas or where corridor space is limited, the base and surface layers are kept at the same width. The undisturbed sides of the formation tray will provide adequate support to the path edge. Some vegetation encroachment will occur, but this may be desirable to give a visually softer path edge for a more natural look.

Edging on a fully excavated formation tray

2.2.6 Path building materials

In most path construction projects, you will need to find suitable construction materials for the base and surface layers.

Construction materials used to build paths are called 'aggregates'. Aggregates are generally from natural, recycled or industry waste by-product materials used in construction, which are described by size, angularity, etc. Aggregates are generally sold as mixtures of different particle sizes, where each one is designed for a specific purpose. Aggregate mixtures, are generally described either as traditional mixtures, (20mm down to dust) or standardised mixtures based on the Department of Transports' Specification for Highway Works (SHW) (Type 1 granular sub base). Aggregates are also defined by compliance to British Standards (BS) or European Norms (EN) standards.

Type 1 aggregate.

Aggregate mixture sizes are determined by standard range of sieve sizes used for sieving during the materials production at a quarry. Standard sieve sizes are: 80mm, 62.5mm, 40mm, 32mm, 20mm, 16mm, 14mm, 10mm, 8mm, 6.3mm, 4mm, 2.8mm, 2mm and up to 0.063mm.

Under European Norms standards, aggregate mixtures are determined by the size of sieve that the aggregate does not fit through (lower range d) and the size of sieve that all aggregate must pass through (upper range D). The standard formulae used to write a European Norm aggregate mixture is d/D. For example, Type 1 granular sub base is specified as 0/32.

Following the SHW specifications, aggregate mixtures consist of several aggregate sizes mixed together in known proportions, with size distributions described by the meaning of 'grading', as follows:

- **'well graded'** - contains a good range of different particle sizes in the aggregate mixture which allows it to naturally interlock, forming a strong solid mass once compacted
- **'uniformly graded'** - contains mostly particle sizes of the same size in the aggregate mixture which interlock less when compacted, leaving plenty of voids.

Aggregates used for path construction are generally of high quality. If won 'as dug' aggregates or recycled aggregates are locally available, these materials should be considered first, before quarried aggregates. Such aggregates depend on availability and suitability, but if a particular type of material is required it must be specified clearly. Before using these aggregates, obtain a sample to check it out, and test it to ensure it will perform to your requirements, before purchasing.

Making the grade

In many parts of Scotland naturally occurring deposits of glacial material lie beneath the soil, which can be won and used to build the base layer and, in some circumstances, the surface layer if suitable. Materials that are found on site are called ‘as dug’, which is won from excavated pits called ‘borrow pits’. Make sure that you get permission to dig borrow pits first.

Looking for suitable materials in a borrow pit.

A simple material test can be used to decide on whether the materials on site are likely to be suitable, or if recycled or quarried aggregates will need to be transported-in to site.

Using local as dug or recycled aggregates that may be highly variable in quality and not suitable for a path, choosing commercially available aggregates produced to the Department of Transports 'Specification for Highway Works' specifications, is a safe and better option, as minimum standards in grading and material quality are monitored.

2.2.7 Planning to do maintenance

One of the fundamental considerations for path construction is how you intend to maintain the network. You will need to be able to secure resources for the long-term management of any path infrastructure you build from scratch or upgrade. That could be money to pay contractors, staff or finding a source of volunteer labour. However, many funding organisations are reluctant to sign up to ongoing 'obligations' or revenue funding. Ultimately you may find a conundrum of being able to secure the capital funding to build a path but struggle to match that with a long-term commitment for maintaining what has been built or upgraded.

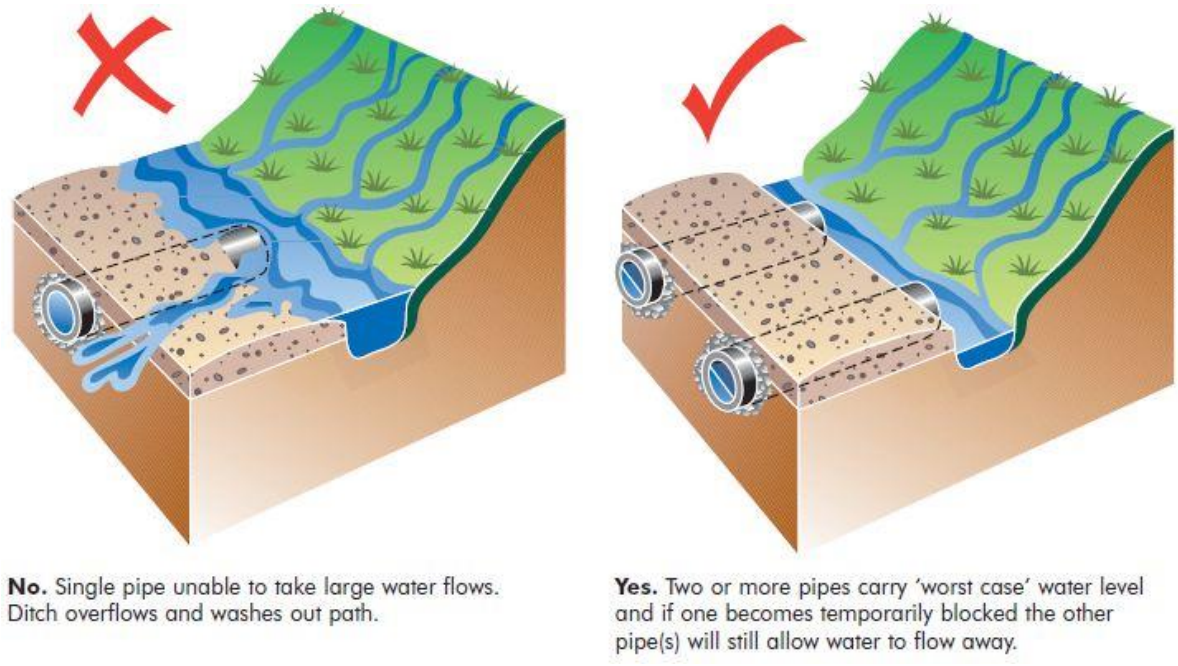
Each path within the network needs to have a maintenance schedule – which could vary from annual inspections to frequent grass cutting. As part of the initial planning for your network, you will need to strike a balance between the level of construction and the ongoing maintenance. Highly engineered paths still need some routine maintenance, and in some cases, it may be more appropriate to undertake low-key improvements coupled with ongoing maintenance to retain that level of reasonable condition.

Reducing maintenance requirements

When creating a new path, or significantly upgrading an existing one, try to design all the features to require the minimal level of maintenance. The good practice techniques described in this guide are summarised in the following table.

Good practice in reducing maintenance requirements
make the drainage system capable of carrying the largest possible water volume likely to be encountered in an area, allowing for some blockage by silt, debris or vegetation
use multiple pipes in a ditch system. If an individual pipe becomes blocked others will ensure the drainage system still functions properly (see image below)
build catch pits in French drains (filter drains) to allow silt removal and easy cleaning of all pipe sections. Line filter drains with geotextile to reduce the amount of silt getting into the free draining stone
try to make ditches 'self-cleaning.' Aim for a gradient of 1:40 or greater, but less than 1:15 to avoid scour and erosion
avoid using timber edging as it will require periodic replacement, will not stop vegetation encroachment and can prevent shedding of surface water. If 'hard' edging is required because, for example, weak soil needs the extra support, consider using recycled plastic edging instead of timber, which does not rot. If you do use edging make sure the path surface level is finished above the top edge, so surface water can easily run off, unimpeded by the installed edging or landscaped verges
ensure path verges are smooth and level to allow easy grass cutting by mower or flail

keep the path edge at least 3m back from tree canopies to reduce leaf litter and prevent tree root damage to the path surface. Use careful route choice to achieve this with minimum tree removal
ensure efficient removal of surface water to prevent scouring or the formation of rain ruts
select a path surface that is appropriate to the gradient. If a bound surface is undesirable, reduce the path gradient to suit an unbound or semi-bound surface
ensure path construction is robust enough to take maintenance plant and equipment without damage
be generous when specifying the path's base layer depth. A heavy vehicle may cross or use a path – legitimately or not –and a strong base layer will allow this without serious damage occurring
be generous when specifying the path's width. Path users or maintenance vehicles travelling along a narrow path may damage the path edges and verges – a wider surface will allow users or vehicles to remain on the path



Use multiple pipes in a ditch system.

2.2.8 Deciding which path to take

There are a multitude of path construction and management options, many of which will depend on the considerations already outlined.

You will need to work out what the network has to provide and who is going to use it, rather than approaching from what you think the path should look like. There are large variations in the cost of the different options, which you will also need to take into account. There may need to be compromises and some difficult decisions might need to be made – going through the planning steps also helps to give you a rationale for your choices which can be helpful when you need to justify the project to users, landowners or potential funders.

One way of assessing the opportunities and options available is to look at the 'whole life' costs. It may be cheaper in the long run to spend more on the construction and have a low

annual cost. However, if the location of the path is, for example, prone to flooding, it may be cheaper to maintain a low-key resource, rather than end up with a large repair bill for a high specification path that has been seriously damaged. The whole life assessment needs to look at the current level of demand and environmental conditions, but also requires some 'crystal-ball gazing' to evaluate the potential changes that might affect the path.

Surface	Pros	Cons	Long term management
Natural	Cheap, fits in well with the landscape	May not stand up to heavy use. Not easy for people on wheels to use	Vegetation will need to be managed on an annual basis. Surface wear and drainage need to be monitored
Unbound	Can provide a good surface for many activities. Hard wearing on level ground or shallow gradients	Surface is liable to scour if water is allowed on the path. Not very stable on gradients. Easily marked by horses during and after wet weather. Very susceptible to frost heave (whin dust)	Frequent maintenance required on gradients. Vegetation encroachment may occur
Semi-bound	Can harden to provide a durable surface. More robust on gradients than unbound surfaces. Suitable alternative where bound (sealed) surfaces are unacceptable in the setting. Cheaper to install than a bound surface	Materials may not be locally available. Susceptible to wear and tear if material is loose and not hardened off. May be affected by frost heave	May need occasional repair on steeper gradients
Bound	Can provide a very durable smooth surface. Good surface for wheeled users. Okay for horses on level or shallow gradients. Low annual maintenance costs	Very expensive to construct. Intrusive in some landscapes. Slippery where leaf litter covers surface. May need gritting in winter. Experienced surfacing contractors required for laying. Good access for plant required. Only suitable for laying in the summer	Annual removal of leaf litter required
Porous	Helps to meet SUDS requirements. Robust surface – reinforced grass can fit well into the landscape	Expensive to install. Base and surface layers need to be carefully constructed with tightly specified materials. Experienced contractors required for installation	Reinforced grass paths need regular inspections and aftercare (mowing / fertiliser application)

2.2.9 Planning for climate change

Scottish Natural Heritage commissioned a report about how path management is likely to be affected by climate change. The overall message was the need for careful long-term planning by assessing and controlling the risks posed by predictions of warmer wetter winters and drier summers.

There are two aspects to the predicted impacts of climate change:

- **chronic impacts** - slow continuous deterioration caused by the gradual change in weather patterns over an extended period of time
- **acute impacts** - rapid deterioration caused by severe weather associated with a changing climate.

It may not be possible to eliminate the risk posed by acute impacts and it is almost impossible to predict the probability of extreme weather occurring at a defined location, but this should not be used as an excuse to avoid forward planning. Approaching lowland path management in terms of creating and managing path networks provides a useful perspective for dealing with the challenge of climate change. Looking at a network as a whole gives you an opportunity to identify 'weak links', or critical points where action would be required in the event of acute impacts occurring and to look for alternative options to keep a network 'functional'.

There is limited 'generic advice' that will be useful, because of the enormous variation in paths across Scotland. Therefore, a risk assessment process can be used to identify the climate change hazards for your network, the probability of occurrence and the scale of impact. This produces a risk score which can be used to identify high, medium and low risks. These should be sub-divided into risks associated with Chronic and Acute impacts as they may require different adaptation approaches. For each high risk impact a 'control' or adaptation needs to be devised, which will provide a practical response to predicted climate change for the path network. This could include actions that can be taken in advance, such as changing the specification of drainage features to cope with increased surface water, or to identify (and hold) contingency funding to deal with very low probability but catastrophic events.

Some of the climate change hazards will be specific to the location of your paths – for example riverside paths may become more liable to flooding in wetter winters (chronic impacts) and bridges could be at greater risk of damage from extreme flood events (acute impacts). It is therefore important to use local knowledge of the landscape to plan your network to avoid unnecessary risks (e.g. multiple bridge crossings) or to look for adaptations to existing infrastructure to cope with predicted changes (e.g. upgrade unbound surface to semi-bound, bound or porous surface). Planning ahead can allow you to prioritise tasks so that you can make adaptations over a number of years, rather than needing to use emergency funds when something catastrophic occurs that could have been prevented.

Coastal paths are an extremely popular concept and have been built to varying standards across Scotland. They are, in many cases, susceptible to damage during extreme weather events and there may be limited options for providing alternative routes where damage does occur, e.g. following storms. Careful consideration about the long-term planning and management of coastal paths is therefore of high importance to ensure that existing investments are adequately protected and unsustainable schemes should be avoided, even where there is demonstrable demand.

Climate change may also bring opportunities in Scotland, particularly if summers do turn out to be warmer and drier as predicted. More people may be inclined to use paths and increased demand could be beneficial to securing resources for more and better paths. Providing opportunities for 'active travel' could also help to encourage more people to switch away from using motorised transport and thereby reduce society's impact on the environment.

2.2.10 Permission to proceed

Before you can start any path construction work, you need to consider who needs to be informed of your plans, and whether there are any legal procedures that need to be completed. Trying to catch up and work retrospectively is more difficult and can be costly.

Working with landowners

When you are planning your path network you need to be aware of the needs of land managers as well as those who are likely to use the paths. A common issue that arises in the development of path networks is being able to find ways to provide access for the public with minimal impact on a land manager's operations. Many land managers are realising that paths can be beneficial in managing public access to their land and that they do not have any additional liabilities under the Land Reform (Scotland) Act 2003 if people exercise their right of responsible access.

You may find it helpful to discuss ideas with land managers at an early stage in your planning. These discussions may help to identify new opportunities to resolve existing issues as well as avoid creating additional problems. This will also help to define expectations on all sides as there is limited value in trying to build a new path through an area that would have a negative impact on land management operations. Equally, you may be able to persuade a land manager to provide alternative access that will reduce the potential for conflict with their operations.

Realistically there are very few land managers who will allow a path to be built where it will have an adverse impact on their own interests and you may find that some land managers are wary of encouraging public access on their land. There are, however, some benefits for land managers where paths provide an inviting alternative to 'roaming' across the countryside. You may even be able to help unlock funding for the landowner to undertake some of the proposals. Some opportunities exist to improve access that will also benefit the land manager, but you will need to be careful to demonstrate the public benefit of the work, and you could look at asking the land manager for a contribution towards improvements that they may otherwise need to instigate themselves.

If you are looking for funding towards path development it is likely that the funder will ask for some form of legally binding agreement that will secure the investment. This could be a lease or a licence agreement. You will probably need to cover the reasonable costs of developing any agreement.

Planning consent

Local authorities take different approaches to paths across Scotland so it is probably best to speak to your local authority or national park authority access officer and the authority's development planning department, rather than to assume that you can just get on with developing your path network.

If you anticipate building new paths you will probably need to get planning consent from your local planning authority, or may be national park planning authority if the new path to be developed is situated in a national park. Some upgrades of existing paths may be classed as 'de minimis' or permitted development depending on their location. Where you intend to use signs or interpretation around your network, these may be subject to Advertisement Consent, but again this varies between local authorities.

Natural and cultural heritage designations

You will need to make sure that any proposals do not have an adverse impact on natural or cultural heritage, in particular sites that are protected by law. Scottish Natural Heritage and Historic Scotland are the two bodies charged with protecting the natural and cultural heritage respectively.

Natural Heritage

The natural heritage, such as the landscape or wildlife, around path networks is part of the attraction for many people who use paths, but it is important to ensure that the path does not have a negative impact on that natural heritage. Some areas are protected by law and you will need to check with your local Scottish Natural Heritage (SNH) office whether your paths pass through a designated site.

Depending on the legislative status of the site you may need to get permission to undertake the work and this could affect how you do it, as well as where and when. For example, there may be restrictions on disturbance of birds at certain times of year, or some habitats may be sensitive to damage during the construction phase. For some designated sites, such as a Special Area of Conservation (SAC), you may need to provide information to allow an 'appropriate assessment' of your proposals to be made by a 'competent person', to ensure that the designated features will not be significantly impacted on by the path construction work. The scale and scope of that assessment is meant to be proportionate to the proposed work. The best advice is to contact Scottish Natural Heritage and ask for their assistance with minimising any impacts, or helping to enhance the natural heritage around your path network.

Reinforced grass path on the floodplain of River Dee SAC.

Cultural Heritage

As part of the early planning stages, identify historic sites and features of interest and importance around your path network, preferably assisted by an archaeologist. This will ensure that you avoid inadvertent damage to historic sites, and that you are able to make the most of opportunities for enhancement and interpretation of historic features.

Some existing paths may be historic sites themselves – for example, paths following old drove roads, ancient Roman roads or historic towpaths [Heritage Paths]. The fact that a route has been around for hundreds of years is an attraction in itself for users. It may also offer useful pointers when thinking about what is appropriate by way of upgrading or replacement. For example, paths which follow former railway track beds will have a different character to those which follow old farm tracks, while those following Roman roads may require special treatment. In this context you may wish to consult the Historic Landuse Assessment (HLA map) website, which is a source of useful information about earlier land uses.

Some historic sites are protected by law as scheduled monuments and must not be disturbed. You will need to discuss any proposals that relate to changing access to or across scheduled monuments with Historic Environment Scotland.

2.2.11 Project team considerations

For your path project to be successful, it is important to consider and appoint a project team to design, plan and manage the project for you. The consideration of who you appoint should happen at the early planning stage, and their appointments made as early as possible, so their involvement provides a real benefit to the project.

Regardless of your projects size, complexity and risks, who you appoint into the project team will depend on how many contractors will be involved in construction stage. The CDM Regulations 2015 separates construction projects into two types based on how many contractors will be working on site at any one time.

The two types of project are:

- **one contractor project** - if your project only needs one contractor to carry out all of the work, you will need a designer and contractor. An example of where this might happen - one contractor resurfacing a tarmac path when no other contractors are required to do any work.
- **more than one contactor project** - if your project needs more than one contractor to carry out different parts of the work, you will need a principal designer and principal contractor. For example, a contractor building the base layer of a new path (including groundworks and landscaping works) and a surfacing contractor laying the new tarmac surface. The contractor who builds the base layer would be principal contractor and the surfacing contractor a sub-contractor, under the control of principal contractor.

Others to consider for large and complex projects

Project manager

You may choose to appoint a project manager to represent you and to act as the lead person for the day-to-day management of the project, where you do not have the skills, knowledge, and experience to manage a large and complex project. If you have asked them to (in

writing), the project manager will provide advice and assistance in managing all key tasks connected to the project, such as:

- preparing a client brief
- managing risks and changes
- managing a project budget and programme
- appointing a consultant as required
- deciding on procurement options
- seeking project funds
- managing project recording arrangements
- carrying out clients CDM responsibilities.

Quantity surveyor

You may want to appoint a quantity surveyor to provide cost advice and assistance to the project manager during the project, on:

- preparing cost estimates
- preparing bill of quantities
- developing and preparing tender document
- dealing with tender queries
- receiving and assessing tenders
- preparing the tender report (with recommendations)
- monitoring project send
- preparing and issuing regular cost flow reports
- dealing with measured valuations
- dealing with interim payments
- assisting with negotiations, if any work variations (changes) occur
- cooperating with contractor (or principal contractor) on final contract and defects period payments.

2.2.12 Getting expert help

If you go along with the principles in this guide, you should gain a good understanding of good practice in path project management. However, delivering small or large path projects does need skills, knowledge, and experience of designing, planning, and managing projects, as well as health and safety coordination and management. Whether you need external help or not, will largely depend on the in-house capabilities available within your own organisation, as well as the size and complexity of a project. The level of risk with the project will also have a bearing.

There are a small number of external consultants and contractors specialising in path project management, who have the skills, knowledge and experience of lowland path construction practices and health and safety.

There are also civil or structural engineering companies with engineers, who will have some experience of path construction projects. These engineers will be able to design larger structures such as bridges or earthworks, and will have extensive knowledge and experience of construction design and management (CDM), and other health and safety regulations.

You could speak to other organisations who have used particular contractors or consultants in the past for delivering their path projects. Word-of-mouth can prove invaluable. Alternatively, check out the Community Path Contractor List on Paths for All's website.

When looking to hire consultants to do design work produce a 'client brief' outlining what you want them to do. You need to be confident that the consultant you appoint is suitably skilled, knowledgeable, and experienced in path design work. You can ask consultants bidding for the work to provide specific information about their health and safety training, design decision-making experience, and hazard elimination and review procedures. You could also ask them to provide evidence of previously completed design work relating to similar path projects like yours.

When you assess a consultants' suitability to work on your project, you could also ask them to provide information about their membership of any relevant professional bodies, such as the Institute of Civil Engineers. However, some designers may not be members of a professional organisation, as they do not have qualifications in a civil or structural engineering or health and safety disciplines. In this case, you need to rely on evidence of their previous experience working on similar path projects.

2.2.13 Health and safety

One of your first important tasks in commencing a path project is the consideration of health and safety at planning phase. Many people feel that health and safety is a burden, creates extra work, and costs a project more money. If, however, you consider health and safety as part of the project, right from the start and not as a bolt-on extra, you will see that it is an important part to making sure a path project is successful and safe to build, and when finished safe to maintain and use as well.

Everyone involved in a path construction project has 'duty of reasonable care' towards each other, and must comply with legal duties (responsibilities) set by health and safety law and regulations. Equally those affected by the work, e.g. members of the public, should also be protected from the risks created by those who make them. Accidents can have serious financial implications for organisations, which could lead to adverse publicity, and a lack of trust. In the worst-case scenario, accidents can also have a significant and long-lasting effect on the individual involved. So, don't ignore health and safety – integrate it in to your projects from the beginning.

There are several health and safety regulations that affect the undertaking of path construction projects, for example, the Construction (Design and Management) Regulations 2015.

Construction design and management (CDM)

On 6 April 2015, the Construction (Design and Management) Regulations 2015 replaced the 2007 CDM regulations.

Regardless of project scale, complexity, and level of risks and number of contractors involved, your path project will need to comply with the Construction (Design and Management) Regulations 2015 - referred to as CDM or CDM 2015.

CDM 2015 is the main set of regulations for manging health, safety and welfare on all small or large construction projects (this includes path, bridge or boardwalk projects), and applies to all

construction work as well as maintenance. The main point of CDM 2015 is to integrate health, safety and welfare into designing, planning, and management of construction projects, but also to:

- make sure that health and safety issues are properly considered during a project's development so the risk of harm or ill health to those who have to build, maintain, use the structure is removed or reduced to acceptable level
- make sure that the people involved in a project team are working together to deliver a successful and safe project - the individuals (or organisations) in the project team should treat health and safety as a normal part of a project's development - not an afterthought or bolt on extra.

CDM 2015 requires individuals or organisations to be appointed (in writing) at the right time to carry out the roles and responsibilities of 'duty holders' in the project team. The organisations or individuals you appoint can carry out the role of more than one duty holder, provided they have suitable skills, knowledge, training, and experience, and (if an organisation) the organisational capability, necessary to carry out the roles in a way that secures health and safety.

The five main duty holder roles are:

- **Client (non-domestic)** - an individual or organisation who has a construction project carried out for them, or does it themselves. A client, generally the project initiator, could be community volunteer group, community council, development trust, local or national park authority, access or countryside trust, or a partnership of more than one organisation or individual.
- **Designer** - an individual or organisation whose work involves preparing or modifying designs (drawings, specifications, bill of quantities, or calculations, for a structure, e.g. path, bridge or boardwalk, or a product, e.g. type of anti-slip surfacing material to go on decking boards on a bridge or boardwalk) relation to construction work.
- **Principal designer** - an individual or organisation who plans, manages, monitors, and coordinates health and safety at pre-construction stages of a project (when most design work is carried out). They are a designer, generally a 'lead designer', appointed by the client of a project with more than one contractor. This duty holder is a new role replacing the CDM co-ordinator (a former role under the CDM Regulations 2007).
- **Contractor** - an organisation or business in charge of carrying out the actual construction work - anyone who carries out their own work, directly employs, or engages workers to do the work is a contractor. A contractor (on a project only with one contractor) has a responsibility to plan, manage, monitor, and coordinate and control their own work, as well as health, safety and welfare on site. On the other hand, if working on a construction site, where more than one contractor involved, they will be under the control of principal contractor, whilst doing the work.
- **Principal contractor** - an organisation or contractor appointed by the client of a project with more than one contractor on site at any one time. A principal contractor plans, manages, monitors, and coordinates the construction work and health, safety and welfare of own workers but also of other contractors on site.

The sixth role but not a main duty holder role is the 'Worker' - an individual working for a contractor on a construction site, or organisation doing their own practical work.

Don't ignore CDM...

The time and effort from the above duty holders invested at the start of, and throughout a path construction project will pay dividends not only in health and safety, but also in:

- reduced project delays
- more reliable project costs and completion date
- improved communication, cooperation and coordination between everyone involved in the project
- improved quality of finished path, and any other structures, e.g. a bridge, at the end of the project.

So, integrate CDM into a path project (or bridge, or boardwalk project) from the beginning and throughout to the end.

Project benefits of CDM

The aim of the Construction (Design and Management) Regulations 2015 (CDM) is to make health and safety an essential part of delivering successful path construction projects. The CDM prioritises the safety of everyone working on the construction site where the path is being built, and to those who will be maintaining or using the path once finished.

If you are going to be involved in a path construction project for the first time, are not familiar with CDM, or see them as an obstacle to overcome. Don't be put-off, CDM can provide your project with a number of key benefits, even beyond health and safety improvements.

Improved planning and management

Improved planning and management of a path construction project can help to ensure that health and safety risks are removed or reduced and controlled. But also, good planning and management will benefit your project, helping to make sure it is completed on time and budget, and to the required good practice.

Safer and healthier sites

The key purpose of CDM is to remove if possible or reduce the risk of accidents and ill health. The fundamental benefit for those that fully comply with CDM will be a safer and healthier site and reduced risk of accidents and ill health.

Reduced costs

At first it may seem that CDM increase costs. Yes, there will be additional costs that you need to budget for and find the funds. However, as CDM requires members in the project team to work together, and focus on better design, planning and management - unexpected problems, changes, and accidents during the construction phase should be reduced - last minute changes, problems and accidents can be costly for a project.

Reduced delays

CDM requires much more consideration to be given to good designing and planning at the earlier stages in a project. Therefore, the consequences of decisions, and the implications of the work should be finalised before pathwork commences on site. This allows time for properly programming the work in ahead of time reducing the risk of delays during the construction phase.

Safe to use

Safety on site when a new bridge is installed is important, but it is also important that the structure is safe to use once complete. Those slippery boards on the bridge should be a thing of the past, as the bridge design should remove the slipping hazard if possible or reduce the remaining risk to users to reasonably acceptable level.

Look to the future

Paths and their related structures change over time through wear and the weather. Maintenance will be needed to meet those changes. CDM requires the safety of those carrying out any major repair, replacement, improvement, upgrading or demolition/ dismantling work in the future to be considered. The health and safety file (if one is available) contains important health and safety information for future works - sound knowledge of remaining or unobvious safety and health risks makes planning future works much easier.

Will CDM apply to our project?

This is one key question that you need to answer at the beginning of any path project. You may feel that the Construction (Design and Management) Regulations 2015 (CDM) does not apply or does not have any relevance to your project. For example, you feel that the project is small scale and nature of practical work is not construction work.

The important thing to remember is that every path project involving construction, maintenance work is a CDM project. CDM will apply to all path projects, in spite of size, the number of working days, how many contractors are involved, or people working on site.

CDM is there to improve health, safety and welfare on all path projects, especially small projects where improvements are urgently needed. It is all about designing and planning the project well and doing the pathwork safely so no one is hurt, or suffers ill health.

So back to that question - Will CDM apply to our project? The answer is yes, CDM will apply to your project when pathwork, including bridge or boardwalk installation work, is carried out.

When is our project notifiable?

The Construction (Design and Management) Regulations 2015 (CDM) will apply to all path projects when pathwork, or even bridge or boardwalk installation work, is carried out.

Some of those projects will be 'notifiable' projects that need notifying to the Health and Safety Executive (HSE), whilst others will not.

Your project is only 'notifiable' to the HSE if the work will, is expected to:

- last MORE than 30 working days and have MORE than 20 workers working on site at any one time, or;
- involve MORE than 500 person days.

If your project will or you expect it to exceed either one of those notification thresholds above, then it is 'notifiable' to the HSE under the CDM Regulations 2015.

If it does not exceed any of those thresholds, you do not need to notify project to the HSE - the project will then be classed as a 'non-notifiable' project.

It is worth noting, that project work carried out before the construction phase begins should not be considered and included. For example, design work carried out by the designer at the projects design stage of pre-construction stages is not required.

It is also important to note the following points:

- **a 'working day'** is classed as any day, or part of a day, on which construction work takes place. Even if the planned work will only be for 2 hour duration, it will need to be classed as a 'working day' when determining if the project is 'notifiable'. So any day on which work takes place during construction phase should be counted. What matters is how many days of construction work the project entails, not when these days occur, or the start and finish dates.
- **a 'person day'** relates to one individual who carries out construction work on one individual day. It includes workers, plant operators, etc. But they do not actually have to be carrying out any manual work or operating plant to be involved in construction work - if the person is supervising or managing the project on site they must be included as a 'person day'.

As a general rule, you should calculate the number of working days and number of workers working on site at same time, first. If the project passes that threshold, then your project is 'notifiable' and you need not worry about the 'more than 500 person days'.

Who must notify our project?

As the client, you must notify your project to the HSE when you expect it to be 'notifiable'. In practice, you may ask someone else to do this on your behalf, e.g. principal designer.

You must give notice in writing to the HSE, as soon as practical before the construction phase begins. The written notice must contain the information in Schedule 1 of the CDM Regulations 2015, for example, the address of the site or exact description of its location.

The easiest way to notify your project to the HSE is to use the online electronic interactive form called 'F10' on HSE's website - click here to find out more and access the F10 form.

Construction site.

What is ‘path construction work’ under CDM?

Before answering the question, it is necessary to understand first - what is 'construction work' under CDM?

The Construction (Design and Management) Regulations 2015 provides us with definition of what 'construction work' means: 'The carrying out of building, civil engineering or engineering construction work'.

But the definition is even broader, and includes:

- the construction, alteration, conversion, fitting out, commissioning, renovation, repair, upkeep, redecoration or other maintenance (including cleaning which involves the use of water or an abrasive at high pressure, or the use of corrosive or toxic substances), de-commissioning, demolition or dismantling of a structure
- the preparation for an intended structure, including site clearance, exploration, investigation (but not site survey) and excavation (but not pre-construction archaeological investigations), and the clearance or preparation of the site or structure for use or occupation at its conclusion
- the assembly on site of prefabricated elements to form a structure or the disassembly on site of pre-fabricated elements, which immediately before such disassembly formed a structure
- the removal of a structure or part of a structure, or of any product or waste resulting from demolition or dismantling of a structure, or from the disassembly of pre-fabricated elements, which immediately before such disassembly formed a structure
- the installation, commissioning, maintenance, repair or removal of mechanical, electrical, gas, compressed air, hydraulic, telecommunications, computer or similar services, which are normally fixed within or to a structure.

(Source: Managing health and safety in construction, Health and Safety Executive (HSE))

So, what is 'path construction work' under CDM?

Here we have provided some examples of path construction work and other work that is 'construction work' under the definition of CDM. These examples should help you to identify if your path project will involve 'construction work':

- constructing a new path with or without other structures
- re-alignment, extending, repairing, replacing, improving or upgrading, and re-constructing an existing path with or without other structures
- constructing and erecting a new bridge, boardwalk
- repairing, demolishing or dismantling part of an existing bridge, boardwalk
- putting in a temporary access route for hauling materials in to a construction site where a structure, like a path is being constructed
- putting in a temporary structure, like scaffolding, to support a new bridge and to provide safe and accessible working platform when the bridge is being installed
- clearing site vegetation along route in preparation for path construction work
- mobilisation or de-mobilisation of site welfare facilities, plant, equipment and materials storage areas, including site fencing, if required before path construction work begin
- excavations for drainage system, earthworks, formation tray
- digging trial holes for investigating suitability of on-site materials for path construction work
- erecting or dismantling entire or part of a prefabricated bridge, boardwalk
- disposal of entire or part of a bridge, boardwalk.

Groundworks.

Will our project involve more than one contractor?

In most cases and particularly small projects, one contractor will carry out all the path construction work. If, however, the contractor chooses to hire other contractors to do parts of the work - then there will be more than one contractor involved at construction phase. For example:

- a large excavator is needed to do earthworks and groundworks - the main contractor hires a plant contractor (excavator and operator) to do that work - the plant contractor becomes a sub-contractor directly under the control of main contractor
- a tarmac path to build and large bridge to install - the main contractor carries out the site clearance and groundworks, builds the base layer for the path, and does the landscaping work once paths finished - a surfacing contractor will lay the tarmac surface and specialist bridge and crane hire contractors will install the bridge, all under the control of main contractor.

If your project is going to involve (or you foreseeable expect) more than one contractor to carry out the work on site at any one point, you need to appoint (in writing) a principal contractor under the CDM Regulations 2015. You must appoint this duty holder to your project team as soon as practical, before the construction phase begins. If you do not appoint them, you must fulfil their CDM role and responsibilities (duties) on your own project.

The principal contractor needs to be a skilled, knowledgeable, and experienced contractor, who will plan, manage, monitor, and coordinate the path construction work and any other work - they may not actually do any of the work themselves as other contractors appointed by them and under their control, will do it. The principal contractor is generally appointed at tender stage of pre-construction stages and the other contractors before construction phase begins - but if you need the principal contractor to do any design work, under control of principal designer, you appoint them at planning stage to start the design work at design stage.

If your project is only going to involve one contractor working on site, you will need to appoint (in writing) a contractor only - no principal contractor required for project.

2.2.14 Paths and green networks

Paths obviously do not exist in a vacuum and working out ways to improve the environment around a path will have benefits for the people using the path (a better experience) as well as the environment itself (improved biodiversity). One of the ways of thinking about this is to look at the idea of linking path development with green networks.

A green network is made up of the greenspaces that are found within and around villages and towns, which link out to the wider countryside. It can include areas such as parks, graveyards, allotments and other open space within an urban area as well as the larger green spaces such as woods and grass fields in rural areas. Crucially, green networks can also include paths, and other transport corridors.

Green space.

Green networks can help improve the biodiversity of an area by allowing plants and animals to survive and move through built up areas. But green networks are also designed to benefit people. A good green network will incorporate paths and other active travel routes so that more people can get around without having to use their cars. This is not just good for the health and social well-being of the people who live there – having good access to green spaces can have economic benefits as well. For example, developers will be able to get a better price for houses in areas with good green networks and businesses may be more likely to have their offices in places where their employees can get out and about. That means green networks can have social, environmental and economic benefits, so many local authorities are keen to develop them in their areas. Some Local authorities are now producing supplementary planning guidance on green networks (for example, this is what Highland Council has produced - Green Networks - Supplementary Guidance) and may have mapped out potential green networks in their areas. Within the central belt, there are several green network projects – including the Central Scotland Green Network and the Glasgow and Clyde Valley Green Network.

If you are developing a path network in your area, it should link in with any emerging green networks. You can check with your local access officer to see what planning guidance and green networks mapping have been produced in their local authority area. If there are indicative maps published, you should be able to see how to ensure your paths fit within this bigger network. If maps have not been published, you should still try and think about how your paths can have maximum benefit. For example, are there places where a new path will link up two green space areas? Can you create a wildlife corridor that will also serve as a route for

commuters to use to get to their shops, offices or school? Could you improve the design of your path to ensure it has maximum environmental benefits, or conversely, are there areas which are currently just being used by wildlife (for example, tree shelter belts) which you could use as part of a path network?

The precise details will vary depending on your local situation, but the over-arching principle is to look at the surrounding landscape when planning your projects. That way your path can have multiple benefits and, because green networks are important to the government, you will have a better chance of getting funding.

2.2.15 Path surveys

In order to plan your path or path network effectively you need to gather enough information to help you make decisions, work out how much it will cost, and then take appropriate action. However, it is a waste of effort to undertake a highly detailed survey at an early stage – this is best done when you have decided to work on a particular path. The following survey types (adapted from the survey methodology used for upland paths, which were developed for the Upland Path Advisory Group) should help you to prioritise the collection of information to make sure you have enough at each stage of the planning phase:

Descriptive (Green) survey	desk-based collation of information about a path or network
Condition (Amber) survey	rapid assessment for looking at the condition of a path or network
Specification (Red) survey	detailed assessment of path repair, replacement, upgrade or construction needs.

Descriptive (Green) surveys

A descriptive 'green' survey brings together the basic descriptive information about the path: who uses it; the terrain it crosses and who owns or manages the land around it.

The purpose of the survey is to provide you with enough information to make decisions about what type of action is required and any issues that will need to be considered, or dealt with at early stage in a project. It is essentially a desk-based exercise, but a site visit can help to get an idea of path condition and the type of path construction work required.

The information contained in green surveys has been agreed by Upland Path Advisory Group and follows a standard format. However, this has been adapted to be more appropriate for the use of lowland path management.

The survey should collect as much of the information in the following table as possible.

Path feature	Survey information
Setting and features	route description (type of path, where it goes and any links or gaps, landscape features, etc) associated features (car parking, directional signs, tea shop, etc) location (proximity to settlements, transport options)
Users	current user groups, activities, frequency of use (manual or automatic counter data)
Physical setting	land use and management (including access restrictions) geology and topography watercourse locations (including known wider site drainage issues) weather trends (including snow levels, rainfall, etc)
Designations and status	Natural Heritage interests (Site of Special Scientific Interest (SSSI), National Scenic Area (NSA), Special Area of Conservation (SAC), etc) cultural Heritage interests (Scheduled Ancient Monument (SAM), etc) access status (Core Path, Right of Way, Long Distance Route, Local Network, etc)
Land ownership and management	owners' name, address and contact number
Assessment of path condition	visual – how bad does it appear? safety – are path workers or users in danger as a result of the path condition or other site hazards (steep slopes, mine shafts, cliffs, contaminated land, etc)? physical – existing surface condition, known physical barriers, known structures (bridges, gates, signs, seats, etc)
Assessment of path construction work	previous path management (including maintenance) path condition (overall assessment) construction considerations (access, materials, public utility service locations, etc) work identified (major repairs, upgrade, replacement, construction)
Development issues	design and style of construction priorities (general rating low, medium, high) planning permission (yes, no or possible but not sure)
Health and safety file	is there a Health and Safety File available (yes or no)? If yes, make note of its name, where it is kept, and in what format (Word or PDF or hard folder)
Additional information	for example, details about potential funding sources or a description of how the path fits into an access strategy

Sources of information

Using the data to be recorded in green surveys as a checklist, the first step is to look for existing information about the site. Relevant information will be available from a variety of sources:

- local authorities are a key source of information. Look for access strategies and local development plans. They may have information about planning requirements, existing survey data, maps and photographic records. Many local authorities also fund access work and will give advice about their policy
- Paths for All will be able to point you towards a community path group or local access officer who may have specific information about a path or network
- community councils may have access to information about local historical points of interest, estimates of levels of use, alternative local routes and shortcuts. Information gleaned from community councils may be more anecdotal than that provided by local authorities, but it can be useful
- Scottish Natural Heritage (SNH) will provide detailed information about nature conservation issues and access strategies and legislation. SNH offices hold a wealth of useful reference material, which may include aerial photographs of the relevant area
- landowners, factors, land agents, farmers or estate managers will know all about the ground they manage on a day-to-day basis and may be able to provide useful information about many areas of paths and access management on their land. You will need to find out about how they manage their land (i.e. farming, shooting, recreational activities, woodland or forest management, vehicle access), and how that might impact on paths, and vice versa. Pay particular attention to livestock management. Sometimes improving a path can help land managers to do their work more easily
- path users who use and know the path may be able to provide detailed information about path development and drainage during heavy rainfall/thaws, seasonal variations, etc. You may be able to find information from organised groups affiliated to Ramblers Scotland, British Horse Society Scotland or International Mountain Bike Association UK. Your local access panel may be able to help in relation to people with disabilities. For contact details of your local access panel visit the Disability Equality Scotland website.
- organisations such as local tourist information centres and businesses that promote access may be able to provide information about visitor numbers etc

Do not expect to find information on every aspect of your path or path network: most green surveys contain information in only half or two-thirds of the categories. However, if you are not able to find some basic information, then it will need to be collected. Additional green data can be added as it becomes available, and **it is not necessary to have all aspects covered** before starting to manage the route.

Condition (Amber) surveys

If you are looking at more than one route, or working more widely on an area basis, you may wish to collect information about the current condition of all the routes before deciding where to focus your efforts. This is effectively a reconnaissance stage and you will need a consistent method of collecting data that can be compared between routes. This information can then be used to decide how much work is necessary, whether surveyed routes can be repaired, upgraded or constructed, and should help to inform priorities about which routes would provide the greatest benefit for the investment. You may also be able to make an indicative estimate of costs to repair, upgrade or construct each route. An amber survey is used to

collect this information, which will be a mix of measurement, descriptions and assessments about the routes.

Amber surveys measure the condition of routes using a series of more than 30 measurements for each section of the route. The measurements collected cover the physical characteristics of the route such as slope, width and other real figures, along with assessments of condition, drainage and dynamism (how quickly change is likely to occur).

The amber survey method is designed to be fairly quick and, if required, more detailed information can be collected later using the red survey [internal link] method. Try not to get bogged down in too much detail, there will be variations along a route and it is not necessary to capture everything at this stage.

Although this next section might appear quite daunting, the amber survey methodology is well structured and reasonably intuitive. It provides four types of data:

- **descriptive data** - describing route location, route type, and vegetation
- **physical measurements** - of route length, width, gradient, erosion depth, and number of braids
- **assessment of path condition** - using indices (from 1 to 5) describing the condition, dynamism, drainage roughness, and erosion
- **path management, information and comments** - describing urgency of work, an outline of the work requirements, and comments about site conditions.

Descriptive data

Path location

This information should provide clear and unambiguous instructions about where the survey commenced and where it ended. Subsequent to survey completion other people should be able to locate the path and be confident about the start and end points. Provide grid references (or GPS coordinates) at the start and end of the path and a note of the feature(s) at these points.

Path sections

Each path is divided into sections in the field and a new section commences when an obvious change in path character occurs, for example, a significant change in width, gradient or adjacent land use or vegetation. Path sections are numbered consecutively from the start point and path length is measured using a measuring wheel. There is no set length for path sections (but less than 250m gives rise to reams of data to work with!), but you should be able to divide a path ‘logically’ on the basis of common characteristics within each section – it will require you to make a judgement about where to end a section. The reason for a section change should be noted on the survey sheets.

Vegetation

The average ground cover and main species within surrounding vegetation should be noted. Surrounding vegetation can have a large impact on path development: certain species may be extremely tolerant to trampling or may confine the path width. However, surveyors should not spend a long time running through the National Vegetation Classification (NVC) methodology, the important point is to illustrate how the surrounding vegetation may affect path development.

Path type

Although many lowland paths have evolved largely as a result of recreational use, some paths have been constructed to cater for recreation and/ or active travel. The following categories can be used to describe path type:

- **evolved line** - informal path that has evolved to get from place to place or run across open space or around the coast
- **evolved slope** - informal path that has evolved more or less directly up or down a slope
- **single use path** - a path that has been designed with a particular user group in mind such as mountain bike 'single track' or equestrian path
- **shared use path** - a wide path constructed with unbound, semi-bound or bound surface for unsegregated recreational use or active travel
- **pavement** - a roadside path with a bound surface
- **stalkers' path** - a narrow path constructed in remote rural locations as, or in the style of, a stalkers' path. Typical features are relatively low gradients, unbound surface, drainage by top side open ditch and pipe or stone culverts or cross drains, and occasional water bars
- **forest or estate road** - a wide off-road route with unbound or bound surface for unsegregated recreational use
- **public road** - a minor road without any verge or roadside pavement (generally connecting other sections of a network and do not need to be surveyed in detail)
- **other** - a route that does not fit into any of the above categories.

Path surface

The existing surface may be ‘natural’, ‘unbound’ or ‘semi-bound’ or 'bound'. If the path section is a mix of different materials (e.g. some steps but mostly aggregate) select the one that is most common, but put a note in the comment section so that these features are not forgotten.

Physical measurements

Number of braids

Record the number of paths present and any braids (narrow worn desire lines, sometimes parallel to main path) that it will have to be managed. It is uncommon to manage more than one path if two paths arrive at the same destination point, although you may have situations where different users have specific requirements and more than one path is needed. For example, you may need to negotiate a slope that is too steep for people on wheels or horses, so a long shallow ramp is required, but decide that a set of steps is the only way to stop a short-cut developing.

Braid lines, on the other hand, occur close to the main line and usually develop as people try to find more comfortable lines. For example, the braids might have less rough surfaces, easier gradients or are drier under foot. Braids are path lines separated from the main path by a strip of vegetation or un-trampled ground; they are not simply the trampled path margins. Again, some judgement is required to record information which illustrates the nature of the path. Braids are often only 10 or 20 m long, and it is clearly impractical to have a section change every time a braid occurs or disappears. The record should however provide a flavour of the site – for example, if braiding occurs over a large proportion of the site and the section is likely to remain braided.

Path width

Both the bare (un-vegetated) width and the trampled width should be recorded. Look for the minimum and maximum widths along a section, as well as an estimate of the typical bare and trampled widths. For typical widths you do not need to take lots of measurements and find the mean, just recording an approximation is sufficient. In cases where ground vegetation has encroached onto a constructed surface you should record the original constructed width as the 'typical' and put a note about the encroachment in the comments.

If the path is braided the total amount of bare ground across the braided section should be given, so if the path comprises three lines each 1 m wide, then the bare width would be 3 m.

It is a little more difficult to measure trampled width accurately. The edges of the trampled path margins are not usually clearly defined, but damage to vegetation and changes in species composition are good indicators of trampling.

Eroded depth

The eroded depth is defined as the depth at which the path surface is below the surrounding ground levels. If the path surface is gullied, measure the maximum depth in the section.

Long gradient

Long gradient is measured along the path and is the gradient of the path expressed as a percentage. It is not necessarily the angle of the slope that the path is climbing or descending as the path may meander or zigzag up steep slopes in order to reduce the long gradient.

If long gradient is to trigger a change of path section it should be because it increases or decreases across a threshold that is significant in terms of erosion or path management processes.

Cross gradient or cross fall

Cross gradient or fall is defined as the steepest angle, in any direction, on the slope over which the path runs, i.e. the route and angle that a stone would naturally roll away or water runs.

Managing paths with low cross gradient can be quite problematic. If low cross fall is accompanied by low long gradient, it is difficult for water to run away from the path and drainage may be difficult.

Assessment of path condition

Five indices are used to assess a range of 'qualitative' aspects of each section along the route. The five factors are roughness, drainage, erosion, dynamism and condition. A scale of 1 - 5 is used to score each section for each of the five indices. Throughout the survey a score of 1 represents the worst condition, most active or higher priority sections, and a score of 5 the least damaged, least active and lowest priority sections.

Condition

This is an assessment of overall current condition including bare width and trample width, drainage and surface condition. When recording this information relate the assessments to reference photographs or the descriptive table (see below) and do not score sections on a relative basis.

Dynamism

Dynamism has been used to describe the rate at which a route is developing (usually deteriorating). Assessment of this process will be based on judgements about rates of erosion and how quickly path width is increasing, or the path is braiding. This is quite a difficult process to assess as a route may be highly damaged but reasonably stable and therefore not dynamic. Conversely, a route may not be in very poor condition at present but might have just passed a threshold that will lead to rapid breakdown. For example, surface vegetation might have recently been removed through trampling pressure exposing top soil surface underneath.

Drainage

This index measures a combination of water flow (including seepage) and standing water. It is obviously easier to get a better idea of drainage conditions during or immediately after heavy rainfall, although this is not always practicable and sometimes assumptions will have to be made about drainage. However, there are a number of indicators that provide clues to drainage conditions when a route is surveyed in dry conditions, some of which are fairly obvious.

Examine the surrounding ground. The presence of peat or clay soil usually indicates that it is poorly drained, whereas sandy soils and stoney ground are better drained. Shallow soil depth and bedrock close to the surface encourage very rapid runoff of water after rain. Vegetation types usually coincide with different drainage conditions to a large extent and can be used as indicators of drainage.

Observe the condition of the route, if it is gullied it was probably subject to high water flows. Look for material that has been washed from the routes surface on to surrounding vegetation or elsewhere. Check the composition of the surface material, an absence of fine materials may indicate that they have been washed out by surface water runoff. An accumulation of silt on the surface, on the other hand, can indicate the presence of standing water during wet conditions. A wide route and braid lines could also have resulted from poor drainage. Make a note of blocked or damaged drainage features on constructed paths, since damage to these structures will cause drainage problems.

Roughness

This is an assessment of the condition of the routes surface. Research has demonstrated that roughness has a strong influence on width. If the surface is rougher than the surrounding ground, people are likely to stray off and cause trample-related damage either on the margins or on other more comfortable lines.

Erosion

Erosion is strongly influenced by drainage and gradient. However, levels of use, surface material, topography, altitude and vegetation also affect rates of erosion. Erosion is an ongoing process, and a one-off visit to a site will only provide an estimate of the rate at which erosion is occurring. Combinations of steep gradient, loose surface material, high levels of use, sparse vegetation, bedrock close to the surface, high rainfall and/or rapid thawing with poor drainage have the potential to lead to erosion. Evidence of high rates of erosion includes gully formation or route surface well below surrounding ground and surface material washed onto surrounding ground or vegetation.

Standard indices for Amber surveys

For each of the five indices used, photographs should be appended to show examples of sections scoring: 1 (most damaged/highest priority); 3 (average damage/medium priority); and 5 (lowest priority/least damage).

The most difficult part of using the indices is to make sure that the values you use are comparable with other routes, and surveys done by different people. The following table may help to set 'standards', but there is no substitute for photographic records to check between routes.

Score	Condition	Dynamism	Drainage	Roughness	Erosion
1 - Extreme	constructed features mostly broken, sub base exposed, overgrown	path will show major deterioration within a year	deep standing water or waterlogged surface, drains choked or broken or not present	boulders or sub base exposed on long sections	deep gullies or complete removal of surface, actively changing
2 - Severe	path surface badly worn, broken in places, sub base partially exposed	path will show some deterioration within a year	some standing puddles and waterlogged sections, drains inadequate or poor condition	occasional exposures of sub base across path width	gullies through to sub base, partial surface removal, actively changing
3 - Moderate	signs of wear to path surface and other features, some vegetation encroachment	path will deteriorate in 1 to 3 years	small puddles, boggy sections, drains functioning but close to capacity	pot holes across part of path – not continuous	scouring of surface, no sub base showing, loose material present
4 - Minor	very little sign of problems	path will deteriorate in 4 to 6 years	drains functioning but needing attention	occasional potholes or uneven surface	slight scouring of surface, little sign of active change
5 - Negligible	path can be used by all intended users	path is stable	all drainage in good working order	smooth surface appropriate to materials used	no obvious signs of scouring

Path management, information and comments

This part of the amber survey is 'qualitative' and designed to help path managers to understand issues relating to the management and potential development of a path.

Work urgency

This is the urgency with which work is required to prevent damage or further damage occurring to the path in its present condition. The urgency should be consistent with the assessment of path condition, and essentially summarises that information. A high score should be allocated if a path is currently in reasonable condition but likely to degenerate rapidly if no pre-emptive work is undertaken. An index score can be used:

1 = extremely urgent, gross damage imminent (or already occurring) if no action is taken; and

5 = path reasonably stable, improvements are of low priority.

In terms of time scales:

1 = high priority: work should be undertaken within the next 1–3 years

3 = medium priority: work should be undertaken in the next 3–5 years

5 = low priority: work may be required in the next 5–10 years, often depending on the results of monitoring information.

Work urgency is not necessarily a priority rating. Other factors will influence priority, such as availability of funding or importance of a path in terms of network connections and popularity.

Prescription

As the amber survey is a quick survey method it is not designed to provide specification details. To simplify matters, prescriptions can be categorised into a list of treatments required, such as upgrade existing path, construct new path, etc. The list of treatments can be adapted to specific management styles and the needs of different geographical areas. The amount of each prescription is also required and you can calculate outline costs for budgeting purposes from this information.

Site access

The ease of access, or not, for plant and equipment, and distance from the nearest road or vehicle track for hauling materials to the construction site where the path being built will have impact on the cost of works. It may also dictate whether certain path construction methods are viable if there is no way to bring in the relevant plant, equipment and materials.

Comments

Include any information not collected elsewhere which is important in terms of path development or management. Also note any useful reference points. Include notes about the availability of suitable on-site materials, alternative alignments, etc. Comments about the site conditions should include any localised conditions that have not been clarified elsewhere. For example, an erosion problem caused by a burn overflowing or a path section with a peat surface and short aggregate section might not have been previously noted.

Photographs

Photographs are a key component of the amber survey and are best stored digitally. They provide a visual record of path condition and setting and you should include three or four images for each section surveyed. Take note of the location and direction in which they were taken.

How to collect Amber survey data

Amber surveys require a field survey followed by desk-based analysis. Data are collected in the field and recorded on pre-prepared survey sheets. Data can also be recorded directly into a hand-held computer at the site. This can save time, but there is some concern about the reliability of hand-held computers in cold and wet weather. Dictaphones can also be used, but a survey sheet will still be required to ensure that all measurements are recorded.

Distances are measured using a measuring wheel which provides relatively accurate measurements over most terrain. Shorter lengths and path widths are measured using a tape measure. A hand-held global positioning system (GPS) is used to generate accurate eight figure GPS grid reference information. Gradients are measured with a lightweight clinometer. A digital camera, which should be waterproof, is essential for recording path condition, etc.

If you are surveying a large number of paths, storing the data on a spreadsheet or in a database may be the best way to manipulate the data. However, do not lose sight of the purpose of this survey – a quick assessment of path condition and its management needs.

Tips	Amber survey
Be objective	do not emphasise the most damaged parts of a section. Data should reflect the characteristics of whole path lengths
Be consistent	some data collection relies on the judgement of the surveyor. Apply decisions consistently throughout the survey, and if more than one surveyor is involved spend some time together in the field to standardise the approach to surveying
Be aware of the function of the survey	do not describe paths in minute detail. This is a broad-brush look at path condition and management requirements and will not provide costs with a dependable accuracy of more than ± 20%
Use suitably experienced people	Amber surveys rely to some extent on the judgement and experience of the surveyor. Useful and relevant data are likely to be collected if the surveyor has extensive experience of path development processes and construction techniques
Work safely	produce a risk assessment for the field survey stage and monitor the effectiveness, especially reporting-in procedures

Specification (Red) surveys

Specification (Red) surveys are detailed field sketch maps of the current route condition and path construction work required, with accompanying written descriptive notes about the proposed work, to meet the requirements of the defined users. The detailed field sketch maps are created using a standard format and a full set of pictorial symbols, describing everything from large boulders to ditches and drains, etc. The detailed field sketches and written

descriptive notes use elastic scale, providing detail where required, and are used as the basis for drawing up the path's cross-sectional drawings and specifications which are used to produce a bill of quantities for tendering.

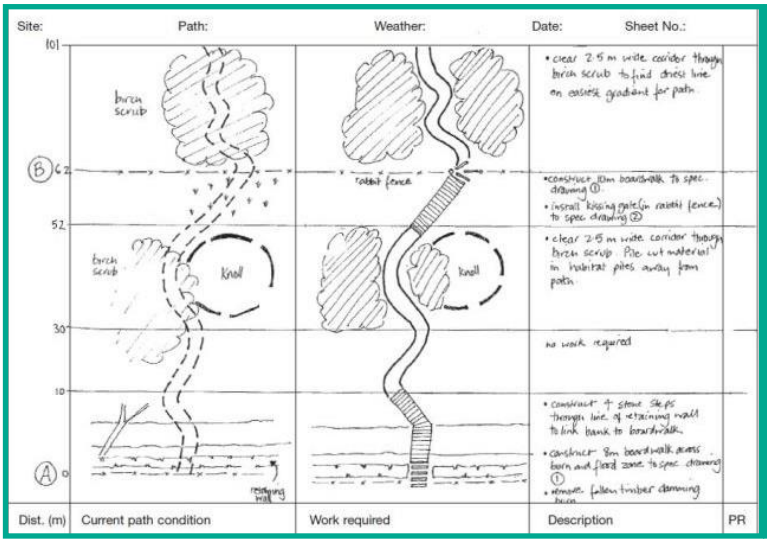
Specification (Red) surveys are the most detailed of the three levels of path survey, and are made up of detailed field sketches of the route as it is now and how it will look after completion of any physical work. They provide a:

- pictorial assessment of the current path condition
- pictorial description of work required
- written description of work required.

Specification (Red) surveys are often included in tender documents to guide tendering Contractors when pricing the work and to direct the contracted Contractor undertaking the path construction work on site. For those reasons, the survey sheets need to contain enough detail to identify every item of work required on the route within the construction site.

How to carry out a Red survey

Draw your field sketches and written descriptive notes, using the three columns: current path condition, work required and description, on to the site assessment survey sheet, starting at the bottom and working up to the top of the sheet. Use an elastic scale for the pictorial representation and one survey sheet may represent 500m or 50m on the ground. The scale depends on the complexity of the path section, the condition of it, and the amount of actual work that is required. The scale may also vary on individual survey sheets. Both section length and cumulative distance should be measured in metres using a measuring wheel, and recorded in the distance (Dist. (m)) column on the survey sheet.



Specification survey sheet example.

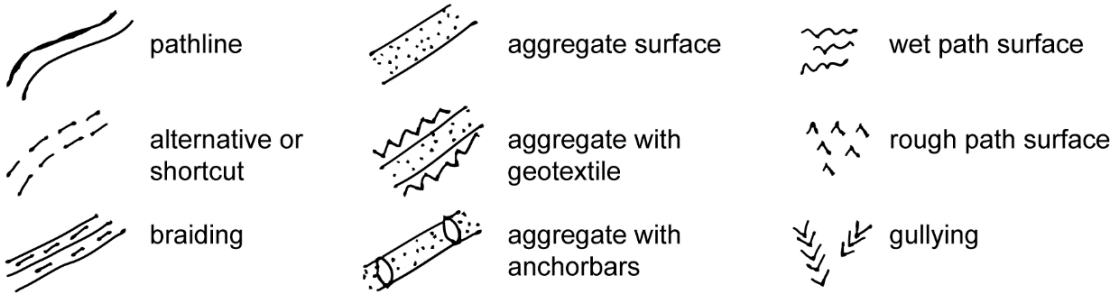
All the information on the site assessment survey sheet should be entered and read from the bottom of the survey sheet towards the top.

A standard set of picture (hieroglyph) written symbols are used to represent various physical characteristics and recommended path construction works (including any other structures to be installed e.g. bridge) on the ground.

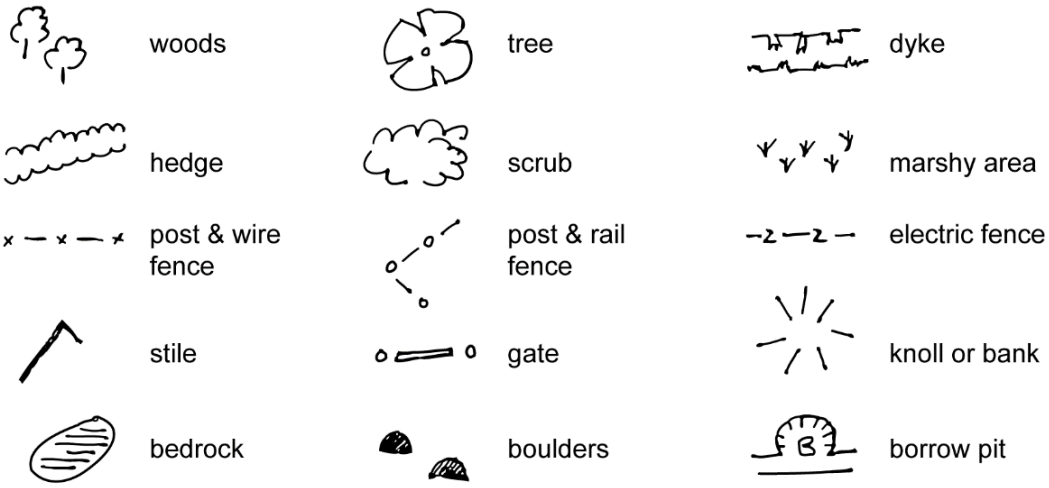
Hieroglyph symbols

The same picture written symbols as used for upland path surveying are suitable for lowland paths, but additional symbols may be required for some path structures or features. Make sure that you include a key on any diagrams that use symbols, including any you have created yourself.

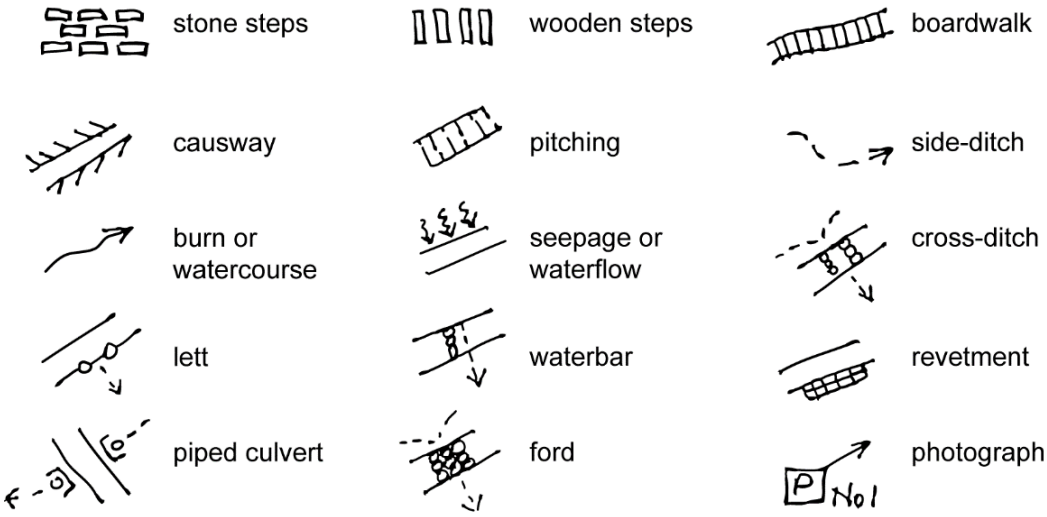
Path Surface



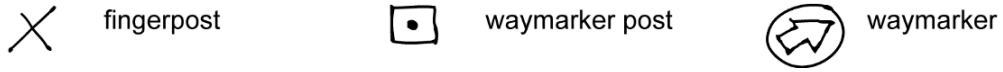
Features



Techniques



Signage



Path sections

To simplify the survey and design work, divide the path into sections using easily identifiable physical features, such as a burn crossing, a building, a bridge, a pond, etc. If you have already commissioned an Amber survey for the route, these sections should match. You may need to divide the sections into shorter subsection lengths in order to provide more detailed and prescriptive information. If no suitable features are present, mark the start and end of sections with discretely located flags, wooden pegs or canes, but remember they will need relocating in the future either by you or someone else. Bear in mind that flags and pegs could get moved or even taken out by people so don't rely entirely on marking out the sections if there is likely to be a long gap between the survey and construction work. It should be possible for future users of the survey information to locate the start and end points of sections in the field. Mark the route of the path and location of path sections on a 1:25,000 or 1:10,000 map, or use a Geographical Information System (GIS) to take section points which will help with relocation at later time.

How to write up the survey

A 'neat' version of the detailed field sketches and written descriptive notes should provide enough information to allow the Designer to 'take-off' the relevant information for preparing drawings, specifications at the detailed design phase. It should identify all elements of path construction work, including any other structural installation work, and possible issues on site. The site assessment survey sheets are likely to form part of tender documentation so it is important that other people can read and understand what you have drawn and written on the sheets. If the information is not clear and concise, do not expect a Designer or Contractor to understand it. Include all written descriptive notes in the right-hand column to explain the detailed field sketches. You will find it useful to include cross-sections of actual path construction work to clearly illustrate dimensions and materials. Similarly, it might be useful to include cross-sections of drainage features (including dimensions) such as piped culverts, cut-off drains, ditches and closed French drains.

Bill of quantities

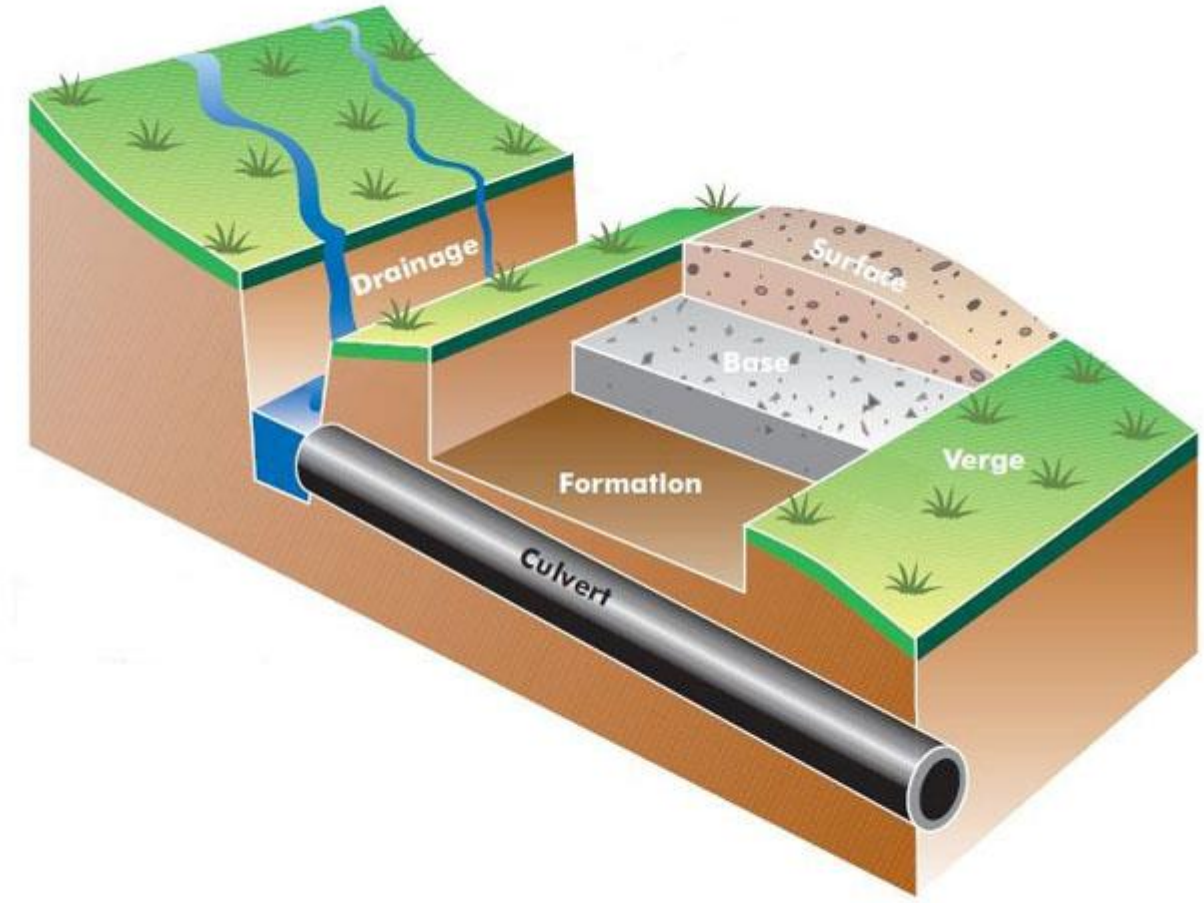
The bill of quantities is derived from the Red survey and is a useful summary of the work required. It should provide a detailed written description of individual items that have been specified and the number or quantity of each item. Materials that are to be used should be specified and dimensions included. The bill of quantities also forms part of the tender documentation and will be used by tendering Contractors for pricing the proposed path construction works, and any other site preparation or structural installation works.

Plant and costs

Consider what plant and other equipment would be required to undertake the work efficiently. Remember to include the cost of materials and any additional transport costs in your calculations.

The costs can be estimated to provide a budget figure for the work, but bear in mind that Contractor prices can vary greatly according to the location in the country, distance from roads, price of materials and the availability of other work, and timing of the contract.

Tips	Red survey
Remember the users	make sure that the specifications take account of the needs of the proposed users of the path, and avoid introducing unnecessary physical barriers/ or hazards in the design such as water bars and cross drains
Realign if necessary	evolved path lines that climb directly uphill present various path management problems e.g. fast flowing water causes erosion down the path surface. It may be possible to realign a path to reduce the gradient and make it more attractive to users and less intrusive, allowing the original line to recover
Be aware of budgets	if budgets are limited, identify priority sections and ensure that specifications are prepared for those sections first. There is little point wasting resources preparing specifications that are unlikely to happen in the near future. Remember, a Red survey will have a shelf-life of no more than 3 years
Use suitably experienced and qualified people	Red surveys rely to a large extent on the judgement and experience of the surveyor. Surveyors should have extensive experience of path design and construction techniques
Surveyors are not infallible	specifications are based on one or two visits to a site. Modifications may be required to design and specifications as work progresses and a contingency plan should allow for this
Test the suitability of available materials on site	do not assume that ‘as dug’ materials will provide the required durable surface or that you will have to import all aggregate for surfacing. A simple test can simulate the effects of compaction, displacement, and erosion in wet and dry conditions on any potential surfacing materials
Use a clinometer to measure the gradient	it can be tempting to look at a route on a slope and try to guess its gradient by sight alone. However, this is a surprisingly difficult skill, so use a clinometer to measure all gradients along the route when surveying



3 Path Design

Assuming that you understand the principles of path planning, you will need to look in more detail at the design considerations and construction techniques that are available. Although there is a wide variety path types, they share some underlying construction details. The path will be constructed from three or more layers, and may have additional features according to the terrain or surface of the path.

The following sections explore different design options and technical specifications that can be used to design paths including information about the other features related to paths:

In addition, the following sections look at designing a path that is safe to construct, safe to maintain, safe to use and delivers good value including the various design paperwork required for the tender document, and information about how a bill of quantities is prepared by a Designer:

3.1 Dealing with water

In section 2.2.4 of this guide the principles of keeping water off the path were discussed. We have assumed that you have read and understood these principles before looking for detailed specifications of drainage features.

This part of the guide provides detailed specifications for the drainage techniques used to intercept, divert or move surface water and ground water off, under, or away from a path. In addition, there is useful information on how to deal with existing drainage, designing drainage, and practical solutions for dealing with drainage problems on paths.

3.1.1 Getting water off the path

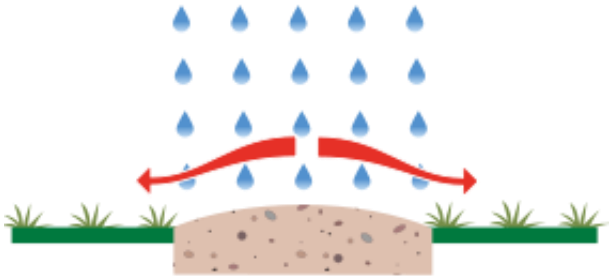
Getting water off the path surface should be one of the first priorities when designing a path. The surface profile of the path is an important factor in removing water that is lying on or flowing down a path. Flat or undulating surfaces can result in ponding of water or scour, which will cause inconvenience to users, and can lead to erosion. So some form of drainage feature is required in the path surface to ensure water flows off easily and quickly.

When designing how to get water off the path, you need to consider who will use the path so that you don't create physical barriers that form trip hazards and make access for people difficult. Designing drainage features, such as water bars, in to the path surface should be considered as last resort - they create a step which can cause a trip hazard or puncture a bicycle tyre, but most importantly they will make taking access for most users difficult - a wheelchair, bicycle or pram will have to pass around the raised feature in order to continue along the path. In the first instance, you should consider the least restrictive option which is the camber, crossfall or cut-off drain.

The following sections explain the drainage techniques for catching and moving water off the path surface: camber, crossfall, grade reversal, cut-off drain and water bar.

Camber

A camber is where the centre of the surface is higher than both path edges, which allows surface water to run off to either side of the path and onto the verges.



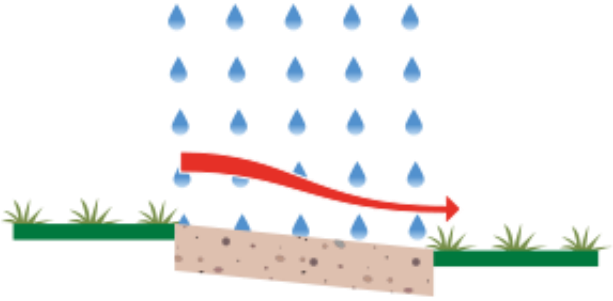
Camber

Cambers
are preferred to a crossfall by wheeled users, such as cyclists or wheelchair users, as they can travel along the centre of the path without needing to correct steering
that are steep tend to be uncomfortable for walkers and horses
are most suitable for paths that cross level ground where surface water will be able to run off to side ditches or onto the adjacent ground
are not suitable on tight curves as they tend to create adverse conditions for path users

Camber specification
the slope from the centre to each path edge should be a maximum of 2.5% (1:40), which translates to 40mm height difference for a 2m wide path, and 25mm for a 1.2m wide path

Crossfall

A crossfall is a gradient across the path surface which allows water to flow towards the lower path edge. It is generally recommended to produce a crossfall inwards towards the slope, when a path contours around a slope, to prevent users on wheels inadvertently steering off the edge of the path. Likewise, on a curve, the crossfall should be towards the centre of the radius of the curve (often referred to as a favourable crossfall).



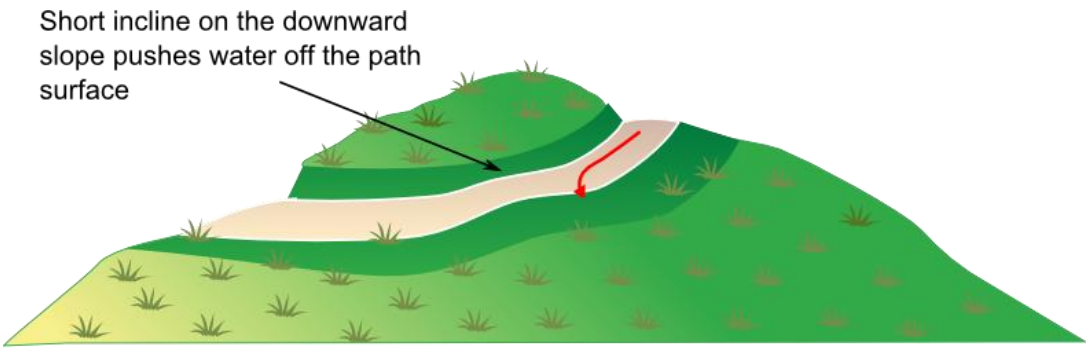
Cross fall

Crossfalls
are generally used on paths where the natural drainage is not suitable for a camber, like crossing a side slope, or on bends where the radius of curvature is small
are easier to form than cambers as the level surface slopes in one direction only
with 2% (1:50) gradient are preferred by wheeled users, such as wheelchair users, as steeper crossfalls can make steering difficult over any distance

Crossfall specification
a crossfall should typically be no more than 2.5% (1:40). This means that a 2m wide path may have a height difference of up to 50mm across its width, or up to 30mm for a 1.2m path

Grade reversal

Grade reversals can be the most unobtrusive of all drainage features and are most effective on narrow paths (1.2m or less). A grade reversal is actually a change in slope to a short incline on a downhill section and this technique diverts water off the path before it has a chance to cause damage. It is most commonly used on mountain bike trails, but could be used on lowland paths with either unbound or semi-bound surface. A grade reversal cannot easily be ‘retro-fitted’ into an existing path surface without excavation works, and even then, may not be effective. Grade reversals are best installed when the path is first built.



Grade Reversal

A grade reversal needs to be combined with a crossfall to ensure that the water does not pond on the path surface. The outlet area should allow water to freely drain away into the ground where it is unlikely to flow back onto the path.

Grade reversal specification
on a sustained incline or across the side slope, mark the location of natural changes in gradient
at each decrease of gradient, reverse the downhill gradient for about 3 to 5m to form a minor incline in the surface
the crossfall will need to be altered to accommodate the dip and incline
take care not to exceed the maximum long gradient that has been specified for the path (based on the needs of users)
the outlet area should be at least 500mm wide and sloped to prevent debris from building up at the entrance or water ponding on the path surface

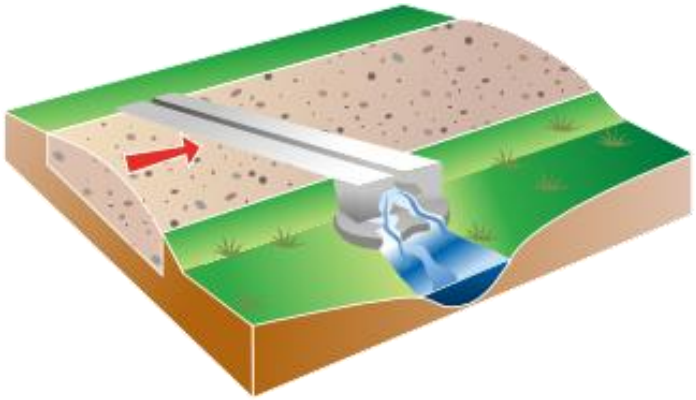
Grade reversal maintenance
annual inspections will be necessary to ensure that the grade reversal is deflecting water off the path without causing surface erosion
some surface top up may be necessary with unbound surfaces
remove all debris from the outlet area that is stopping water from draining away from the path

Cut-off drain

A cut-off drain can be used to intercept fast flowing water on sloping paths without introducing a wide open gap, like a cross drain or a raised step, like a water bar, in the path surface. This means that they are suitable for creating ‘barrier-free’ access without a trip hazard or a hazard where a horse’s foot may become trapped, then damaged or broken. Most cut-off drains have a u-shaped cross-section and grating over the top. The grating provides a continuous surface across the drain, and should be strong enough to withstand the load of any traffic that is expected to use the path.

A cut off drain can either be constructed on site using wood or, preferably, made from sections of ‘linear drain’. These prefabricated units are more robust and have a longer life span. They are available in a range of sizes (from 50-250mm deep) and come with tightly fitting gratings. The channel unit can be made from HDPE plastic, pre-cast concrete, polymer concrete or stainless steel, with galvanised steel or HDPE plastic gratings. Linear drains used for this purpose can either have a channel with constant depth or ‘built-in’ fall (where one end is deeper than the other). For use as a cut-off drain, the constant depth type is suited to paths with a crossfall.

Linear drains are available in six 'load classes’ that comply with the European Standard DIN 19580, for intended specific purposes - class A 15kN and class B 125kN are suitable for paths. They need to be laid in a concrete bed so are difficult to retrofit without major construction works.



Cut-off drain

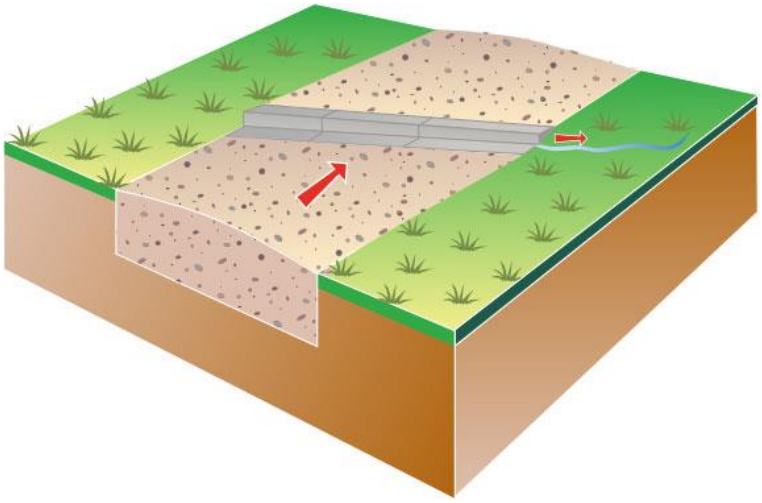
Cut-off drain specification
install Class B polymer concrete linear drain (constant depth type) on 100mm concrete bed at an angle to the path line between 45°- 60°. Ensure the drain has a crossfall towards the outlet side
install Class B galvanised grating, 3mm - 5mm below the finished level of the path surface
extend drain length by 300mm on each path verge
if required, include a large flat stone to act as a splash plate at the outlet end to prevent erosion of the path edge or a silt trap to collect washed off surface material

Cut-off drain maintenance
inspect drain channel frequently to ensure it has not become blocked with debris - leaf litter and silt are a particular problem. It may be necessary to remove the grating in order to inspect the channel properly
if installed, inspect the outlet silt trap and remove any material annually (or after extreme weather events) – washed out surfacing could be reapplied to the path if it is relatively free from debris

Water bar

Water bars are used on unbound surfaces to prevent scouring. They are built across the path on slopes with a ‘shedding bar’ to catch running water and to divert it off the surface. However, by creating a raised bar across the path to intercept water you will be introducing a physical barrier for most people including cyclists, wheelchair users and people with visual impairments. For that reason, water bars should only be used as a 'last resort' but preferably cut-off drains should be considered first. Water bars should be installed when the path is constructed or upgraded, but can be installed on existing paths as an erosion control measure.

For water bars to catch and disperse water effectively they must be carefully positioned on the path. This depends on where water is coming onto the path, expected water volume and good dispersal areas – where water will not flow back onto the path further down. A ‘liner’ - a row of level stones - should be installed on the uphill side to prevent undercutting of the shedding bar.



Water bar

Water bars

should be used as a last resort as they introduce a raised step in the path surface, which can cause a trip hazard but also puncture bicycle tyres

should not be used in locations where they are not the best option for accessibility where more suitable alternatives like cut-off drains should be used

in rural locations are normally built from locally won stone obtained on site. When local stone of a suitable size is not available, water bars can be built from alternative materials – standard concrete kerbing, dressed stone, slate, sawn timber, sawn logs, recycled plastic lumber, and even conveyor belt rubber

should have a channel installed on the uphill side of the shedding bar to prevent water from scouring the path surface or undermining the bar. An outlet is also required to allow water to disperse easily

spacing and frequency depends on the path gradient. For example, on an 8% (1:12) path gradient the distance between water bars should be around 12 metres

Water bar specification

using local won stone of suitable sized dimensions construct a water bar between 45° and 60° to the path line

shedding bar depth should be a minimum 50mm at upper path edge rising to approximately 100mm at lower path edge

the liner stone(s) should be flush with the path surface and match the crossfall of the path

extend water bar by 300mm on each path side

if required, include a large flat stone splash plate at the outlet end if the ground drops steeply or install a silt trap to collect washed off surface material

construct path above the water bar level with the top edge of the shedding bar and, below, the front edge of front liner

Water bar maintenance
annual inspection is required to ensure that the bar is functioning and in safe and good condition
a well-constructed water bar should be solid, immoveable and ‘self-cleaning’ but it may need clearing if there is a build-up of surfacing or debris (e.g. leaf litter)
if a silt trap is installed this should be emptied annually (or after heavy rainfall) – washed out surfacing could be reapplied to the path if it is relatively free from other debris

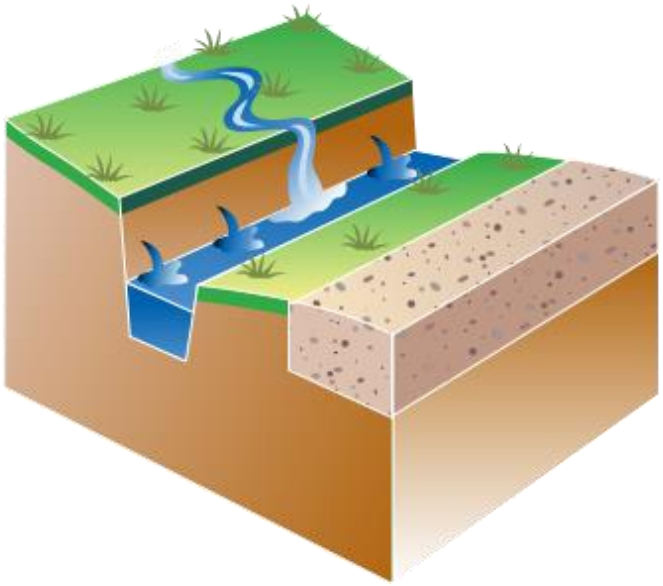
3.1.2 Stopping water reaching the path

The first line of defence in protecting a path surface from the effects of water is to intercept as much of it as possible - whether that is water flowing over the surface or below it. This captured water then needs to be safely directed away from the path and allowed to continue its drainage without adverse effects on the surrounding land.

The following drainage techniques can be used to keep water off paths: open ditches, turf lined ditches, French drains, culverts and soakaways.

Open ditches

Open ditches are the simplest option – they can have a V-shaped or U-shaped channel section, depending on the amount of space available within the path corridor. Verges between the ditch and the path should be a minimum of 300mm or maximum of 500mm. At shallow gradients, ditches should have smooth beds for unrestricted water flow. Ditches must have a sufficient fall to allow free flowing water, but not so steep that scouring or undercutting to the bottom and sides of the channel occurs. Gradients between 1:15 and 1:40 will work effectively. If steeper ditches are unavoidable, try to include bends and level areas to reduce water flow speed. Short steep sections may be piped to avoid erosion of the ditch.



Open ditch

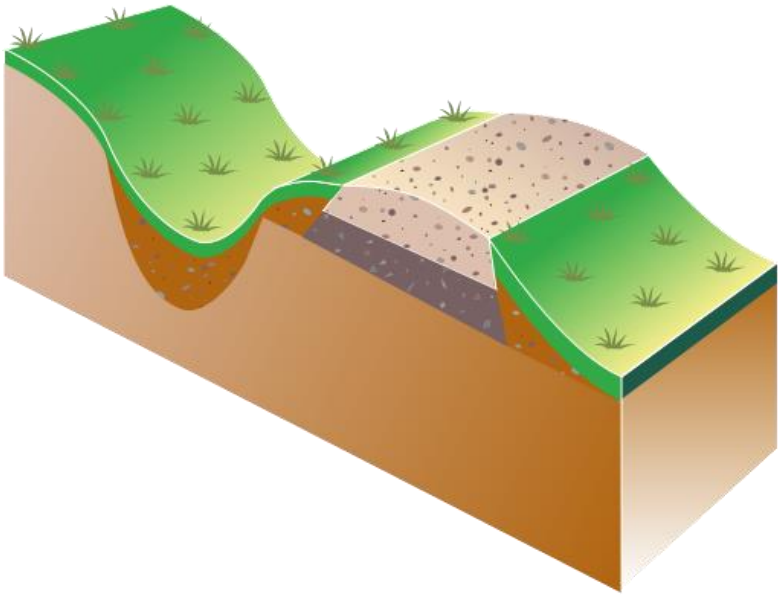
Open ditch specification
V-shaped ditches should be 150-300 mm deep, with 45° side slopes
U-shaped ditches should be 200-300mm deep and 300-450mm wide at top – the sides should be angled slightly for stability

Open ditch maintenance
all ditches should be inspected annually and cleared of blockages
remove silt and debris and ensure it will not re-enter the ditch
clear and remove vegetation growth so that it will not enter the ditch as debris

Turf lined ditches

A more expensive ditching option is to form a larger turf lined ditch which can be used to control surface water runoff from larger areas and at steeper gradients. In some situations, materials excavated from the ditch can be used to provide ‘as dug’ aggregate for path construction – the material dug from the ditch is used to help build the path's base layer and the vegetation stripped from the path line can be used to line the ditch. This type of construction is sometimes called ‘high-and-dry’.

Once installed and vegetation re-established this type of ditch is resistant to erosion and will carry relatively large volumes of water. Turf lined ditches are generally used in upland paths to reduce the visual impact of any ditches in sensitive landscape. However, where there is vigorous plant growth these ditches can become ineffective where the vegetation is not cut back or if shrubs or trees become established in the channel.



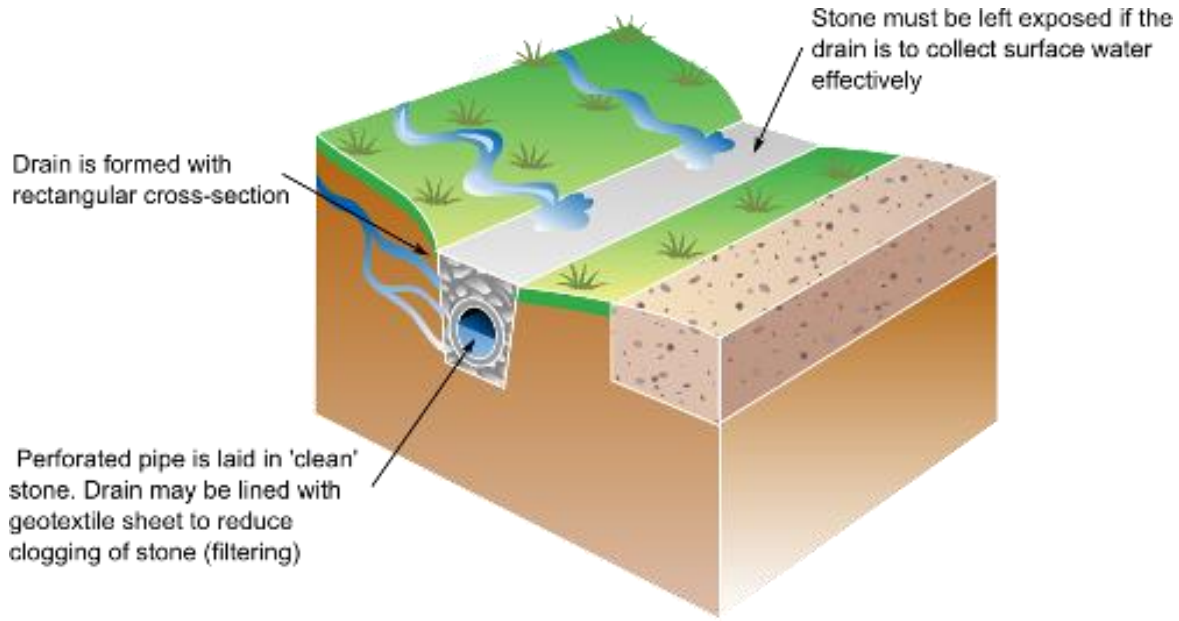
Turf lined ditch

Turf lined ditch specification
the ditch should be 0.5-1m wide (but may be up to 2m wide in some situations) and at least 200mm deep
existing vegetation should be stripped back as cut turfs and carefully stored for re-use
excavate subsoil to form a shallow sided ditch
line the bottom and side of ditch by replacing turfs, butted tightly together without exposed gaps
if possible, turfs should not be placed directly on unconsolidated gravel/ alluvial material as they are easily washed out and may need to be pinned into place (wooden pegs will biodegrade and are preferable to metal ones)

Turf lined ditch maintenance
annual inspection is necessary to ensure that the ditch is functioning properly
vegetation clearance may be required if the ditch's water-holding capacity is reduced by a third or more (minimum of one cut per year)
remove any tree seedlings/ saplings that become established within the ditch

French drains

French drains are essentially trenches that have been filled with clean free draining stone and can be used to drain surface water or intercept groundwater. They may have a perforated pipe installed to increase the volume of water that can be drained. The name comes from the 'inventor', Henry French, rather than the country.



French drain

French drains

can be used where open ditches are considered to be an unacceptable hazard or where available space is limited with no room for an open ditch alongside the path

should have the clean free draining stone fill reach the surface where the drain is required to intercept surface water runoff from a path or a slope. However, mud and silt can easily block the gaps between the stones and encroaching vegetation can allow surface water to bypass the drain

can use a permeable geotextile sheet to line the excavated trench, which acts as a filter to reduce clogging by silt and mud

should have a minimum gradient of 2% or 1:50 to work effectively

can be used on steep slopes

French drain specification

starting at the lowest point in the drain line, excavate a 300mm wide trench to 300mm - 500mm depth below ground level with a continuous gradient

dispose of the excavated spoil on-site at designated locations

if required, line the trench with lightweight permeable geotextile sheet, allowing 300mm either side

fill the bottom of the drain trench with graded aggregate - single size clean gravel or quarry stone (20 - 40mm) with no fines

lay 150mm PVC perforated land drain pipe (sometimes referred to as Flexicoil or Wavincoil) in the base of the trench, on top of the laid graded aggregate. Use 100mm for small drains. Ensure that there is a continuous gradient down slope

fill drain trench with graded aggregate to 250mm – 450mm below top edge of trench sides using single size clean gravel or quarry stone (20-40mm) with no fines. Alternatively, use screened ‘as dug’ gravel without fines, recycled crushed brick or railway ballast without fines

if a geotextile liner has been used, wrap the sheet over the top of the aggregate before filling the trench as follows:

- for intercepting water on the surface and ground water, fill the remaining trench with graded stone or gravel
- for intercepting ground water only, fill the remaining trench with excavated materials. A geotextile sheet at the base of this layer will help prevent clogging of the drain
- provide an inspection/ sediment pit at regular intervals (or where there is a junction/ bend)

French drain maintenance

annual inspection of French drains should be a high priority

encroaching vegetation should be removed and any tree seedlings/saplings near the line of the drain should be removed

pipes can be cleaned using drainage rods and silt dug out of the bottom of inspection pits

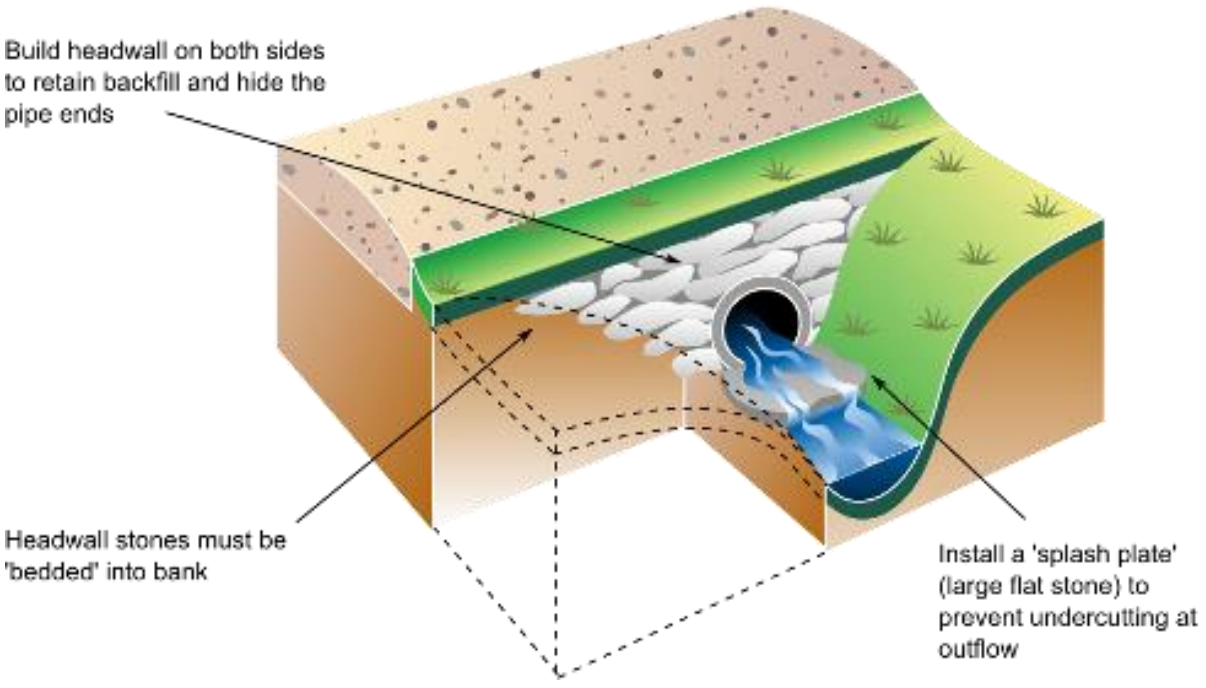
Culverts

A culvert is used for crossing a watercourse or to allow water caught in a side ditch to across under the path for dispersal. In either case you need to make sure that the size of pipe will allow unrestricted flow of the water. Speak to local people, including land managers, about known stream water levels.

For culverts across watercourses, inspect any existing culverts and choose a size at least as big as those that are obviously working well. If there are none, you need to calculate the 'discharge area' of the watercourse in spate conditions (width of channel x maximum depth of water). You then need to specify a pipe, or pipes, with twice this area (the area of the pipe = radius^2 x 3.14).

The most commonly used pipes are the 'twin wall' polypropylene type. They are lightweight, easy to handle, strong and relatively cheap. Concrete pipes can be used if deep cover is not possible and heavy vehicles require use of the path. Stone 'box' culverts may be suitable in some locations, e.g. if material is available on site and access is difficult. These are traditional culverts comprising a rectangular section stone channel, capped by flat stones under the path. The culvert may either be completely buried or else the capping stone can be incorporated into the path surface.

On small burns, place culverts on a straight section, preferably where water speed is likely to be low. If this is not possible, provide suitable rock armouring to prevent scouring and erosion.



Culvert

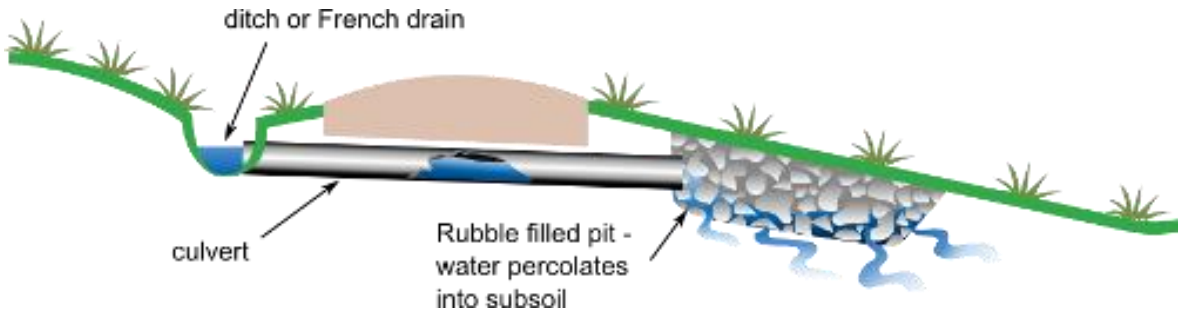
Culvert specification	
Gradients	longitudinal run on pipes should be a minimum of 1:40 to prevent silting. Where possible, avoid pipe gradients greater than 1:15 to prevent potential erosion problems at the outlet
Sizing	pipes should never run full. Ideally, they should be no more than two thirds full at the worst-case water flow. For deep, slow moving streams, use a pipe diameter which is twice that of the stream depth. For ditch system culverts use several 300mm diameter water pipes set at regular intervals – every 10 to 20m depending on amount of water flowing into ditches
Construction	pipe bedding material should be smooth and free of large stones which could puncture pipe walls. Lay the pipe on a bed of graded aggregate (the top level of which must not be above the streambed level). Backfill the pipe with well compacted graded aggregate as used for path base. Cover depth should be 50-100% of pipe diameter, depending on expected loadings, with a minimum cover of 150mm
Headwall	build a stone headwall around both ends of the pipe to retain pipe bedding and backfill materials and to hide the pipe ends. Headwalls may be dry or mortared. Walls should be 150-450mm thick depending on depth of backfill. All stones must fit together well and be firmly set into the stream or ditch sides. Install a large single mantle stone across top of pipe ends - take care not crush the outlet and inlet ends. Alternatively, arrange stones to provide an arch around pipe
Inlet	for multiple pipes provide flow 'splitters'– long thin stones wedged between pipes to direct water flow into pipes without washing out pipe backfill materials. Place a bed of flat stones around inlet to prevent scouring under or around the pipe
Outlet	install a 'splash plate', which is a single flat stone immediately below the pipe outlet to prevent undercutting. Also provide a wider bed of flat stones, around the outfall, to prevent scour and erosion
Handrails	if culverts present a falling hazard to path users (more than 600mm drop), consider installing a suitable handrail of an approved design, depending on user types and the depth of the culvert

Culvert Maintenance
annual inspections are necessary to ensure that culverts do not become blocked
more frequent inspections will be required in some situations - particularly after heavy rainfall which may have washed debris into the pipe
inspect the culvert inlet and outlet to identify any scouring or erosion
routine maintenance may involve removing any debris in the pipe or from the inlet or outlet ends

Soakaway

If there is no watercourse nearby, the water that has been collected from on or around the path needs to be dispersed back into the surrounding land without causing erosion or increasing flood risk. Water entering the soakaway will disperse over a period of hours so it is best to pick an area of land that drains freely and does not get waterlogged at times of heavy rainfall.

Soakaways can be placed at the end of French drains or culvert outfalls to allow water to percolate into the sub-soil downslope from the path.



Soakaway

Soakaway specification
a large cube-shaped excavated trench, if necessary lined with permeable geotextile sheet filled with clean free draining stone or rubble
there is no available standard size or position because these depend on the amount of water, type of soil and topography
a soakaway should be placed far enough away, and low enough down the slope to avoid water backing up and possibly flooding the path
soakaways must also be built above the level of the natural water table

Soakaway maintenance
there is very little scope for maintaining soakaways, but they should be inspected annually to ensure that there are no signs of heavy silting up (e.g. culverts are full at the entrance or French drains are overflowing)
the stone fill could be dug out and replaced or cleaned in extreme cases

3.1.3 Dealing with existing drainage

When upgrading an existing path, or creating a new one, it is likely that you will encounter the existing drainage, especially if the path is on disused railway line or land used for agriculture. This may be a few drains and ditches. In the case of disused railway lines or agricultural land, it may be a comprehensive system of drains.

Existing drainage should be located and inspected to determine if they are working effectively and are adequate for your needs. Make sure that existing sub-surface field drains, discharging excess water from the soil into perimeter ditch, are not damaged during your explorations. It is best to allow for some budget when costing a project, just in case replacement of existing drainage is required. Further investigations and trial digs are best undertaken when ground preparation works are being carried out, before any path construction starts, when plant and machinery are available on site. When designing any additional drainage, do not exceed the capacity of the existing drainage system, if new drainage is connected into it.

Locating existing drainage tips
ask the current (and past) landowners on the whereabouts of drainage systems on their land
look for signs of sub-surface clay pipe drains (or modern plastic perforated pipe – see image below) on the field surface e.g. standing water on low lying areas
look for any obvious linear strips of crops, grass or other vegetation taller than the surrounding ground which could indicate a drain
look and listen for fast flowing water running along drains and coming out of pipe outfalls (see image below)
carefully dig inspection trenches where the line of a drain may be (see image below)
you could use divining rods to try and identify the line of a drain
look for old clay pipe drains running through railway cuttings which may have inspection pits at regular intervals that allow access to cleanout blocked drains

3.1.4 Drainage design considerations

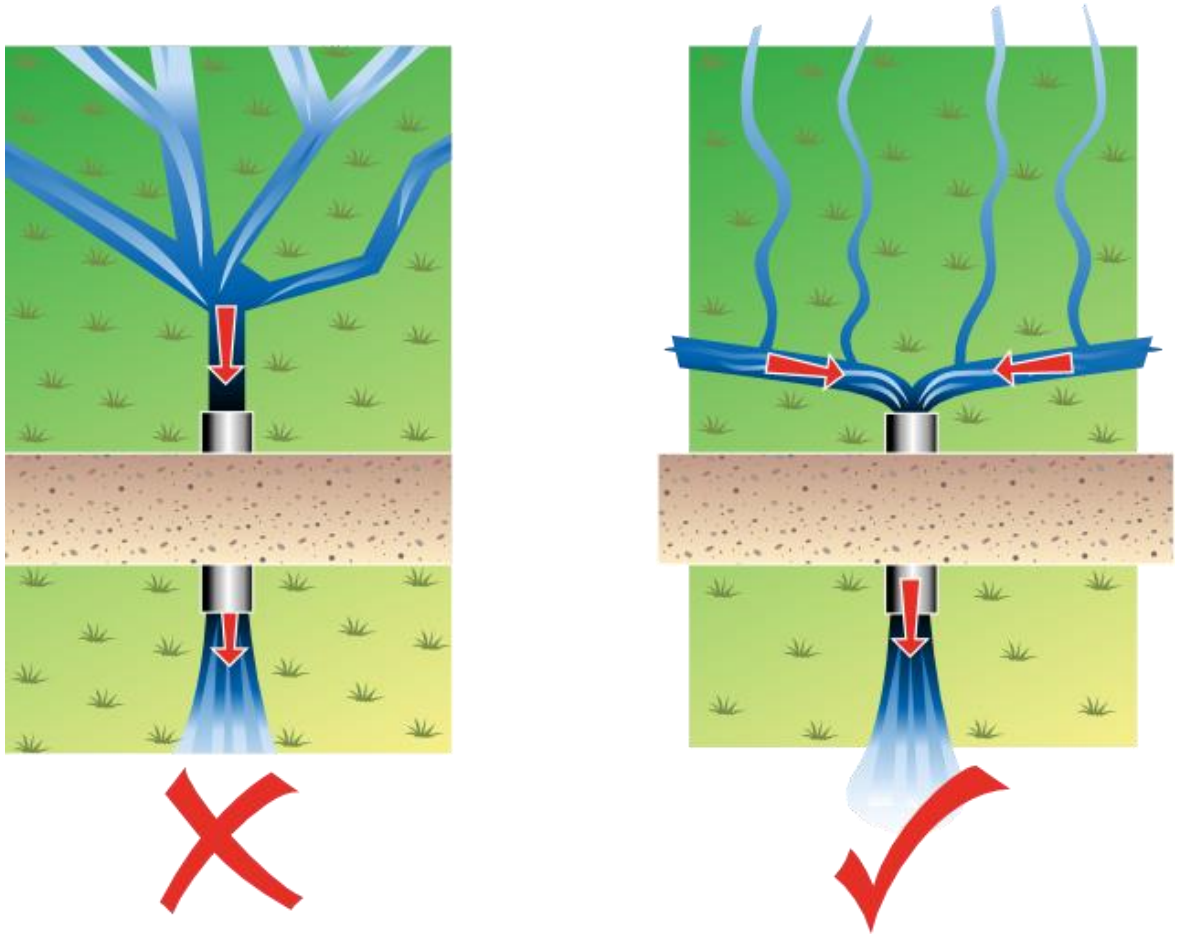
Resist the temptation to install too many ditches – it can easily end up looking like an artificial river system.

When considering drainage:

- plan the most efficient way of intercepting the water, which could be lateral drains along the length of the path, with frequent culverts to disperse the water on the downslope side
- pay attention to the outflow from drains and ditches to make sure that you do not create a problem further down on the path or for a neighbouring landowner.

You need to give careful consideration to the outfall from ditches into a stream. High water levels in the stream could flow back up the ditch and possibly flood the path. Place the ditch outfall above the highest expected water level of the stream.

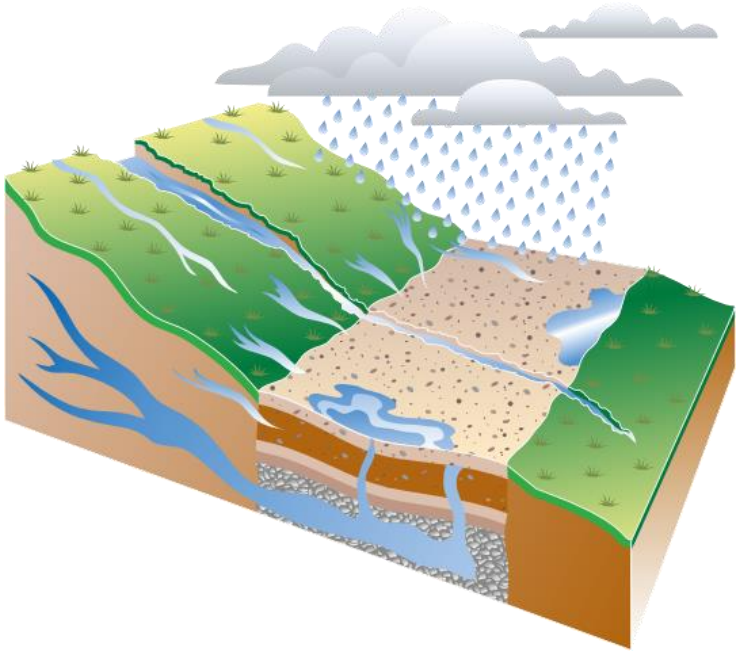
Consider including ponds in a ditch system to increase the overall capacity of the drainage system. They can be used to give extra water capacity for high intensity, short duration rain storms. Ponds with shallow and deep water will also provide habitats for flora and fauna, although fluctuating water levels and silt build-up may limit their ecological value. Care needs to be taken to avoid introducing additional hazards, particularly for small children – do not construct steep sided ponds.



Efficient drainage pattern

3.1.5 Practical solutions for dealing with drainage

Visit the path in wet weather conditions, or after a period of heavy rainfall, to identify any problems caused by water.



Water sources

Look for clues on the path or nearby, such as:

- problems caused by water lying on the path such as ponding or mud
- problems caused by water flowing onto, or under, the path from the ground such as seepage, underground springs, soft patches or side slopes
- problems caused by water flowing down, or across, the path such as seepage, scouring or watercourses.

The following table shows typical path drainage problems caused by water, with examples of practical solutions that can assist in dealing with each problem. Use the list to identify any problems you may have found on your path, and then select a practical solution that can fix it.

Problem	Examples of practical solutions
Muddy path	scrape off mud, if required remove overhanging vegetation to allow sunlight and the wind to dry out the surface clean out existing ditches or closed drains where blocked install new ditches or closed drains if none currently exist improve, or create, cambers, or cross falls, to drain water into ditches or drains build an aggregate path to raise surface above adjacent ground levels
Soft, deep mud on the path	find the source of water and divert it away from the path with an open ditch or closed drain e.g. French drain improve, or create, cambers or cross falls to drain water into ditches or drains build an aggregate path on geotextile or geocomposite to separate and protect the path from the soft ground
Soft mud deposited over the path	scrape off mud and re-dig ditches to prevent water running onto the path, so that the problem is eliminated
Path crosses wet ground	divert the route of the path if possible if the ecological value of the wet ground is low – install a suitable drainage system if the ecological value of the wet ground is medium – build a raised aggregate path on geotextile or geocomposite to separate the path from the wet ground if the ecological value of the wet ground is high – build a boardwalk using either a timber boardwalk with recycled plastic support posts, or an entire recycled plastic boardwalk
Water flowing onto the path from a side slope	if an obtrusive drainage system is suitable for the site, install a ditch to catch water with piped culverts to carry water under the path if an obtrusive drainage system is not suitable for the site, install a French drain, or filter drain to collect and carry water away from path
Water running down the path	install a cut-off drain where water runs onto the path to catch and carry water off the path. Don't install a water bar, as the raised bar will create a step in the surface which will cause a physical barrier, and potential hazard

Water flowing across the path	install a piped culvert where water flows across the path to catch and carry the water under the path. Do not install an open cross drain, as the drain will create a large open gap in the surface which will cause a physical barrier and potential hazard
Water ponding on the path	install a lett at the path verge or a grip through the verge to drain water off the path
Wet, soft patch on the path	if the problem is caused by a seepage or spring under the path, find the source of the water, catch it and then carry it away from the path with an appropriate drainage feature. Repair the section of path affected by the problem

3.2 Earthworks

Modification of slopes is only really practical by using machinery, and you will need to give careful consideration to the scale of earthworks that are appropriate within the context of your path and the landscape. In some landscapes relatively large scale works could be acceptable, but in areas of open or sensitive landscapes it may not be possible to undertake major earthworks. Where you are dealing with cross slopes or gradients along the length of the path (longitudinal slopes), some earthworks will be necessary:

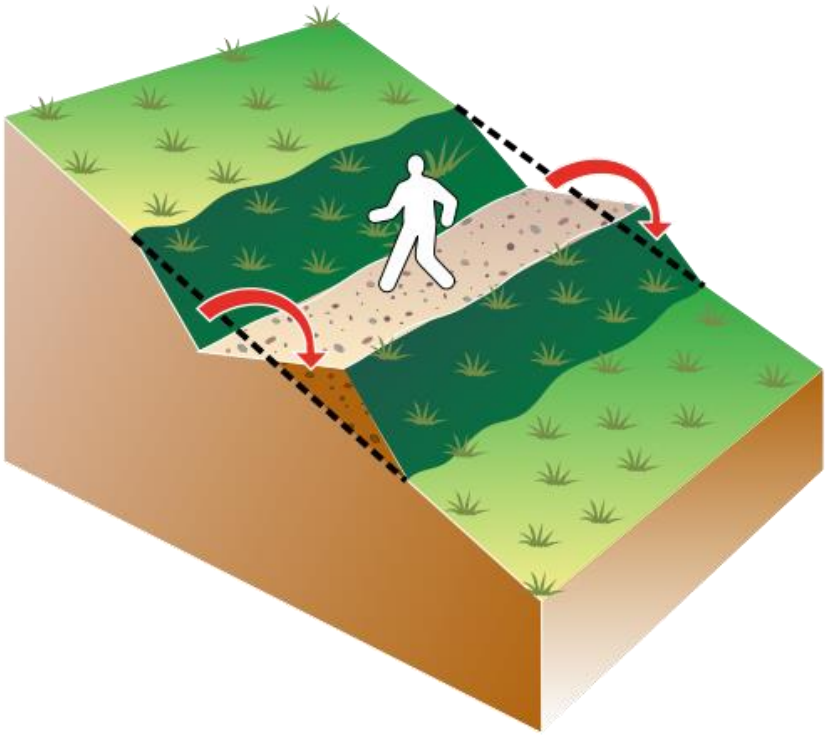
3.2.1 Cross slopes

In order to produce a path of adequate width across a slope it will be necessary to form a level ‘bench’. This can be done either by cutting a ‘bench’ into the slope or by building up to the level with a suitable bulk fill material. Carefully store top soil and any turfs that have been removed and use them to help protect bare slopes – turfs may need watering if stored for any length of time (remember to include provision for watering of turfs in any conditions of contract and specification).

The angle of the cut slope is important for stability of the path and is dependent on the strength of the soil and underlying material (e.g. glacial till or rock). In order to keep water off the path, you need to cut a sufficient width to include drainage between the bottom of back slope and edge of the path. If space is restricted and steeper slopes are required, you may need to use slope stabilisation methods, such as a geotextile or a retaining wall.

If you are building up a bench with bulk fill material, remove and store the vegetation and topsoil first and be sure that the imported bulk fill material has the strength to remain on the slope. Ensure that the fill part of the bench is formed in well compacted layers.

In some circumstances the material cut from the slope can be used as fill on the lower side of the slope. This will reduce, or eliminate, the amount of bulk fill material to be imported onto site.



Cut and fill method to bench a path

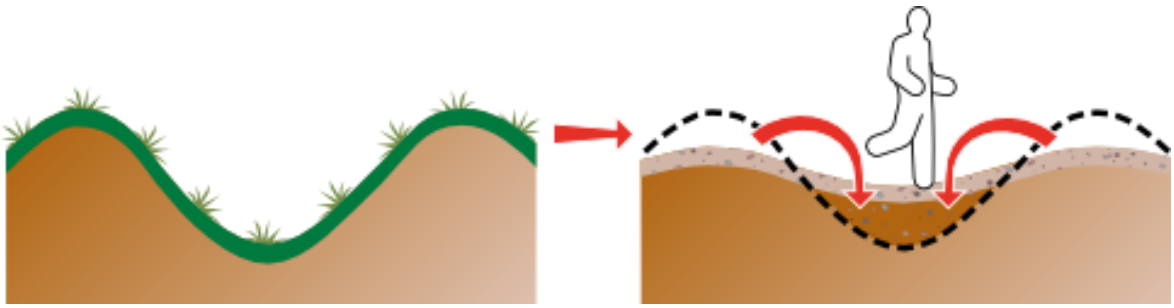
You can use ‘cut and fill’ technique on slopes where the cross gradient is less than 33% (1:3). Only use cut and fill if the soil is strong (i.e. does not contain a lot of clay) otherwise it will not remain stable when the path is used. Test the soil for strength and look for granular, ‘gritty’ feeling soil. If the soil is weak, form the bench by only cutting material - this will produce a large amount of material for disposal on or off site.

3.2.2 Longitudinal slopes

Assuming that you have chosen the best route to minimise the amount of earthworks required, you may need to cope with small scale undulations or steep slopes.

Undulations

For small scale undulations, the easiest technique is to transfer material from the high points into the low points, forming a series of rises and falls within the required gradient.



Coping with path undulations

Steep slopes

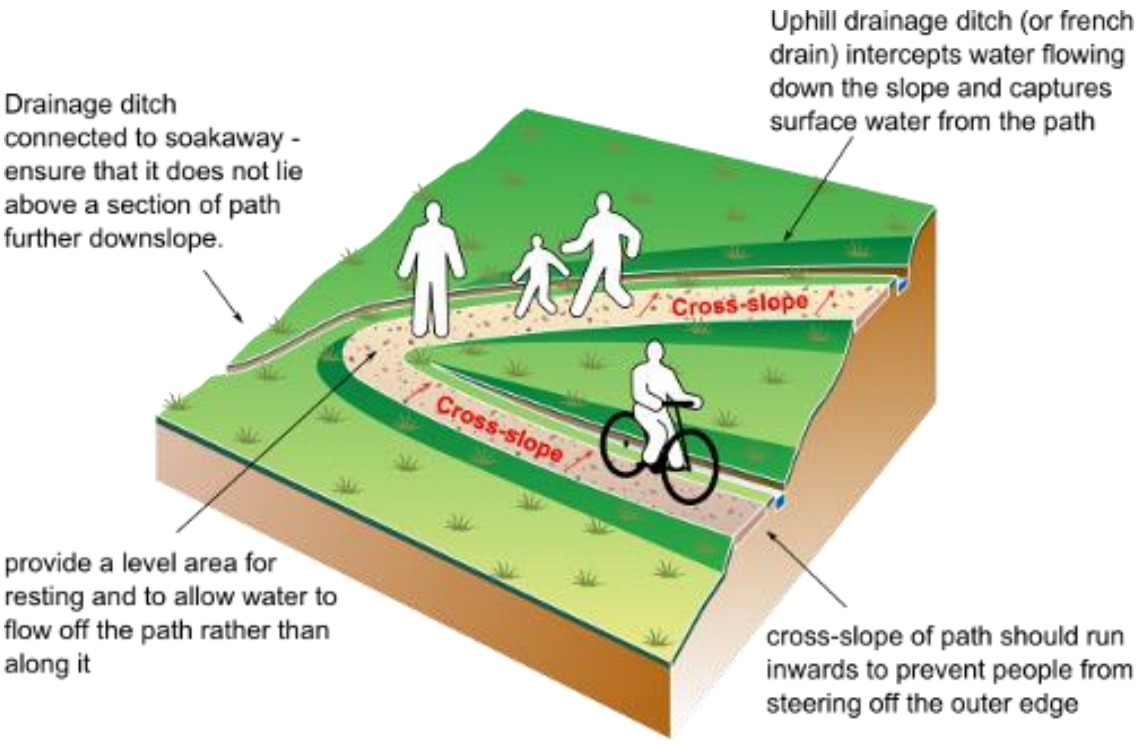
If space allows, short slopes can be reduced in gradient by cutting and filling material to achieve the required gradient, otherwise you will need to create ‘zigzags’ to increase the length of the path up the slope at a shallower angle. The use of zigzags means that you will need to adopt the techniques for dealing with cross slopes, in order to form a bench for the path. The turns will need to be wide enough to allow all users to negotiate the bend and additional earthworks will be required to form a level ‘platform’ for the turn. These turns are good places to include resting places.

Steep slopes calculations
the length of the path that will be needed as zigzags is based on the height gained and the average gradient of the path. First measure the total height of the slope to be climbed using a level or clinometer (height = Sin(angle°) x distance). The length of path is then calculated using:
gradient of path as a percentage: length = height rise ÷ gradient (%)
gradient of path as a ratio: length = height rise x ratio (1: G)
for a 20 metre height gain with a path surface slope of 5% or 1:20 you will need 400m of path (400m = 20 ÷ 0.05 (5%) or 20 x 20)
you then need to divide the length of path by the width of the path corridor, to determine how many ‘legs’ you need (e.g. on a 100m wide corridor, you will need 4 legs, each of 100m plus 3 platform turns, in order to gain 20m height with an average gradient of 5%).

The following table gives some typical figures that may help with estimating your needs:

Average path gradient	Length of path needed to gain 20m	100m path corridor	50m path corridor
5%	400m	4 legs, 3 turns	8 legs, 7 turns
6.67%	300m	3 legs, 2 turns	6 legs, 5 turns
8.3%	240m	3 legs, 2 turns	5 legs, 4 turns
10%	200m	2 legs, 1 turn	4 legs, 3 turns

The path should be pegged out accurately on site to ensure correct gradients and remember to add on the ‘platform’ for turns in your calculations of materials required and length of path. Avoid using ‘symmetrical’ zigzags of the same length and consider blocking potential short-cuts (with vegetation, boulders or even barriers) as these will lead to rapid erosion of the slope. Make sure that drainage from higher levels does not interfere with lower sections, by extending the outfall / soakaway points beyond any lower section of path.



Long Slope drainage

Steep slopes tips
earthworks to adapt the gradient should be considered as a last resort – try finding an alternative line that does not require cutting or filling
earthworks may disturb sub-surface water flows and so drainage issues not found during the site assessment survey may become apparent. In particular, cuttings will attract water and suitable drainage provision will be required
allow a minimum of a 500mm verge between a path edge and a side slope. If space does not allow such a verge, consider whether a hand rail will be required
ensure that newly formed side slopes have a maximum gradient of 50% or 1:2 (66% or 1:1.5 for stronger soils). All slopes should be dressed with topsoil and preferably turfs or appropriate grass seed mix. Using turfs will rapidly establish and regenerate vegetation and avoid leaving large scars of bare earth. A vegetated slope is also less susceptible to slipping. If turfs are scarce, lay those that are available along the foot (toe) of a slope since growth here is particularly important for slope stability. If side slopes must be made steeper due to width restrictions, use some form of slope stabilisation or retaining wall
edges of new slopes should be curved into existing slopes to avoid harsh, straight cut lines
if you need to dig borrow pits to generate fill material ensure they are left tidy and present no hazard to users who stray off the path. Ideally, fill borrow pits with unsuitable soil taken from the path route and cover with excess turfs
to reduce the landscape impact of earthworks, consider using additional planting to hide unavoidably large cuttings

3.2.3 Stabilising slopes

When forming benches across side slopes in locations of restricted width, some form of slope stabilisation may be required to allow steeper side slopes. Steep river banks, which may be susceptible to erosion and collapse may require stabilising and reinforcing before the path is built. There are hard engineering methods (use of stone etc.) to reinforce slopes, or soft engineering methods using 'natural processes' including tree roots for binding the surface. Soft engineering methods can take some time to become established but can provide a satisfactory long-term solution in many situations. Some hard and soft engineering methods can be combined to take advantage of both durability and aesthetic benefits.

Soil reinforcement involves the use of a variety of geotextiles, both man-made and natural. Slopes as steep as 60 degrees can be formed, but require complex civil engineering techniques beyond the scope of this guidance. Further information should be sought from a civil engineer or specialist manufacturers of available slope stabilisation materials.

Retaining walls can also be complex structures requiring specialist design. A well-built wall looks very attractive and can be an additional feature on a path. However, a retaining wall beside and below a path edge may present a falling hazard to path users and some kind of handrail may be required, depending on the height involved and local setting.

Timber walls

These comprise support boards or logs with timber or steel stakes driven into the ground. They are low cost, easy to install and can be reasonably unobtrusive. Timber walls can deteriorate after a relatively short period (5 to 10 years), although they can often be repaired or partially replaced to extend their life.

Gabion walls

Gabion wall.

These are wire mesh rectangular baskets filled with stone, which are available in various sizes. Stone should be 200mm down to 100mm graded, crushed rock built into the basket very much like a dry stone wall. Gabions should be perfectly rectangular and should not sag or move about. Gabions can be stacked up and even pinned together (or pinned into a large slope) to form large walls. The stonework can be infilled with soil and seeded to help stabilise the gabions, as well as giving them a more natural look. They are fairly cheap and will last a

long time (15 to 20 years). However, they are very vulnerable to vandalism – cutting the basket wires will result in an immediate collapse. Gabion baskets are also vulnerable to rust in coastal environments and need to be filled with larger stone if they are to be exposed to wave or current action.

Stone walls

Retain a slope with a solid stone wall laid either dry or mortared. A good source of local stone is essential (purchasing stone should be avoided if possible, for budget reasons). Careful choice of suitable sizes and shapes of stones is essential for stability, bearing in mind that a retaining wall has to withstand considerable pressure from soil pushing behind it. Skilled stonemasons/ wallers should be used to undertake construction. Stone walls can last a lifetime if well-built and they are very resistant to vandalism.

Rock walls

These are essentially walls constructed with large rocks. If a supply of large rock is available on site, they can be used in a variety of situations to stabilise large slopes, support extensive causeways and protect bridge abutments from water scour. A large excavator will be required to place them into position and care should be taken loading them on to large dumpers.

Retaining walls specification
specifications for small retaining walls are given in the TCV 'Footpaths' handbook
if larger or more complex walls are required, seek specialist advice from a consultant structural engineer. There are a number of techniques available, some of which are simple and low cost

Retaining walls maintenance
annual inspection should be undertaken for all retaining structures to record visual condition and structural stability
a longer-term technical inspection cycle (e.g. every 5 years) by a suitably competent person is recommended

3.2.4 Constructing earthworks with aggregates

Various mixed size aggregate mixtures are available for constructing earthworks, which are made of natural or recycled aggregates from quarries, road re-construction or maintenance and construction sites.

The following aggregate mixtures, based on the Specification of Highway Works (SHW) are:

Class 1A Well Graded Granular Material

This is a bulk fill material which ranges in aggregate sizes of between 90mm down to dust. There is no limit on how much of the mixture is large or small. So, it could be available as 75mm down to dust, or 40mm down to dust.

Class 6F5 Selected Granular Material

This is a capping layer fill material which contains crushed concrete, recycled asphalt, and possibly crushed brick. The aggregate sizes are defined as 80mm down to dust. It has a good distribution of large and small particle sizes that ensures some interlocking and less voids between particles. This material when compacted to refusal with a roller will produce a much stronger layer than Class 1A.

Class 6F3 Selected Granular Material

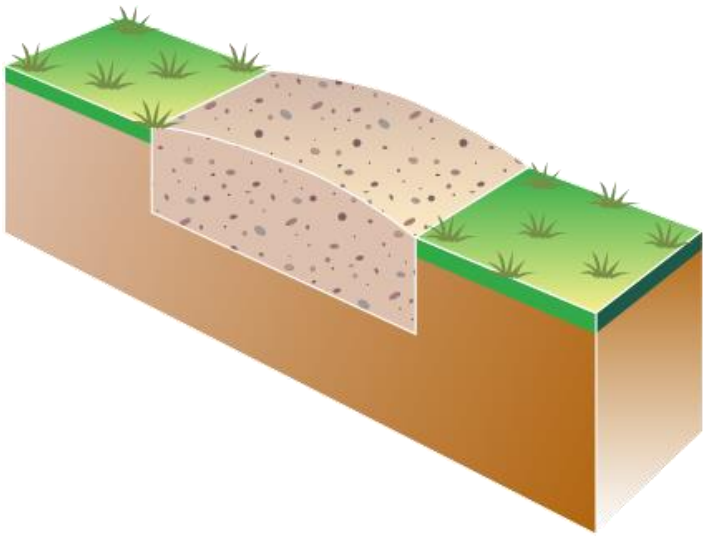
This aggregate mixture consisting of 100% recycled road planings and asphalt has same aggregate size distribution as Class 6F5.

3.3 Formation Layer

The formation layer is the prepared ground surface on which the path's base layer is laid and compacted. The hardness of the ground, depth of top soil and free draining properties of the sub-soil will determine which of the following approaches is adopted:

3.3.1 Full tray excavation

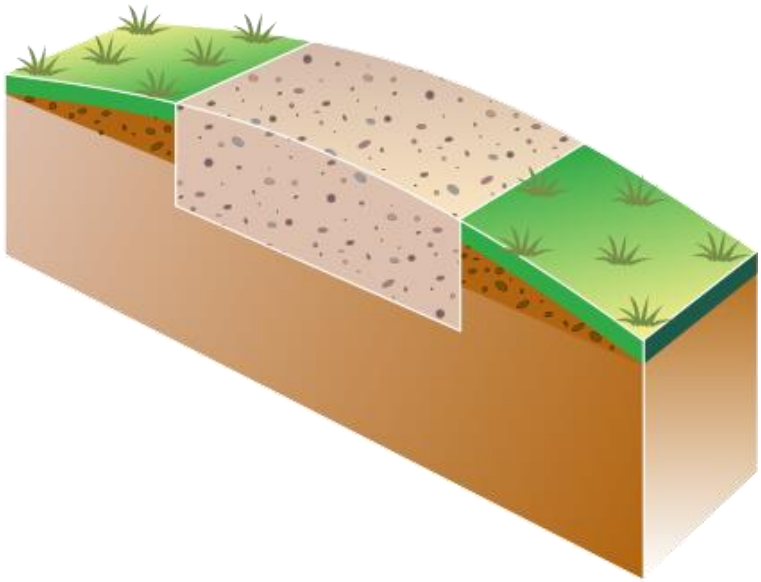
Ground vegetation and topsoil is removed to expose firm sub-soil and to form a formation tray to the specified width and depth. The tray should be rectangular in section with vertical sides. The depth of formation tray will depend on the strength of the sub-soil and the likely users of the path, but the final surface level is similar to the original ground level. Carefully store turfs and soil for use elsewhere.



Formation - full tray excavation

3.3.2 Semi-tray excavation

The path surface level is raised above the surrounding ground to aid drainage. Remove vegetation and excavate topsoil to form a tray for part of the total construction thickness. Prior to infilling, use excavated topsoil and stripped turfs to create a formation tray for the remaining thickness required. The tray should be rectangular in section with vertical sides and outer edges of the formation sloping down to the original ground levels.

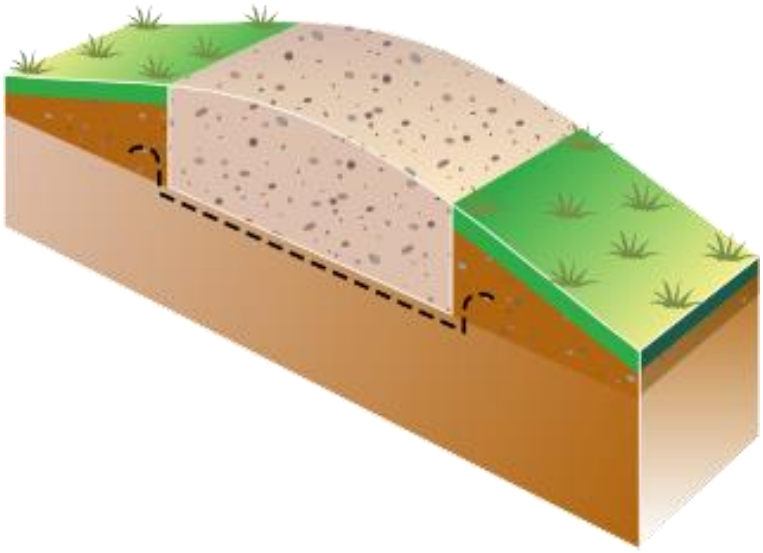


Formation - semi-tray excavation

Semi-tray excavation specification
excavate ground vegetation and topsoil to form X metre wide formation tray to maximum depth of X mm below ground levels. The tray should be rectangular in section with vertical sides and level base
stripped vegetation and excavated topsoil to be cast and spread locally on site, either side of formation tray and landscaped into existing ground levels. If space is limited cart excess materials to suitable location on site for spreading and landscaping
if soft spots are present, excavate the area below formation level until the sub grade is stable. Back fill with lower quality granular sub base material to formation level and compact to refusal

3.3.3 Floated construction

On weak soil (high clay content) the path is ‘floated’ on geotextile (Geotextiles and geogrids). The degree of formation works will depend on soil composition. However, as a minimum, the vegetation and topsoil should be removed to a depth of 50mm to form a shallow tray. This approach is called ‘site strip’. If the soil is very wet and soft (e.g. peat) then the path can be built on a geocomposite laid in the shallow tray. This will provide the extra strength to support the weight of heavy machines, the built path and users. Avoid building the path straight onto vegetated ground as vegetation beneath will rot down causing the path to settle below ground levels – creating an uneven surface and potentially leading to drainage problems.



Formation - floated construction

Floated construction specification

strip off ground vegetation and excavate topsoil to form X m wide formation tray to maximum depth of 50mm below ground levels

use stripped vegetation and excavated topsoil to form raised path verges on either side of formation tray. Source extra topsoil on site. The tray should be rectangular in section with vertical sides and level base

if the formation level contains high clay content, lay and secure geotextile sheet in the formation tray. Geotextile sheet should line the base and both sides. Overlap joining sheets by 1.0m

if the formation level is very wet and soft, lay and secure geogrid on top of geotextile sheet. Geogrid should not protrude up the sides of the formation tray. Overlap joining sheets by 1.0m. Use a combined geocomposite instead of separate geotextile and geogrid.

Floated construction tips

don’t excavate more than 150- 200 mm looking for a firm sub-soil. If the topsoil is so deep that more excavation is required then use the floated construction technique. This will reduce the amount of material produced during formation works and reduce the amount of imported stone fill required. Small localised soft spots may be excavated and back filled with stone to the formation level, or supported with geotextile and geogrid, if required

soft spots can be difficult to identify before the formation layer has been excavated. As a contingency, it is useful to provide a provisional sum in the bill of quantities for excavating and back filling soft spots. Where a formation layer needs to be increased in depth because of soft spots, it is more cost effective to deal with the problem at this stage, rather than having to re-construct a section of path that has failed, because a soft spot was not dealt with when the path was first built

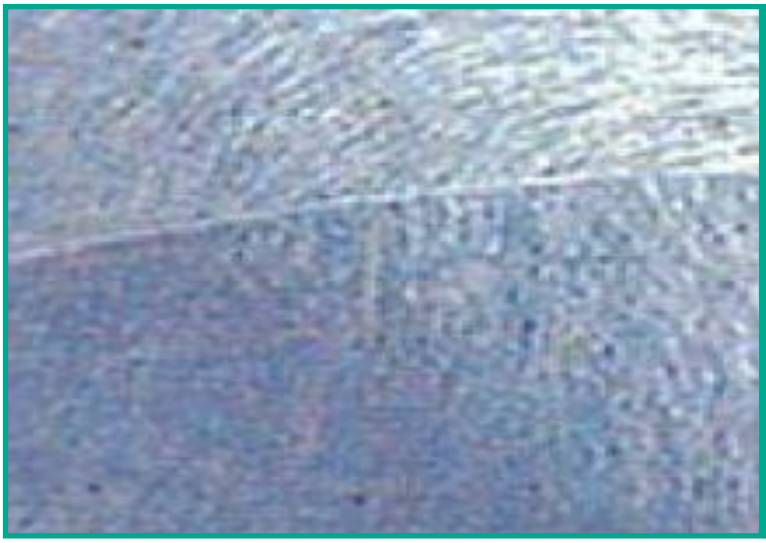
3.4 Separation and reinforcement layers

Geotextiles

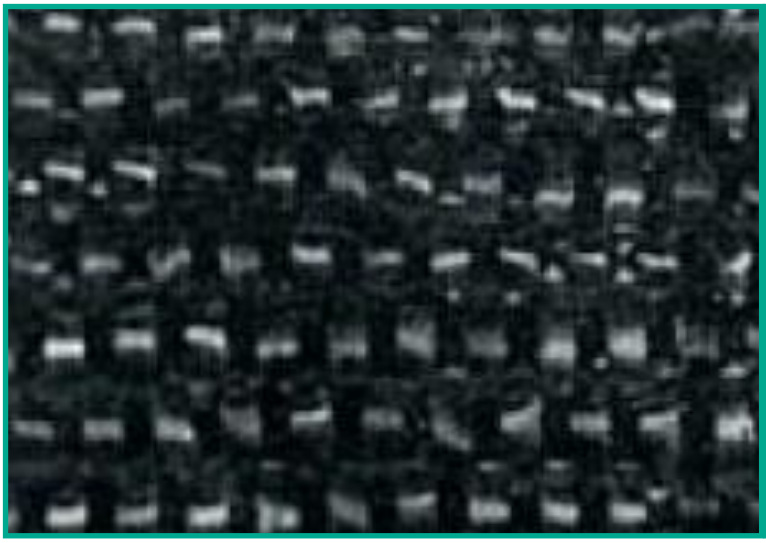
Geotextiles are rolled out over a prepared formation level in the formation tray, and then stone is tipped on top to build the path's base layer. The stone is spread out and compacted with the sheet stretching until full compaction is achieved. The softer the ground, the more stone is required and more strain is placed on the sheet. It is therefore important to use the right grade and strength of geotextile. Manufacturers will give information and recommendations on what grade to use. They are typically available in 100m long by 4.5 - 5m wide rolls. Some of the commonly used geotextiles for path construction are:

Only use a geotextile if there is significant clay content in the soil (i.e. the soil is soft and 'sticky' when wet) or if the soil is very weak (i.e. it contains a lot of organic material such as peat). If the formation is hard or well drained and the sub-soil is granular with little or no clay content, a geotextile will not be required.

A geotextile can help to prevent vegetation growth through a path. 'Terram' and similar woven felt-type geotextiles are particularly resistant to vegetation. Some geotextiles are susceptible to damage by chemical weed killers so it is important to refer to the manufacturer's information for details.



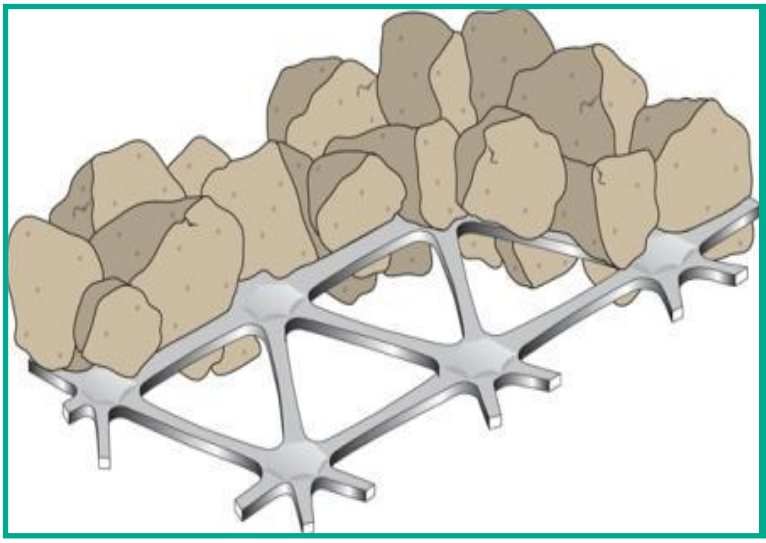
Non-woven felt.



Woven polypropylene.

Geogrid

A geogrid is a tough moulded plastic mesh with large holes and generally greater strength than a woven geotextile. It can be installed on top of a geotextile in the formation tray, or, used on its own, directly on top of the prepared sub-soil. The mesh will hold the aggregate preventing it from moving downhill or sinking into the ground. This makes them of particular use for paths on sloping ground or crossing very soft ground. Commonly used geogrid is made by 'Tensar'.



©Tensar TriAx TX geogrid.

Geocomposite

This is simply a combination of a geogrid laid over a geotextile to provide additional strength to a formation layer.

©Tensar Geocomposite (TriAx geogrid on top of non-woven geotextile).

Fascines

Fascines are tightly bound bundles of freshly cut brushwood which are laid across the path width and were the traditional predecessor to geotextiles. They have been used over many centuries and can still be used in areas where importing an artificial material may be inappropriate, being a constructive use of cleared vegetation. It is good practice to use

fascines when crossing very wet ground as they can provide initial support to a geotextile sheet during base laying operations.

Geotextiles and geogrids can be used in the following situations	
Separation	to prevent base stone from disappearing into weak soil formation (geotextile) to prevent soil pumping into base stone (geotextile) to prevent the wash out of base stone from underground springs (geotextile) to prevent vegetation growth through a formation (non-woven felt geotextile)
Reinforcement	to strengthen a base layer laid on a weak soil with high clay content (geotextile) to float a base layer over a very weak soil (peat) (geocomposite) to prevent migration of aggregate down the slope on gradients steeper than 1:12 (geogrid)
Filtration	to line filter drain or French drain trenches to prevent silting up of drain stone and perforated pipe with fine particles washed out of soil (geotextile)

Fascines specification
use a medium grade of geotextile sheet for most path applications (Autoway 120, Terram 1000, Terram 1500, Terram 2000, Lo Trak 16/15). Heavier grades are used for high loadings, such as paths with vehicle use or high volume of different user groups)
overlap successive sheets of geotextile and geogrid by 1 metre along the formation tray length. Geotextile sheet edges should extend about 150mm beyond the formation tray edges and should be covered by verge soil or turfs to a minimum depth of 150mm. If a geocomposite is used, the geogrid should be facing upwards with the geotextile beneath, cut to the required path width within the formation tray. Geogrid edges should not curve up the tray sides
cover the geotextile and geogrid with path base stone. Minimum cover should be 150mm to prevent possible localised exposure on unbound path surfaces which are prone to frost-heave. Geotextiles and geogrids should not be visible after path verges have been landscaped.

Fascines maintenance
a path should not require maintenance to the geotextile or geogrid once the path is constructed
exposure of the geotextile or geogrid is an indication of other problems with the design or construction of the path

3.5 Base layer

The base layer is the main load bearing layer of a path structure which spreads the weight and forces of different users in to formation layer below. For that reason, the base layer should be built to high standard. A base layer is generally laid by tipping successive loads of well graded granular sub base material, such as Type 1 from a dumper into the prepared formation tray, which is then spread manually with a rake or an excavator with grading bucket.

Alternatively, a ‘drag box’ can be used to quickly lay the base layer to any depth, creating a high-quality finish with an even surface.

Why compact the base layer?

The base layer should be thoroughly compacted in layers to maximise its strength and binding properties. Compaction of the base layer removes the air between stone particles and therefore increases the solid mass density of the well graded granular sub base material. A vibrating roller is used to compact the material until it refuses to move or settle any further, when the base layer is said to be ‘compacted to refusal’. A properly compacted base layer should not have loose material or show roller marks in the surface.

For detailed information about the well graded granular sub base materials used to create a base layer including how deep a base layer can be and how they are constructed, read the following sections:

3.5.1 Base layer materials

Materials used to build a path base layer are generally well graded granular sub base materials which help to spread the weight and forces of different path users in to formation layer below. The base layer can be built with one type of material or in combination with another type. For example, the lower half of the base layer can be built with a lower quality material such as crushed concrete (demolition waste), whilst a higher quality material like Type 1 granular sub base is used on the top half to remove all irregularities before laying the surface layer.

Well graded granular sub base materials can be: natural aggregates, or recycled aggregates and secondary aggregates.

Natural aggregates

The Department of Transport 'Specification of Highway Works' (SHW) defines a number of well graded aggregates based on the composition of particle sizes contained in the commercially produced mixture. Clause 803 defines ‘Department of Transport (DTp) Type 1 granular sub base’ and Clause 804 describes ‘DTp Type 2 granular sub base’. These aggregates are more commonly referred to as 'Type 1' and 'Type 2'.

Type 1

This is the most common well graded granular sub base material used to construct a path's base layer. It is a well tried and tested component of lowland paths that has been used for many years as the default base layer material. Commercial quarries supply DTp Type 1 granular sub base consisting of crushed rock graded to a specification that has a defined proportion of stone particle sizes. Well graded Type 1 contains a good mix of angular aggregate sized between 63mm and 'fines' (sand sized particles), however, most of the aggregate content is less than 32mm in size - the European Norm standard for Type 1 is 0/32. The solid stone particles should not exceed 63mm in size and less than 9% of fines. This

ensures the material has an acceptable level of natural interlock between the angular aggregate particles and no voids once compacted. Type 1 is subject to regional variations based on geology - most quarries in central, west and south Scotland produce it from grey whinstone, a few quarries in eastern Scotland produce it from reddish whinstone, and further north it is produced from granite.

Type 1 aggregate.

Type 2

Like Type 1, this is crushed rock less than 32mm in size with less than 9% 'fines' but with no specified grading. It usually contains finer material than Type 1, being composed of fewer angular aggregate sizes. Type 2 is not as strong as Type 1, so for that reason, it is not generally used on its own to build a base layer. It would usually be used to form the lower part of a base layer with Type 1 laid on top.

Type 2 aggregate.

Type 3

Another crushed aggregate with a lower 'fines' component than Type 1 or Type 2 - there should be less than 5% 'fines' and over half of the aggregate particles are greater than 4mm in size. This uniformly graded aggregate material is suitable for a free draining base layer for porous surfaced paths.

Type 3 aggregate.

Crusher run

This granular sub base is a waste material from quarry stone processing. It is crushed material that comes straight off the rock crusher after the first crushing stage, which is not carried forward to sieving stage. It is similar to scalpings, its strength is variable, and is available in different maximum particle sizes, based on the screen sizes used on the rock crusher, which means there is no guarantee that the waste material is well graded. Providing that the rock crushed is not too soft, crusher run can be used as an alternative to Type 1 or Type 2.

Crusher run aggregate.

Scalpings

This is a waste material from quarry explosions which is removed (sieved out) before the larger rock is crushed. It is often referred to as quarry waste, its strength can be variable and there is no guarantee that its well graded. It is often much cheaper to purchase than the other granular sub base materials because of quality issues. Particles range in size from 100mm - 40mm to dust. Scalpings can be used as fill material to make up the formation level where it has been excavated deeper than originally specified to deal with soft spots. It can also be laid as the lower part of a base layer with Type 1 on top. If carefully selected, scalpings may make a reasonably good base layer when used on their own, but avoid wet material with high clay content. It can cause problems.

Scalpings.

‘As dug’

This granular sub base material should consist of free draining, naturally occurring sands and gravels with sufficient clay content to bind the material together when compacted. It is sometimes referred to as ‘hoggin’. Such materials are usually glacial tills found mainly in glaciated areas and river valleys. ‘As dug’ material is taken straight out of the ground from small scale borrow pits alongside the route being built, and has not been crushed or graded to any specification. It can also be imported to site from one large borrow pit where onsite materials are not suitable for path construction.

'As dug' materials can be used to provide the bulk of a base layer, which can then be overlaid by a regulating layer of higher quality Type 1 on which the path surface can be laid. To improve the quality of the ‘as dug’ material it can be graded on site using a portable non-vibrating screener attached to the dumper or a larger mobile vibrating screener. The latter is suitable where good access is available.

‘As dug’ materials may be the only source of stone in some areas where it is impractical or prohibitively expensive to import commercially quarried aggregates. These situations could include small scale upgrades, or particularly remote locations. However, if the range and composition of particle sizes would result in a poor-quality path, such as too much clay or soft rock, it is worth investigating other options before settling for ‘as dug’ material.

Hoggin.

Recycled and Secondary aggregates (RSA)

In recent years there has been an increase in the availability and use of recycled aggregates and re-useable by-products from industries. They tend to be locally available and the quality can vary greatly, but recycled and secondary aggregate quality standards are now available. In many cases it will be necessary to use RSA along with conventional path construction materials.

Typical recycled aggregates are road planings (from road re-construction or maintenance) and crushed concrete (from demolition waste). All recycled and secondary aggregate products should be chosen carefully. Industrial by-products that do not form a specified standard aggregate mixture design must be individually assessed, because some materials are prone to leaching or just not suitable for construction.

Demolition waste

Recycled Type 1, Type 2 can be produced from a variety of materials arising from demolition waste (crushed concrete, brick, hardcore) from buildings or other structures. However, quality can be variable so check the specification with the supplier before purchasing the material - check for a well graded size distribution. Recycled demolition wastes can make good bottoming or lower half of the base layer with Type 1 laid on top. Some path base layers have been successfully built using just recycled Type 1 where the material has been well graded to the specified quality standard.

Type1 recycled demolition waste.

Road planings

These are crushed or milled bitmac or asphalt arisings produced in road or pavement reconstruction or maintenance work. This material has similar properties to well graded aggregate. If rolled hard in hot weather, the bitumen binder can soften and then re-bind the bitumen coated stone to form a hard surface. For this reason, planings have been mainly used for path surfacing, but they can be used to create a base layer. The planings can be either part of the base layer with higher quality granular sub base laid on top, or as a whole base layer.

The price of planings can vary considerably. Unscreened planings purchased straight from a site may be cheaper, but the quality will be variable. Well graded screened material bought

from a processing centre will probably be processed to a material specification to produce a recycled Type 1 granular sub base material.

If you plan to use road planings for path construction, check where the material has come from before accepting it. It is possible that materials from deep planing of old roads may contain tar products, which generally should be treated as hazardous / special waste and not recycled. However, in some situations tar bound planings may be reprocessed in agreement with Scottish Environment Protection Agency (SEPA). It is important therefore to seek their advice before purchasing and using road planings.

Road planings.

Blaes

This industrial waste by-product of colliery spoils and spent oil shale bings is reprocessed as a secondary aggregate and is available in some areas of Central Scotland, particularly West Lothian. Blaes from colliery spoil is either black or red. Black material contains coal dust that is combustible. Red material has been burnt, and can be re-used for other construction purposes. Blaes from spent oil shale is pinkish, and similar in nature to red burnt colliery spoil.

Blaes.

Blaes consists of particles of variable sizes making quality very variable. It can provide a well bound base layer material that is suitable as bottoming or the lower part of the base layer, with

a higher quality granular sub base laid on top. It generally needs to be laid to greater thickness than other granular sub base materials to make a strong layer.

Care must be taken when using near to watercourses as some materials can be highly toxic. If you plan to use blaes for path construction, seek the advice of SEPA before using it, especially if the path is to be built near a watercourse.

3.5.2 Base layer depths and construction methods

Base layer depths

It is not necessary to carry out precise calculations for providing different base layer depths for paths that are not expected to carry vehicles. The following table provides a guide to base layer depths and whether to or not to use a geotextile.

Formation description	Test for soil strength	Geotextile	Base layer depth
Disused railway, with ballast still in place	Visual	No	50mm
Disused railway, ballast removed, ash present	Visual	No	100mm
Glacial till/sand and gravel	No heel marks produced, no standing water, free draining shallow topsoil	No	100mm
Firm well drained granular soil, parkland, agricultural fields	Small or no heel marks, no standing water, topsoil may be deep (100-150mm)	No	100-150mm depending on topsoil depth
Granular soil with high clay content, hard when dry, soft when wet	Medium to large heel marks dependant on wetness	Yes	150-200mm depending on users
Clay with minimal granular content	Large marks unless very dry – test in wet to avoid false reading	Yes	200-250mm
Peat with minimal granular content, wetland	Visual, no support of any load	Yes	300-500mm rock causeway with 100mm base on top

An extra 50mm or more of base layer depth is recommended on paths where equestrian use is expected to be heavy.

Construction methods

The approach to constructing the base layer, generally depends on hardness of the exposed formation level in the tray. If the formation level is reasonable hard and well drained, and the depth of granular sub base is to be less than 150mm, the base layer can be laid and compacted as one single layer. However, if the formation level will not be able to support the

weight of dumpers travelling on it, because of its soil properties (soft when wet, clay or peat with minimal granular content), and the depth of granular sub base is to be more than 150mm, the base layer is best laid and compacted as two single layers - up to 150mm at a time and compacted before adding the next layer of aggregate - this helps to prevent damage to the formation tray level, reduce irregularities, and improves the compaction of the aggregate.

The best approach to undertaking the double layer construction method is to lay the first layer of granular sub base from the start of the formation tray (the end nearest to the material heap) and continue to lay materials along the tray to opposite end (the end furthest from the material heap). That first layer is then compacted with a heavy vibrating roller. The second (final) layer of granular sub base material is then laid on top of the compacted first layer. A dumper, which can now easily travel along the formation tray without damaging it, will lay the second layer of granular sub base material on top of the compacted first layer working from the opposite end and back to the start of the path. The final layer of laid granular sub base is compacted to refusal with the roller again.

A ‘drag box’ is a useful method of making sure each layer of granular sub base material is laid relatively evenly, either as a single layer or double layer. A 'drag box' is a sledge which is filled with aggregate and dragged (by excavator or dumper) along and inside the excavated formation tray. Aggregate is spread rapidly and evenly, and some Contractors have drag boxes that can form a camber, making it easier to roll the camber to specification.

Base layer construction specification
using hand rake or drag box, lay dry granular sub base material to the specified width and depth in the formation tray forming a camber or cross fall as required
the base layer should be laid and compacted in layers not exceeding 150mm. For example, a 200mm thick base should be built as two separate layers - 150mm layer and then 50mm layer
compact the granular sub base material to refusal by multiple passes with a heavy smooth wheeled vibrating roller (either ‘double drum’ or ‘single drum’ type, depending on the width of path)
there should be no high spots or dips along the base layer surface. Check the level of the surface at regular intervals along the base layer for a consistent even surface, which should have a maximum gap of 10mm under a 3m straight edge laid along the compacted surface. Any area of the base layer surface deviating from the required level should be raked off or topped up with extra material and re-compacted to the correct levels
the final compacted base layer surface should be ‘closed tight’ with no exposed surface voids. If necessary, fill any openness with fines. The compacted surface should also be free of ruts, dips, potholes and roller marks, before the surface layer is laid

Where the lower half of the base layer is built with lower quality granular sub base material such as demolition waste, asphalt road planings or as dug material, a specified higher quality granular sub base material, such as Type 1 can be laid on top to bind together the lower layer to make it stronger. This practice also removes all irregularities (low points, high points or hollows) providing an even surface ready for laying the path's surface layer.

Mixed base layer construction specification
using a drag box lay lower quality granular sub base material (screened ‘as dug’ stone / RSA) to 150mm depth in the formation tray forming a camber or cross fall
compact to refusal with heavy vibrating roller
re-run the drag box over the compacted base layer laying maximum 50mm depth of higher quality granular sub base (recycled or quarry Type 1)
re-compact to refusal with heavy vibrating roller

Drag box.

3.6 Surface layer

The choice of path surface should be based on a range of criteria, including the expected users and the terrain. The available budget will probably constrain the options, but it is important to think about the ongoing maintenance cost of different surface types to determine their ‘whole-life cost’. Do not assume that a highly specified path surface such as a bound surface e.g. bitmac will be totally maintenance free. They do need inspecting and some planned, routine maintenance during their useable lives.

This section looks at different path surface types to consider when designing a new path, or replacing or upgrading an existing surface. In addition, information about the issues to consider when selecting a surface type to be used by equestrian users are provided.

3.6.1 Unbound surfaces

Consider unbound surfaces where a formal path surface is required but a natural look is desirable.

Ideally lay unbound surfaces using a drag box to maximum depth of 25mm to seal the base layer from the ingress of water, protecting it from frost heave, and for even surface.

Always specify the tolerance of surface evenness for unbound surfaces - less than 5mm gap under a 3m straight edge placed along the path surface provides a smooth and even surface which will prevent puddles forming, and pleasant surface for all path users to enjoy safely.

New unbound surfaces tend to be soft until fully consolidated. If horse and bicycle use is expected allow a new path to consolidate before use (usually after the first fall of rain and some further pedestrian use).

Materials

As dug

A won surfacing material consisting of free draining, naturally occurring sands and rounded gravels with relatively high fines and clay content to bind the sand and gravel particles together when compacted with a roller. It is commonly sourced from on-site burrow pits alongside the path under construction, or imported to site. As dug will bind well after plenty of rolling and forms a reasonable firm surface, but it can be very variable and its quality and consistency should be monitored when used.

For best results, as dug materials should be sieved and graded to produce suitable sized material for surfacing which binds naturally together once rolled e.g. 6mm down.

Beware of as dug materials with a very high fines and clay content. If the fines content is too high, the material will go soft, rut and become slippery when wet. When considering any as dug material for path surfacing, check its suitability first.

Hoggin.

Natural aggregate

Crushed whinstone, limestone or granite ranging in size from 6mm stone particles down to fine dust. Commonly used quarry aggregates are whin dust, granite dust and limestone dust, depending on availability and local geology.

Whindust surfacing.

3.6.2 Semi-bound surfaces

Semi-bound surfaces are generally spread and levelled using an asphalt mini paving machine. However, where access may be more difficult for larger plant, a drag box could be used instead. A drag box will lay the material reasonably well.

Where hand laying is necessary, take care not to over rake the material as the coarser and finer materials will separate, with the larger material coming to the top.

For best results, lay materials whilst damp and then compact using a heavy vibrating roller (120 type roller is recommended) to ensure adequate compaction. This material does not harden quickly after delivery, allowing time to get the material into difficult work sites (it can be stockpiled for a few days on site before laying).

The recommended laying depth for semi-bound surfaces range from 50mm to 100mm.

Always specify the tolerance of surface evenness for semi-bound surfaces - less than 5mm gap under a 3m straight edge placed along the path surface provides a smooth and even surface which will prevent puddles forming, and pleasant surface for all path users to enjoy safely.

Materials

Semi-bound surface materials available in Scotland tend to be composites from one or more recycled or secondary aggregates such as screened road planings, blaes, crushed concrete.

In central Scotland, Toptrec is available to purchase as a 100% recycled material made of well graded aggregate products including shale waste and screened road planings. This material is generally graded as 20mm to dust and has reasonably good binding properties from the road planing content. It is proprietary product produced by Tarmac, and is best laid by surfacing

contractor with experience and knowledge of how to lay it properly. The main limiting factor for using Toptrec is the cost of haulage from Tarmac's quarry in West Lothian.

Toptrec surface.

3.6.3 Bound surfaces

The surface laying methods used for most bound surface applications fall into three categories: surface dressing (tar spray and chip), bituminous macadam (bitmac), hot rolled asphalt.

Where the surface layer is to be machine laid, the base layer must be wide enough and capable of supporting the weight of plant and tar lorries. Path widths less than 2m can be difficult to lay using paving machines. Path construction sites where the ground adjacent to the path may be soft can be problematic - a machine or lorry can get stuck if it moves onto a soft verge.

Always specify the tolerance of surface evenness for bound surfaces - less than 5mm gap under a 3m straight edge placed along the path surface provides a smooth and even surface which will prevent puddles forming, and pleasant surface for all path users to enjoy safely.

Surface dressing (tar spray and chip)

Materials

There are two methods for laying surface dressing:

Single layer

The simplest and cheapest method is a single layer of bitumen emulsion spray and one layer of washed stone chippings rolled in. This is a particularly useful way of upgrading an existing unbound or semi-bound surfaced path or even worn bound surface at a relatively low cost. Alternatively, a new path which has both level and sloping sections can be an unbound surface throughout its length, and then the sloping sections which are susceptible to surface water scouring can be sealed with a single surface dressing layer.

Double layer

A more substantial surface layer is a two-layer application i.e. bitumen emulsion applied to the base layer with washed stone chippings rolled in and then a second layer of bitumen emulsion and washed stone chippings are laid and rolled in. The double layer will be a strong, homogenous surface which will be harder wearing and less susceptible to washout than a single layer. There are fewer loose stone chips on a two-layer surface than on a one layer, if properly laid.

Surface dressing.

Fibredec

'Fibredec' is a proprietary variation on the two-layer method. It has a layer of chopped glass fibres between the two layers of proprietary bitumen emulsion binder, and a top layer of washed stone chippings to provide a high tensile strength, crack resistant thin surface layer on top of new base layer or existing surface layer.

The new formation layer or worn surface layer must be treated with weed killer prior to laying surface dressing or Fibredec. Weeds may break through causing the thin surface to crack. Use a residual weed killer subject to environmental considerations.

Surface dressing and Fibredec quality is dependent on how well a new base layer is laid or how smooth and even the existing worn surface is. Specify a tolerance of surface evenness - maximum gap of 10mm under a 3m straight edge placed along the surface with no high or low points or hollows. Ideally lay the new base layer or regulate the worn surface with a drag box to achieve a smooth and even surface. Likewise, if as dug or recycled secondary aggregate materials are used to build the base layer, regulate with 100mm depth of Type 1 granular sub base to provide a strong even surface layer suitable for surface dressing or Fibredec. If the regulation layer lacks sufficient fines to provide a smooth surface, blind with quarry dust before laying the thin surface layer.

Bituminous macadam (bitmac)

This is a proprietary surfacing technique that requires an asphalt paving machine for high quality laying and finishing. The mixture of bitumen and graded aggregate is laid on a prepared base layer and rolled to provide a durable surface course layer. Bitmac surfaces are best laid with a cross fall rather than camber, to avoid a reduction in surface depth at the

edges, where cracking can occur. This type of surface should be laid to defined tolerance margins to provide a high-quality finish that justifies the investment.

The bitumen content in making bitmac can vary slightly in hardness. This is measured in terms of the bitumen “penetration grade” (measurement of how deep a standard needle penetrates the hardened bitumen at a standard temperature under a standard pressure). Higher penetration grades (where the needle penetrates deeper) are softer and generate a smoother and more forgiving surface. Typical penetration grades for shared use paths are 160/220 pen (softer) or 100/150 pen (harder). The other main variation in bitmac surfaces is the graded aggregate size that is used. Larger aggregate sizes make a porous surface, which allows surface water to drain through rather than flowing across the surface. Smaller aggregate size gives a smoother surface, which is usually preferred by wheeled users, particularly cyclists. Standard maximum aggregate sizes are 20mm, 14mm, 10mm and 6mm.

Brushing whin dust into the surface, immediately after laying, will reduce the initial visual impact of a bitmac surface. The dust will eventually wash off, by which time the bitmac will have faded to a grey colour. Alternatively, dress bitmac with 3mm grit, rolled in before the bitumen binder hardens or lay coloured stone chippings rolled into a bitumen emulsion layer (as described in ‘Surface Dressing (tar spray and chippings)’ above). Coloured bitmacs are available but they are extremely expensive and the colour will fade quite quickly leaving the exposed grey aggregate.

Bitmac.

Hot rolled asphalt

Hot rolled asphalt is a surface course layer used occasionally for path surfacing but is commonly used for road or pavement surfaces. It is a bitumen and sand mix that relies on the presence of hard stone chippings being embedded into the surface to provide durability and traction.

Hot rolled asphalt surface course layer is usually paver laid on top of a binder course, with bitumen coated stone chippings scattered over the newly laid surface at a specified rate, and compacted into the asphalt with roller when still hot.

Hot rolled asphalt.

3.6.4 Porous surfaces

Porous surfaces are constructed using materials containing small or large voids that allow water to pass through, but are strong and durable enough to support the weight of users. Porous surfaces are used as part of sustainable drainage systems (SUDS) to control storm water at source. Rain falling onto a porous surface is stored and released into the ground in a controlled way rather than producing surface water runoff. This process filters out harmful pollutants and reduces the flow and volume of water runoff compared with impervious surfaces such as bitmac or asphalt.

Porous surfaces are a relatively recent introduction to path management, but their use is likely to rise in the coming years. The base layer needs to be free draining to allow water to drain through the stone to reach the underlying ground. Open graded aggregate, such as Type 3 could be used, which is composed of a limited range of stone sizes with open voids between the individual stones to provide free draining properties. The base layer must be designed so that the water level never rises into the porous surface. The surface of porous paths do not need a camber or cross fall for shedding water as water drains directly down through the constructed layers.

Materials

Porous asphalt

Asphalt can be laid as a porous surface by removing the sand from the aggregate mixture to create voids so water can drain freely through. It is generally even more expensive than standard hot rolled asphalt, and is laid in the same way, to a high specification by paving machine and has a coarser texture. It has a long service life and can be recycled.

Resin bound paving

A mixture of resin binder and washed single sized aggregate (size range 6mm – 12mm) is laid and spread over open graded stone base layer to provide a durable and porous surface. Each aggregate particle is fully coated with UV resin before laying. The mixture is spread and levelled by hand held screeding equipment. The aggregate particles adhere to one another

and to the prepared base layer surface whilst leaving voids between each aggregate particle for water to pass through.

Resin bound gravel.

Reinforced grass / gravel paving

Interlocking and continuous plastic ‘cellular’ paving systems provide strong structural load bearing surfaces that will take the weight of users. These paving systems have a large amount of surface void space allowing rain water to drain through easily and quickly.

For porous grass paving, the cells are filled with free draining soil (or sand / soil mixture) and seeded with grass mix.

Reinforced grass paving.

For porous gravel paving, the cells are filled with clean angular gravel over a free draining sand bedding layer. The individual cells contain and prevent the gravel substrate moving laterally.

For both systems, the cells are supported on an open graded stone base layer, covered with a permeable geotextile. This prevents the bedding layer from being washed into the voids between the large stone particles, maintaining the free draining base layer. A second geotextile may be required below the base layer to separate the free draining stone from the formation layer, preventing soil clogging and moving upwards through the open voids between

the large stone particles which will eventually stop water draining through and back into the ground below.

Reinforced gravel paving.

3.6.5 Equestrian use and surface types

Most unbound surfaces will require some initial ‘settling in’ before they fully consolidate, and before then horses’ hooves may cause some marking to the surface layer which may need repairing. Exposed angular aggregate can cause discomfort to horses, so unbound surfaces that have only been blinded with a granite or whin dust can be more problematic for horses' hooves. Loose and large stones should also be removed as horses’ hooves can be easily damaged and the stones will get scattered causing a problem for wheeled users.

Bound surfaces, such as bitmac and asphalt can withstand horse use, but horse riders do not favour them as the hard and smooth surface can cause discomfort to horses’ hooves or a slip hazard. Alternatively, surface dressing or 3mm grit can be applied to the bitmac or asphalt surface at the time of construction to provide the extra grip which will reduce the risk of slipping. The hard grit is spread at a rate of 1.0kg per square metre and rolled in immediately after laying the bound surface. Excess grit is swept and removed from the surface. Surplus loose grit can be a slip hazard for path users.

If space allows, a separate 'softer' surface for horses should be considered, for short distances at least, alongside the main path. This approach allows horses to move off the hard surface for a short period of time, and then to return to the hard surface when the rider wishes too. In the past, where separate horse-riding surfaces have been provided, they have been surfaced using bark/ woodchips. If extra space is limited and only available in certain locations along a route, consider providing short ‘rides’ away from the main path to give horse riders a chance for a gallop or canter. If the ground is relatively free draining, simply clear taller vegetation and overhanging branches, and any other unobvious hazards on the ground to form a natural surface which horses' can easily use. If horse riding is going to be regular daily activity on such 'rides', then consider upgrading the natural surface to more durable surface with a constructed free draining base layer.

Paths on disused railways lend themselves to separate surfaces for different user groups as there is often plenty of space available to share. Remove of all loose ballast and clear a strip of the underlying ash will provide an excellent free draining surface for most users to use throughout the year.

Materials

Bark / woodchips

Wood based surfaces can provide a soft, aesthetic surface for equestrian use that blends well into their location, but are only effective as a horse-riding surface if they are kept dry and free draining. They work well on free draining ground or constructed free draining base layer. Wood based surfaces should not be used on clay, where they may become waterlogged, slippery and the material will rot. They also should not be used in exposed windy locations where the bark/ woodchips will be blown away quickly.

There needs to be good and suitable source of natural or recycled bark/ woodchips available locally. Woodchips from forestry operations may include greenery such as leaves, which rots quickly and will reduce the life expectancy of the surface. There are equestrian surface suppliers who produce equestrian surface products for equestrian facilities and bridle paths. The surface will probably need to be topped up annually, and unless a plentiful supply of material is available locally, this type of surface will incur high maintenance costs.

Bark / woodchips specification
excavate ground vegetation and topsoil to form X metre wide formation tray to maximum depth of 300mm below ground levels. The tray should be rectangular in section with vertical sides and level base
stripped vegetation and excavated topsoil to be cast and spread locally on site, either side of formation tray and landscaped into existing ground levels. If space is limited cart excess materials to suitable location on site for spreading and landscaping
lay and compact 80mm depth of 80mm no fines free draining coarse drainage stone in the bottom of formation tray to form a firm base layer
lay and secure non-woven or woven permeable geotextile separation layer on top of the compacted base layer in the formation tray. Line bottom and sides of tray and overlap joining sheets by 1.0m
lay 300mm depth of bark/ woodchips (nominal particle size range 5mm - 40mm) on top of geotextile separation layer in the formation tray and compact until bark/ woodchips are below existing ground levels

Turf

A better solution than a wood-based surface is to construct free draining base layer and cover with existing topsoil and turfs to form a natural surface, which blends well into its natural surroundings, and provides a firm surface for equestrian use.

Like a wood-based surface, this type of surface is only suitable for free draining ground – not clay or poorly drained wet ground. It is low maintenance surface requiring one or two cuts per year to keep the ground vegetation short.

Turf specification
excavate ground vegetation and topsoil to form X metre wide formation tray to maximum depth of 350mm below ground levels. The tray should be rectangular in section with vertical sides and level base
stripped vegetation and excavated topsoil to be placed to either side of formation tray for later use. Excess materials to be landscaped into existing ground levels or carted to suitable location on site for spreading and landscaping
lay and compact 200mm depth of 80mm no fines free draining coarse drainage stone in the bottom of formation tray to form a firm base layer
lay and secure non-woven or woven permeable geotextile separation layer on top of the compacted base layer in the formation tray. Line bottom and sides of tray and overlap joining sheets by 1.0m
lay 100mm depth of excavated topsoil on top of geotextile separation layer in the formation tray and lightly consolidate
lay available turfs to cover topsoil layer to levels of existing ground. Ensure all turfs are butted tightly together with no exposed gaps, roots and topsoil

3.7 Path verges

It is essential to support the path to prevent lateral spread of the base layer and to protect the edges of the surface layer.

The soft edging method consisting of topsoil and turfs can form verges (shoulders) that makes a path surface on top of wider base layer look much narrower. The same method can also consist of keeping the base and surface layers at the same width, with the undisturbed sides of the excavated formation tray providing adequate support to the path. Some vegetation encroachment will occur with the second method, but this may be desirable to give a more natural look.

Soft edging method.

In some path situations, the base and surface layers have been supported using timber edging or concrete kerbing. However, this hard-edging method on unbound surfaces can eventually cause major problems as the surface wears below the inside top edge: the edge will end up higher than the surface, which will prevent surface water runoff, leading to puddling or scouring.

These exposed edges also pose a trip hazard to users. Timber edging made from boards will rapidly deteriorate, the path will collapse and complete re-construction of the path will be required. Using timber edging or concrete kerbing can also increase construction costs. Concrete kerbing is generally only used for footway pavements constructed to Local Authority roads and pavement standards.

Hard edging method.

For woodland paths, where tree roots are exposed and there is limited availability of turf and soil to create suitable path verges to support the path, sawn logs can be useful alternative. Also, cellular confinement system, such as 'geocells' infilled with free draining aggregate could be used.

Forming and landscaping path verges tips
make sure the planted turf or topsoil is not higher than the finished path surface layer (they should be finished off level with the path surface or just below) - high verges can prevent surface water from running of the path surface causing standing water and scouring
make sure the verges slope down away from the edges of the path surface to allow surface water to runoff and not back on to the path

3.8 Other path features

When planning and designing a path or network, the path surface is only one part of the overall picture. There is a range of path-related features that you will need to consider to allow people to enjoy and use your path network safely and comfortably. Many of these structures can make your paths more accessible to a wider range of users, so it is worth thinking about the practicalities of 'reasonable adjustments' that you can make during the initial planning and design stages of a path project, rather than trying to adapt things later.

Some of the structures associated with path networks are outlined below with internal or external links to more comprehensive guidance. Please note that these are presented in alphabetical order, and some sections need to be considered together, such as gates and turning spaces:

3.8.1 Boardwalks

Boardwalks can provide an alternative surface type for balancing the needs of public access with the protection of sensitive habitats. They are usually made from wood or plastic.

Boardwalks are expensive and require regular inspection and maintenance. Recycled plastic will provide a longer lifespan than wooden boardwalks, and with less risk of becoming slippery. A plastic boardwalk can also be installed at ground level to reduce its visual impact in the landscape as, unlike timber, plastic does not rot. However, in sensitive habitats the introduction of plastic may not be desirable in the long term. Boardwalks can avoid impacts to the hydrology of a wetland site which may be adversely affected by an aggregate path built directly on the ground.

Plastic boardwalk.

For general guidance about boardwalks and specification details for various boardwalk types, refer to the boardwalks section of our 'Outdoor Access Design Guide'.

3.8.2 Bridges

Bridges are an integral part of paths and are used to cross a range of 'barriers'. The need to accommodate different users will dictate variations in the design. Whether crossing a road, railway, river or burn, each bridge poses a different set of planning, design, construction and maintenance issues. So, although there are some common features in bridges, each is adapted to its own circumstances.

Bridge.

For comprehensive guidance to help you negotiate the complex factors involved getting a bridge in place refer to Path Bridges - Planning, Design, Construction and Maintenance (Paths for All, Scottish Natural Heritage, Forestry Civil Engineering).

3.8.3 Fences

Fences for paths, recreational sites or sensitive site areas such as nature reserves or historic sites can provide one or more functions by acting as a physical barrier or visual boundary. Fences can be used for guiding people as well as separating them from potential hazards.

Fence.

For general guidance about fences, key design principles and specification details for various fence types, refer to the fences section of our 'Outdoor Access Design Guide'.

3.8.4 Gaps, gates and barriers

Where a path crosses a boundary, you will need to consider how to allow people across with the least restriction possible – ideally through an open gap. However, in many cases there will be a requirement to control access for other reasons, such as livestock or to prevent unauthorised vehicle access. These situations will require some form of gate or fixed barrier, but you still need to take account of who is likely to use the path to install the most appropriate type. You also need to think about how much turning space might be required.

Kent carriage gap (© Sustrans).

Our 'Outdoor Access Design Guide' has detailed guidance about gaps and barriers and also for gates.

3.8.5 Handrails

Handrails can be attached to structures such as steps, ramps, boardwalks or bridges to provide safety and comfort. In some situations, handrails can give a means of propulsion for wheelchair users.

Handrail.

For handrail specification details on steps and ramps, refer to our 'Outdoor Access Design Guide' 'Countryside Access Design Guide' (Scottish Natural Heritage). You will also find handrail specification details for boardwalks.

For choosing handrail height for bridges and specification details, refer to 'Path Bridges – Planning, Design, Construction and Maintenance' (Paths for All, Scottish Natural Heritage, Forestry Civil Engineering).

3.8.6 Horse mounting blocks

Horse riders have better control of a horse when mounted. However, there are some situations, when riders will need to or are asked to dismount from their horse for reasons of safety. For example, a bridge with low handrails may make it unsafe to ride across in the saddle. In such circumstances, providing mounting blocks at each end of the bridge helps riders to remount their horses safely.

Horse mounting block.

For mounting block specification details, refer to 'Mounting Blocks', available from the British Horse Society.

3.8.7 Joining highways

In terms of safety and comfort, the transition area between paths and roads is critical to the success of many path projects. You may need to consider ways of managing road traffic as well as path users in order to minimise the dangers posed to them. Structures and techniques such as signs, crossings, bollards, flush dropped kerbs, and suitable markings are best incorporated at the planning and design stages, rather than 'retro-fitted'. You may also need to ensure that there is adequate surfacing and drainage around path/ road junctions to prevent water flooding onto a road.

Flush kerb.

The following publications provide general guidance about what to consider when planning and designing paths that meet roads, as well as giving specification details:

- 'Cycling by Design' (Transport Scotland) - chapter 7 deals with junctions.
- 'Cycling Infrastructure: Design Guidance and Best Practice' (South East of Scotland Transport Partnership).

3.8.8 Passing places

Passing places are useful on paths less than 1.5m wide, and the frequency of these areas depends on the setting of the path. The Fieldfare Trust Countryside for All Good Practice Guide (2005) recommends the following spacing:

Path setting	Maximum distance between passing places
urban	50m
urban fringe	100m
rural	150m

Passing places need to be incorporated into the planning and design stage so that they can be constructed and maintained as an integral part of the path surface. Each passing place

should be no less than 1.5m wide and 2m long. The crossfall should not be steeper than 2% (1:50).

Passing place.

3.8.9 Ramps (including landings)

If you have the space and it is practical to construct, a ramp is more accessible than steps. Depending on the height gain you may need to incorporate ‘landing’ spaces to allow rest points along the slope. In some situations, you may need to build a ramp with landings as a series of zig-zags to gain the height, and it is useful to include a set of steps to allow a shorter route.

The maximum recommended gradient of the ramp itself depends on the location, but in all cases a flat ‘landing’ area should be provided for each 750mm of height gained. Each landing should be at least 1.5m long.

For people to use ramps easily, the Fieldfare Trust Countryside for All Good Practice Guide (2005) recommends that a ramp should be no longer than 15m before a rest area or landing is provided. The maximum steepness of ramps for urban or urban fringe paths is recommended to be 8.3% (1:12) and 10% (1:10) for rural paths.

Ramps with landings are built in much the same way as a path and should be even and non-slip with no loose stone in excess of 5mm in size. The crossfall of a ramp should be no steeper than 2% (1:50).

For more information about ramps, refer to our 'Outdoor Access Design Guide' key design principles and specifications for ramps.

3.8.10 Resting places

Resting places provide space for path users to stop without blocking the path and should include at least one seat (preferably with backrest) or one perch. Resting places are particularly welcomed by people with mobility or health issues. Where wheelchair use is expected you should include additional space next to the seating so that everyone can rest together.

However, on longer routes it is impractical to provide a large number of resting places. Sometimes it may be possible to include resting places at the recommended frequency in areas close to the main access points along a path, with more widely spaced resting areas in between.

The Fieldfare Trust Countryside for All Good Practice Guide (2005) recommends the following spacing:

Path setting	Maximum distance between resting places
urban	100m
urban fringe	200m
rural	300m

When looking for suitable locations for a resting place, try to find somewhere with a view or something of interest, to provide a 'natural break point'. Path users will appreciate resting places at the top, bottom and at some point along flights of steps or ramps, which they can see and aim for.

Resting places are best incorporated into the planning and design of the path so that they can be constructed and maintained along with the path surface. Each resting place should be a minimum of 1.5m wide and 3m long. The crossfall of a resting place should not be steeper than 2% (1:50). If you are constructing a path less than 1.5m wide, you should consider resting and passing places together. If you need to retro-fit resting places, they should be built to the same specification as the main path and the path surface should be continuous.

Resting place.

3.8.11 Seats and perches

Seats and perches are usually installed in resting places or viewpoints. They should be at least 600mm back from the path edge to allow other path users to freely pass.

Some people may find getting up from a seated position more difficult so providing perches as well as seats gives people a choice according to their needs. If possible, there should be space beneath seats to allow people to place their feet below the body's centre of gravity when standing up. This is called a 'heel space' and should be at least 100mm deep. Make sure the seat or perch surface has a slight slope to shed water, rather than allowing water to stand on the surface where people's feet will be.

Large logs or rocks and low walls can be used as seats although the 'heel space' can be difficult to incorporate. The provision of seating could give you opportunities to incorporate art or interpretation along the path.

Seats with a backrest and arms are preferable to plain benches as they provide additional support or comfort to those sitting. The arm rests can also provide leverage when standing up or support when sitting down.

The Fieldfare Trust Countryside for All Good Practice Guide (2005) recommends the following dimensions for seats and perches set out in the table below.

Furniture	Dimensions
seat	450 – 520mm above the path surface, although for children, height of 350mm is better
seat with backrest	length of seat (and backrest) should be 2m with the height of the backrest at 700mm
perch	500 – 750mm high – if more than one is to be provided install each one at different height above the surface, as this will allow children to use at least one of them

Bench and perches.

For general guidance about seats and perches and specification details for various seats, perches and picnic tables, refer to the seats and picnic tables section of our 'Outdoor Access Design Guide'.

3.8.12 Signs (advisory and directional)

Advisory signs are provided to let people know what to expect when using paths, to provide information about responsible access and to let people know of land management practices taking place on, or near a path.

Advisory sign.

Directional signs such as finger posts, way markers or orientation panels are used to help people find their way to a given destination or route.

Directional sign.

For general guidance about signage and specification details for various directional finger posts, way markers and orientation panel frames, refer to 'Signage Guidance for Outdoor Access' (Paths for All, Scottish Natural Heritage).

3.8.13 Steps

Well designed and constructed steps can provide convenient, easy and safe access for most people. However, if they are combined with ramps, your path will be more accessible to a wider range of people.

Steps.

For further information about steps, refer to our 'Outdoor Access Design Guide' key design principles and specification details for steps.

3.8.14 Stiles

Stiles are traditionally a common way of crossing boundaries but many people find them difficult or impossible to use. If you can, avoid using a stile by installing a gap or gate. Reliable self-closing gate mechanisms are available so investigate that option with the land manager.

3.8.15 Turning space

Path users with bicycles, buggies or prams and wheelchairs and mobility vehicles, as well as horses need plenty of space to be able to manoeuvre through structures like gates, access controls without any hindrance. To ensure least restrictive access, provide turning space adequate for the least manoeuvrable path users likely to be on your path, and everyone else will enjoy the benefit.

Although the actual size of turning area depends on the length and width of any gate, access control, you should provide at least 1m of path surface (and clear space) beyond the arc of the gate. For one-way opening gates you need to provide enough space for a person to open the gate towards them without needing to come off the path.

The Fieldfare Trust Countryside for All Good Practice Guide (2005) suggests that path turns or structures like gates, kissing gates or chicanes require the minimum dimensions in the following table.

Degree of turn	Minimum space required by wheelchair users
90°	1.2m x 1.2m
180° or 360°	2m x 2m
If space is limited, by manoeuvring backwards and forwards around a central point, a 180° turn can be done in a 1.5m diameter circle. However, mobility scooters need more room to turn. Some need a turning space of 2.1m. The larger ones need even more space	

Turning space.

3.8.16 Tactile cues

Tactile cues are changes to the path surface that are used to alert sighted and visually impaired people that there is a road crossing, flight of steps, seat or tactile orientation panel. Tactile cues can only practically be used on highly specified, well maintained paths, such as shared use pedestrian / cycle paths, otherwise the path user will not be able to sense the change in the surface. The Department for Transport has developed guidance on the use of tactile surfaces and this should be followed to avoid confusing path users with inappropriate cues.

If you are intending to provide tactile cues to assist with the enjoyment of the path, you will need to find a way of informing people what each cue means and what to expect. This could be through the use of trailhead information, for example, with sample cues.

The Fieldfare Trust Countryside for All Good Practice Guide (2005) states that tactile cues must cover the full width of the surface and be 800mm long. Materials used to form tactile cues must be securely attached to the existing surface with a maximum lip of 5mm so that the cue does not cause a trip hazard or make access difficult for other people.

Tactile pedestrian / cycleway paving (© Paving Expert).

3.9 Designing a path

You have now surveyed the proposed routes on the ground and identified those that are feasible and needing work.

The next stage is the preparation of a 'design' for each route, based on information in the pre-construction information and the Specification (Red) survey. Whether it is replacing or upgrading an existing path or constructing a new path from scratch, the same design process will apply. The aim should be to design a path, including any related features e.g. passing places, which is safe to construct, maintain, and use.

What is a design?

A design is a specification, drawing and bill of quantities that relate to a structure e.g. path, bridge, boardwalk or earthwork. A design can also include calculations prepared for the purpose of a design, or a product intended for a particular structure e.g. type of surfacing material, like tarmac or Toptrec, for a path. When designing the path, including the drainage system or any related features, you will need to consider the matters in the following table.

Considerations when designing a path
fitting the path into the landscape over which it will cross
who will be use the path afterwards
least restrictive access (reasonable adjustments for people with disabilities)
width of base and surface layers (to accommodate the different user groups and levels of use)
depth of base and surface layers (based on ground conditions, different user groups and levels of use)
type of separation and reinforcement layer if need (material type and strength grade based on ground conditions and different user groups and levels of use)
site drainage conditions, e.g. work out where water is coming from and likely to go when it drains away)
availability and suitability of materials to build the path (both on-site and off-site in the local area)
reducing maintenance requirements
site ground conditions, e.g. type of soil, wetness, vegetation, how hard the ground is along the route
techniques and methods of constructing the path, including drainage system
preparation of designs with adequate consideration to safety and ill health of everyone constructing, maintaining, and using the path or any other related structures, e.g. bridge
foreseeable hazards on site or with the design harmful to health, likely to cause personal injury or lead to catastrophic events

remaining risks with the design that cannot be removed but reduced and controlled on site by those carrying out the work
site access, e.g. how easy or difficult will it be to get materials on site, where materials can be stored on site, can a one-way system be designed so vehicles do not need to reverse or turn
any statutory requirements that will affect how and when the work is carried out, e.g. Water Environment (Controlled Activities) (Scotland) Regulations 2011

When can a designer start 'detailed design work'?

The preparation of designs for a structure like a bridge, path is categorised as ‘detailed design work’. Under the Construction (Design and Management) Regulations 2015, a designer must not start detailed design work without the appointment of a principal designer. The principal designer needs to be involved in the design process to make sure other designers (if involved) perform their CDM duties properly, have considered and checked all health and safety matters when preparing or modifying the paths or any related structure designs.

A designer has a duty to advise the client of their responsibility to appoint a principal designer, before detailed design work commences - only ‘initial design work' should be permitted by the client without a principal designer appointed. If the client does not appoint a principal designer, they will then be principal designer for their project.

What is 'initial design work'?

Initial design work is 'feasibility work' that a designer could carry out for a client, to enable them to make important decisions on whether to or not to proceed with the project beyond the planning stage. It could also include any work needed to identify the client's requirements in respect of their CDM responsibilities, or possible external constraints on the path's development. The preparation of specifications, drawings or bill of quantities is not considered ‘initial design work’. These design work activities are ‘detailed design work’ carried out at the design stage.

Hazard elimination and risk reduction

The main responsibility of a designer when preparing or modifying designs must be to remove foreseeable risks, if possible, and to reduce and control the remaining and unobvious risks. A designer, when preparing or modifying their designs must take the general principles of prevention in the following table into account - when considering materials, methods, and processes to be used by a contractor, who will build or install the structure designs.

Principles of risk prevention	
Avoid risks	ask yourself, can you get rid of the problem (hazard) altogether? e.g.: • design a bridge so it can be assembled on the ground and then lifted into position across a watercourse with a crane or large excavator to remove the risk of workers falling off when working at height • design a bridge with a high handrail to remove the risk of a horse rider falling off the bridge • position the end of a path away from a material storage area, so workers and moving plant are separated when the path is being built

	• design the drainage using a piped culvert under the path to remove the risk of users tripping over an open cross drain installed in the path surface
Evaluate risks	evaluating the risks you cannot remove, e.g.: • work out whether the effort, time and expense of installing a high handrail on a bridge is appropriate, if the bridge is only occasionally used by horse riders and the distance to fall is not far, and the risk of a rider falling of the bridge can be reduced using a lower handrail • work out whether the effort, time and expense of installing anti-slip surfacing materials on a new boardwalk is appropriate, if the risk of someone slipping over can be prevented by carrying out regular maintenance - brushing off any loose or built up debris on the decking to stop it becoming wet and slippery
Combat risks	combating the risk at source, e.g.: • if possible, arrange for an overhead power line to be isolated (electricity switched off) with the service provider
Adapt to risk	adapting the work to the individual • this relates mostly to buildings used as workplaces adapting to technical progress - consider new techniques or technologies, e.g.: • prefabricating parts of a bridge off site • specifying bridge or boardwalk decking boards with suitable slip resistant surfacing to stop people slipping on constantly wet surface
Replace risk	replacing the dangerous with the non-dangerous or the less dangerous, e.g.: • use stone to pitch a path or install steps that is lighter in weight • substitute solvent-based products with water-based ones • use untreated instead of treated timber • use recycled tyre kerbing instead of heavy concrete ones • use recycled plastic instead of treated timber
Prevention policy	developing a coherent overall prevention policy which covers technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment - set standards, e.g.: • specify cutting of concrete kerbing carried out using block splitter techniques rather than mechanical cutting (cut-off saw) that produces clouds of harmful silica dust
Collective measures	give collective protective measures priority over individual measures, and make provisions so that the work can be organised to reduce exposure to hazards, e.g.: • make provision for segregated routes so that barriers can be provided between pedestrians and moving traffic
Information	give appropriate information and instructions to everyone carrying out the work, e.g.: • use symbols and/ or written information on drawings, plans, or instructions such as intended sequencing of assembling prefabricated parts of a bridge that may be unknown to those tasked to put them together

A designer must not just consider the consequences of their design in relation to just building the path, they must also consider how the design could affect the safety of people who use the path and maintain it.

Health and safety considerations for Designers

The design can influence health and safety in the construction of the path and future maintenance and use in many aspects. CDM does not expect a designer to design out all risks, but should consider the consequences of the design and remove foreseeable risks and reduce and control remaining risks. The risks will vary depending on the extent and complexity of the work to carry out.

The following table identifies four health and safety considerations for designers that will crop up on many path projects.

Health and safety considerations for a designer	
Access	consider access during path construction work and for future maintenance, after the work is completed your design should allow for safe access during construction for site vehicles, plant, delivery vehicles, and pedestrians - consider space for turning, segregated routes, one-way traffic routes, and site access/ egress points
Material	some construction materials may need to be handled on site. Their size and weight can affect the manual handing risks to workers when carrying out the work this should be a consideration on all projects, but particularly where materials need moving around the site, and over long distances, where access is poor and mechanical aids may not be practical to use. For example, if a bridge design can accommodate smaller decking components, movement of materials around site and on the bridge becomes easier for workers. This will also be of benefit to those who will maintain the constructed structure, as replacement of damaged components will be easier and safer
Prefabrication	prefabrication of whole or part of a structure such as a bridge or boardwalk can help to eliminate some health and safety risks the use of hazardous treatments or substances to prepare structure parts is always safer done off-site in a controlled environment. For example, precast concrete products can significantly reduce concrete mixing on site and the risks associated with cement burns, and silica dust amongst others
Trip hazards	you may have seen drainage features like water bars and cross drains across a path to catch running water flowing down the surface or to get water to cross the path from a ditch consider building the path with a sufficient camber or cross fall to remove trip hazards where gradients on a path are moderately steep or steeper, install closed cut-off drains rather than water bars where water in a ditch needs to cross the path, install piped culverts under the path instead of cross drains avoid shallow steps, surface breaks (gaps wider than 12mm) and other uneven surfaces that could cause trips and falls, resulting in minor accidents and broken bones

3.10 Specifications

At present there are no standard specifications for paths as there is for roads and pavements. The practice has been to provide 'bespoke' specifications for every path construction project, based on guidance from good practice resources like this Guide. Clear and concise specifications are essential to inform those who are to construct the path and any related features, of exactly what is required. They should describe the quality of workmanship and materials for the construction work which will assist the tendering Contractors or Principal Contractors estimator to price the bill of quantities. It is essential to cover everything that is required to build the path and any related features. Do not leave anything out, if something is not specified, it will not be built or installed. The following is a checklist of what should be included in a specification for a new build path.

New Build Path Checklist	
Feature	**Specify**

Formation layer (including separation and reinforcement layers)	• excavation width and depth of formation tray
	• working practices:
	  ○ what type of formation tray is to be excavated
	  ○ what is to be done with the vegetation and excavated spoil generated from formation layer work
	  ○ what is to be done with soft spots encountered in the formation level (bottom of the tray)
	• if required, type and grade of geotextile sheet to be installed in the formation tray
	• if required, type and grade of geogrid to be installed on top of geotextile sheet in the formation tray

Base layer	• type of granular sub base materials to be used to build the base layer and BS EN quality standards • maximum depth of granular sub base material to be laid in formation tray • maximum or minimum cross fall or camber gradient for base layer • type and weight of vibrating roller to be used to compact the base layer and state ‘compact thoroughly to refusal’ • surface regularity of finished base layer
Surface layer	• type of surface material to be used to build the surface layer and BS EN quality standards • maximum depth of surface material to be laid on top of base layer • method of surface material laying • maximum or minimum cross fall or camber gradient for surface layer • type and weight of vibrating roller to be used to compact the surface layer and state ‘compact thoroughly to refusal’ • surface regularity of finished surface layer
Path verges	• path edges to be supported with available topsoil or suitable turfs won from formation layer works • base layer material and geotextile sheet to not be exposed along edges of path • landscaped verges to taper down and away from finished surface layer • landscaped verge edges to be finished level with, or below, surface layer • landscaped verge materials should not prevent surface water runoff from finished surface layer

Drainage features	• type of drainage features to be used • type, dimensions and gradients for open ditches • type, dimensions, gradients and materials for closed drains (French drains, filter drains) • type, dimensions, gradients and materials for cut-off drains and piped culverts • BS EN quality standards for materials

The level of detail will depend on the extent and complexity of the path construction project. For small projects, written detail can be given in a simplified format.

Whin dust path sample specification
excavate ground to reduced depth of 150mm below finished path surface level to form 1.5metre wide formation tray. All excavated material to be casted and landscaped into surrounding areas
excavate any soft spots in sub-grade as required and backfill to formation level with well compacted 50mm crusher run
supply and install Terram 1000 geotextile sheet in formation tray bottom and sides. Overlap adjoining sheets by 1.0 metre
supply, lay and compact to refusal 150mm depth of DTp Type 1 granular sub base to falls and levels
supply, lay and compact to refusal 25mm depth of 6mm whinstone dust to falls and levels
where required, landscape verges level with finished surface layer to support path edge using suitable excavated topsoil won from formation layer works
all granular sub base materials to comply with SHW Clause 803

For medium or large-scale projects, where there is greater risk to the Client if something goes wrong, more detailed written descriptions should be considered and included with construction drawings.

3.11 Drawings

Like specifications, the level of detail to provide on drawings will be determined by the extent and complexity of the path construction and any related feature work required but should include:

Location plan

A 1:2500 Ordnance Survey map showing the general location of the route where the path and any related features will be installed.

General site layout plan

A 1:1250 or at least 1:2500 scale plan, showing the proposed path alignment and locations of related features to be installed with relevant drawing numbers. Also marking the locations of

construction site boundaries, access points and routes through the site, site area to be avoided or dealt with specially (SSSI's etc), and any remaining unobvious hazards or risks on the site. These hazards or risks can be highlighted by site safety symbols with appropriate wording e.g. for contaminated land a 'hazard warning symbol' with wording 'WARNING' and 'CONTAMINATED LAND' is suitable and sufficient method to provide health and safety information to those working on site who need to know there is unobvious hazard present which could cause harm.

Site assessment survey sheets

Site assessment survey sheets can provide information about the different construction works along the length of route within the construction site, including location of the works. Remember that these survey sheets are unlikely to be drawn to a precise scale, and if applying for planning permission, you will need to explain this to the planning officer. Like general site layout plans, site assessment survey sheets can also show health and safety information relating to the construction site and path construction and any related feature work.

Construction drawings

Construction drawings are cross section drawings, showing the widths, depths and materials for formation, base and surface layers etc, should also be detailed as part of the design for the benefit of the Contractor or Principal Contractor. Any other related feature or structure such as drainage works should also have a cross section drawing to show all construction details required. These drawings should be cross referenced with the relevant specifications and work items in the bill of quantities.

Construction drawing is also effective communication tool for informing others about remaining safety or health risks with the design. One communication method is to provide 'SHE' boxes on construction drawings.

Checklist for a construction drawing
Maximum formation tray excavation depth and width
Whether a geotextile sheet / geogrid is to be used
Base layer depth, width and type of granular sub base material to be supplied and laid in the formation tray
Maximum and minimum camber or crossfall gradient for the base layer should also be clearly shown
Surface layer depth, width and type of surface material to be supplied and laid on top of base layer
Maximum and minimum camber or crossfall gradient for the surface layer should also be clearly shown
How the finished surface layer should be level with the ground at the edges for full tray excavation, or, how the verges are to be built up level with the finished path surface for semi-tray excavation
It should also state any BS EN quality standards for materials and include a note that the drawings should be read in conjunction with the relevant specification details

3.12 Bill of quantities

What is a bill of quantities?

A tender document produced by a Designer at the design stage which translates relevant information on construction drawings into bill of quantities (BQ) that fully describes the quality and quantities of work to be carried out by a Contractor or Principal Contractor during the construction stage. It is basically a list of work items with brief detailed descriptions and firm quantities for different elements of work to be carried out.

What are main purposes of a bill of quantities?

The main purposes of a BQ are:

- to provide the same information to all tendering Contractors or Principal Contractors, that enables them all to prepare their tenders efficiently and accurately based on the same information
- when a contract has been entered into, to:
    - provide a basis for the valuation of completed work for the purpose of making interim payments to the Contractor or Principal Contractor
    - provide a basis for the valuation of variation work.

What are benefits of a bill of quantities?

Regardless of what form of contract is used, at some stage in the project's procurement process, someone will need to quantify the extent of works to be undertaken for the purpose of:

- obtaining prices from several Contractors or Principal Contractors for completing the works
- valuing the extent of work and variations completed for the purpose of issuing payment to a Contractor or Principal Contractor.

The detailed measurements for the purpose of bill of quantities production is beneficial for a number of reasons:

- it saves the cost and time of several Contractors or Principal Contractors measuring the same design in order to calculate their bids for competition
- it provides a consistent basis for obtaining competitive bids
- it allows the Client to compare different returned bids using a standard measurement, before taking into account quality considerations
- it provides an extensive and clear statement of the work to be completed
- it provides a very strong basis for budgetary control and accurate cost reporting of the contract (i.e. post contract cost control), including:
    - preparation of cash flow forecasts
    - a basis for valuation of variations or changes to the works
    - a basis for the preparation of interim payments
- when priced, it provides a useful source of cost data, which can be used to support claims for grants and for estimating the cost of similar future path construction projects in cost estimating works e.g. approximate estimating and setting costs for budgeting purposes.

What is basic format for a bill of quantities?

The most common format for a BQ is an elemental bill. Elements of measured works are arranged into sequence that is clear and easy to understand and price for a fixed price contract (lump sum). The BQ can be abstracted easily and quickly with measurement and descriptions already grouped in the elemental format. Under each element, the order of works generally follows construction sequence e.g. site preparation works, drainage works, earthworks, formation layer works, base layer works, surface layer works, and landscaping works.

Why are written descriptions required for a bill of quantities?

A BQ requires clear and concise written descriptions in order for tendering Contractors or Principal Contractors to price the work properly. The essential parts of a clear and concise descriptions are:

- all information required by a Contractor's or Principal Contractor's estimator to build up a realistic price
- the first few words in a written description should indicate clearly the nature of work required to be completed
- order of stating dimensions should be consistent and generally in sequence of length, width and depth (where sequence is not appropriate or where ambiguity could arise, dimensions should be specifically identified)
- if an item of work cannot be accurately or fully described, reference should be made to the appropriate construction drawing
- the written description must be concise and not to lengthy, can be shortened by references to the specification.

What content should be included in a bill of quantities?

A BQ should contain basic information presented in elemental format that is clear, concise and easy to understand and price, such as:

Preliminaries

Work items referring to everything the Client wants the Contractor to do before they actually start path construction work or other items that will affect the implementation of the works. Allowances are given for such things as: temporary site welfare facilities; site clearance; dismantling and removal of existing structures; and disposal of waste.

Preliminaries are not required to be measured work items but need to be described in detail and the tendering Contractors will have to price the items that will affect the cost of the works in a 'lump sum' price.

New Class (Measured Work)

This refers to measured work as 'individual' or ‘aggregated’ construction work items. Each measured work item should include reference to specifications and construction drawing as appropriate and should cover all aspects of the specification.

Aggregated construction work items are a way of simplifying the BQ and are well suited to smaller, straightforward path construction projects. Each measured work item quantity should

be measured as accurately as possible so that no parties will make a loss during the implementation of works.

An example of separate individual construction work items (descriptions and quantities) for path construction work is shown in the following table.

Item	Description	Quantity	Unit	£ rate	£ cost
1	Formation layer works: Excavate turfs and topsoil to form 1.5metre wide x 150mm deep formation tray in accordance with drawing 1	500	lin.m		
2	Base layer works: Supply, lay and compact 1.5metre wide base layer on Autoway 150 geotextile sheet using 150mm depth recycled Type 1 granular sub base to form 1:50 cross fall in accordance with drawing 1	500	lin.m		
3	Surface layer works: Supply, lay and compact 1.5metre wide surface layer using 25mm depth 6mm granite dust to form 1:50 cross fall in accordance with drawing 1	500	lin.m		

One aggregated construction work item for the same path construction work would be:

New Class					
Item	Description	Quantity	Unit	£ rate	£ cost
1	Construct 1.5metre wide granite dust path on Autoway 150 geotextile sheet using 150mm depth recycled Type 1 granular sub base and 25mm depth 6mm granite dust surfacing in accordance with drawing 1	500	lin.m		

Provisional quantities Items

Produced similarly as New Class items above but are for work which cannot be accurately measured at the time of preparing the BQ. This situation can happen due to incomplete information about the proposed work or in case whereby the extent of work cannot be fully determined until the work is completed. Such work will be subjected to remeasurement after the work has been carried out.

Provisional Items

For work or costs that cannot be entirely defined or detailed as provisional quantities items at the time the BQ was prepared.

For example, soft spots can be a common provisional item. If the contractor encounters soft spots at the formation level in the formation tray which need to be excavated out and backfilled with granular sub base material before the path is built, they can invoke the provisional items without needing to negotiate a contract variation. If no soft spots are encountered then you get charged nothing at all.

Dayworks

These are contingency sums allocated for any unforeseen, extra works or work items that were more difficult to determine at the time when the BQ was prepared. The Contractor or Principal Contractor is paid per day working on site and has to make an allowance for plant, materials and labour, based on the size of the project. It is always worth asking Contractors or Principal Contractors to provide costs for daywork items, but it may be cheaper to negotiate and agree any extras by using the original BQ work item rates rather than daywork rates. It will be a saving to the Client if such contingency sums are not expected due to no unforeseen extra works.

Preparing a bill of quantities

A BQ (bill of quantities) is prepared for the Contractors or Principal Contractors estimator to provide an offer when tendering for a contract.

There are several methods used by Quantity Surveyors to prepare a BQ. One traditional method involves breaking down the process into two stages, as follows:

Taking off as the name suggests, this involves taking off dimensions from the construction drawing and entering them on a ruled paper called a 'dimension paper'. Clear and concise description detail in the form of explanatory notes is also included to allow the accurate understanding and pricing of the work items.

Working up this process is undertaken in two stages:

Squaring - this involves squaring the measured dimensions and transferring the lengths, areas and volumes to the 'abstract' for abstracting.

Abstracting - the squared dimensions are arranged in convenient order for billing and reduced to recognised units of measurement.

Billing direct

The above method is long and tedious in practice. There is another method that can simplify the process called 'billing direct' that is suitable when the work is relatively straightforward and the number of work items limited.

This method involves taking off and transferring the measured work items directly from the dimension paper to the BQ, eliminating the need to abstract. Each work item is taken off as a separate article in the order in which it will be presented on the BQ, thereby, reducing time and cost of preparing a BQ.

Writing the bill of quantities

This involves listing the various individual or aggregated construction work items with their measured quantities and units of measurement in a suitable order under elemental headings in the BQ document.

For example, in the sample bill of quantities the aggregated construction work item (description, quantity and unit of measurement) is listed under the elemental heading of 'New Class'.

4 Path Construction

In previous chapters of this guidance the construction techniques and options for designing paths have been laid out. In order to put this into practice and produce a path on the ground a series of stages need to be negotiated, all within the context of procurement and management of path construction work. These stages are:

4.1 The contract

The contract you use forms a formal agreement between the contractor (or principal contractor) and you as the client. The contractor (or principal contractor) agrees to provide a service to build the path for you, whilst you agree to pay for their services to build it.

A contract should:

- state what work is to be carried out
- state how the work is to be done
- state who carries out what responsibilities
- state who is responsible to whom
- be agreed and signed between all parties involved (a contract that has not been agreed or signed by all interested parties does not constitute a legally binding contract, and only those who have agreed and signed the contract are bound to it, and have a right to amend it).

It should set out:

- clear conditions that all parties agree to work to
- clear instructions that all parties must undertake if anything should start to go, or has gone, wrong.

Generally, the type of contract used is based on the projects' size, complexity and level of risks. One type of contract that is a commonly used for building paths in the lowlands is a 'fixed price contract'. A fixed price contract, also referred to as ‘design bid build contract’, is a contract between you as the client and a contractor (or principal contractor) for the construction of a fully designed path. If you have chosen to use a fixed price contract to meet your project objectives, the procurement process will run similar to this:

- you invite designers to tender and appoint one designer to prepare the design for the pathwork and any other related features/ structures in detail, including planning, managing, monitoring, and coordinating the pre-construction phase, on a competitive tendering basis
- you invite contractors to tender and appoint one contractor to build the path design (and any other related features/ structures), including planning, managing, monitoring, and coordinating the construction phase, on a competitive tendering basis.

Your designer completes the design fully before the tender to find a contractor commences, which gives you more control over the design and certainty about design quality and cost. However, the design process is longer and slower than other forms of contract, and as the contractor is only appointed once the design is complete, you do not benefit from the contractors' input on the designs buildability as the designer has already developed the design.

A fixed price contract is considered a low risk method of contracting for a client, as the contractor takes on financial risk of completing the work. However, the contractor has no responsibility for the design, so you retain that risk. If the design is incomplete, there are mistakes or omissions in the design, or variations are required after the work has started on site, the cost to you could be significant. Although, some sharing of the risk could happen with the contractor, you take on board the majority of risk as the client.

4.2 The tender

The tender stage of a path project is the process of selecting and appointing a suitable contractor (or principal contractor when more than one contractor involved). This stage is generally named as 'tender' rather than 'tender process'.

The selection and appointment of suitable contractor will make sure you receive best value for your money. If you work for, or with, a local or national park authority, they will have procurement policy and procedures for when competitive tendering is needed and, how the tender selection and award of contract is carried out. You may find that your funders, who are going to fund your project, also have procurement conditions so best if you check this out first with them. If you are not working to formal guidelines, the following criteria below will help you to decide on the appropriate method to obtain contractors services, based on the value of the project. You will usually find that competition is the best means of securing a good price, but also take into account the reputation and skills, knowledge, and experience, and organisational capability of the tendering contractors.

Types of tender	
Low cost projects	e.g. £1,000 - £5,000 can be implemented by acquiring a single tender from one contractor this informal tender can be based on an outline specification and bill of quantities
Medium cost projects	e.g. £5,000 to £25,000 can be undertaken by invitations to tender with a more formal tender, and a fairly comprehensive tender document as the client, you could select the contractors that you wish to invite to tender, but you should aim for a minimum of three tenders to be returned in order to assess cost, quality and capacity
Large cost projects	e.g. greater than £25,000 can be carried out using a formal tender based on an open tendering approach of two stages open tenders are usually advertised through procurement advertising websites (such as Public Contracts Scotland) to attract suitable contractors • contractors, who express their interest to tender, are sent a pre-qualification questionnaire (PQQ) to complete and return by a set date and time • the PQQ asks contractors to give specific information about their business activities e.g. finances, health and safety, management, etc. • returned contractors' PQQs are assessed, scored, and maybe shortlisted the shortlisted contractors are then sent invitation to tender and comprehensive tender document to provide a tender • returned tenders are assessed, evaluated and scored against selection criteria set out in the tender document

Preparing the tender

Tender documents are prepared and sent out to potential contractors to seek tenders (bids) at tender phase. Typically, the tender documents will consist of all or some of the following documents:

Cover letter

A formal letter inviting contractors to tender. It will advise when and where their completed tender should be returned.

Invitation to tender

This provides guidance on how the tender documents are to be completed.

Form of tender

A covering document prepared by the client and signed by the tendering contractor to indicate that they understand the tender, accept the various terms and conditions of the contract, and other requirements of participating in the tender exercise.

Terms and conditions of contract

This document sets out the legal framework and the obligations of both parties signed up to the contract. Tendering contractors must read this document in conjunction with the other tender documents.

Bill of quantities

This document is used as the basis of submitting the tender where all prices for carrying out the work are given. The bill of quantities assists tendering contractors in producing an estimate of costs for their tender. It also provides a fair and accurate system for tendering. Each invited contractor bids against the bill of quantities, stating their price for each item of work. Their priced bill of quantities constitutes their offer. As the bill is made up of prescribed items of work, it is possible to compare both the prices directly between each tender - this lets you make a detailed assessment of which aspects of a tender offer good or poor best value. The prices on the bill of quantities can also assist with negotiations with the preferred tender at later stages in the tender exercise.

Design drawings (general layout plan, construction drawings)

These are clear and concise detailed documents about the construction site, path construction and any other related feature/ structure works. They are the essential ingredients for informing contractors of exactly what is required to complete all the work.

Specifications

This document sets out what needs completing to set standards, including policies, procedures or guidelines. It sets out the performance standards and the outcomes expected. It describes the materials and workmanship standards. They do not include cost, quantity, or drawn information, and so need to be read alongside the terms and conditions of the contract, bill of quantities, and construction drawings.

Quality requirements

A questionnaire about how the tenderer intends to provide the contracting service, including supporting evidence demonstrating relevant experience. This information will help evaluate the quality of the tender.

Tender evaluation criteria

A document advising how returned tender will be evaluated against each other and the contract awarded.

Tender return label

A simple label giving the time and date that a tender must be returned.

Pre-construction information

A document giving relevant information about the project that might influence the health and safety of the paths design and work.

Tendering contractors must follow the instructions and information given in each tender document provided, as failure to do so may prevent you as the client from considering the tender properly.

Producing a tender document could appear bureaucratic for what could be seen as a small path project. However, time spent preparing a tender document can save time and money when the work is carried out at construction phase. There is also extra financial security in having a legally binding agreement with a contractor (or principal contractor). The contractor gets the security of knowing that there will be no surprises on a site at their cost, which will make them more likely to price a tender competitively. In addition, you as the client get the security of knowing that the project will be completed on time and budget.

Finding a competent contractor

Some contractors will have particular specialities, but many will be able to carry out most types of lowland path construction work, if suitably managed. Contractor names can be obtained from local authority access officers, access and countryside trusts, Yellow Pages or by speaking to other organisations that have had paths built recently. A phone call to prospective Contractors will help gauge whether they are able to carry out the proposed path construction and related feature works and if project timescales are realistic for them.

Some of the different types of contractor are set out below along with a few things to consider when deciding which to select. The technical requirements and extent and complexity of path construction project will influence choice.

Path contractors

There are very few contractors specialising in lowland path construction as their main business. However, some upland path contractors have branched out into the wider field of lowland path construction.

> **Benefits** - They will be familiar with path specifications, and should require minimal supervision for a high-quality output. They know what needs to be done to build a path that blends well with the landscape. Some may also have experience of installing small span bridges.
>
> **Points to consider** - Upland path contractors may be less experienced with the more tightly specified path construction work required for urban environments. Some contractors only have experience of building unbound surfaces and may have no knowledge and experience of laying semi-bound or bound surfaces.

Forestry / agricultural contractors

These contractors are common in rural areas. Their main clients are estates as well as the various forestry organisations for whom they build access tracks and roads. They tend to be small businesses. Quite a few of these contractors have ventured into path construction, mainly in rural lowland areas.

> **Benefits** - These contractors are well accustomed to path or track building in forest or woodland sites. They are familiar with working on routes with difficult access.
>
> **Points to consider** - They are less experienced with urban paths where a higher quality of finish is required. They may require close supervision to follow specifications and do work of good quality.

Small civil engineering / plant hire contractors

Their main clients are often bigger contractors who use them as sub-contractors. They will do small or medium path construction work between their main sub-contracting activities. They can undertake most types of lowland path construction: unbound, semi-bound and bound surfaces.

> **Benefits** - There are plenty of small civil / plant hire contractors available. They can usually do small scale asphalt surfacing works.
>
> **Points to consider** - Large contractors are their main clients and may have demands on their time which may affect programming in your path construction project. Tidiness and quality of finishing off can be variable as they generally deliver to tight cost margins and may be used to working on specific aspects of jobs rather than whole projects. They are accustomed to sites with good access and may charge extra if access is poor (seen as a risk).

Large civil engineering / plant hire contractors

These are large national companies with household names, although there are many other smaller companies who fall into this category. They tend to be public companies rather than family concerns. They will have certain specialities but will generally be able to do all types of lowland path construction work. They may sub-contract out elements of work to smaller civil engineering contractors such as small-scale asphalt surfacing work.

> **Benefits** - These contractors are common and readily available. They are able to do everything from path construction works to bridge installation. They are highly professional and will work to approved quality standards. A suitable choice for large scale path construction projects.
>
> **Points to consider** - These contractors are accustomed to working in professional environments with civil engineers, quantity surveyors and project managers. They usually work to tight specification and are closely monitored. Managing such a contractor may be beyond the capability of small-scale path construction projects. Often, these contractors have larger overheads and are not interested in small scale works.

Invitation to tender

An invitation to tender is a formal invitation by you as a client to contractors to tender for the supply of contracting services.

An invitation to tender may follow an assessment of received contractor's pre-qualification questionnaires (PQQ) by you (or the project manager) in response to a contract advertisement. The purpose of pre-qualification questionnaires is to produce a short list of contractors' most suitable for the project who will then be invited to tender. This avoids time being wasted assessing inappropriate tenders.

To identify contractors to invite to tender, you or the project manager:

- prepare a list of contractors from responses received to any advertisements placed
- issue PQQs to listed contractors.

On receiving completed PQQs, you or the project manager:

- check the financial details, etc. on the PQQs
- prepare a short list of contractors
- issue the tender document to contractors on the list
- contact the unsuccessful contractors in writing.

Assessing returned tenders

The procurement process, you use will define how much interaction will take place with the tendering contractors prior to awarding the contract. However, in most situations every contractor should be given time to visit the construction site and read the tender document. This will also allow you as the client to assess the contractors' understanding of projects requirements.

You or the project manager:

- arrange a pre-tender meeting for the contractors
- deal with questions and queries from contractors
- communicate responses and issue to all contractors.

Holding a pre-tender meeting:

- holding a 'pre-tender' meeting is good contract management practice
- invite all tendering contractors along to the meeting at construction site
- for larger projects, pre-tender meeting may be mandatory, but for small and simple projects it may not be cost effective for contractors to attend
- the objective of the meeting is to give all contractors the opportunity to see the construction site and the work so they can work out how they will deliver the construction phase
- if you are leading the meeting, make sure you know about, if relevant: site access points; one-way routes; material storage areas; welfare facility locations; restricted site areas; site boundaries; nature conservation or historic site issues; and environmental site issues
- expect contractors to ask you questions about the construction site and the work. Go to the meeting prepared to give the answers.

Follow up on the pre-tender meeting:

- any design errors or amendments identified during pre-tender meeting should be reported to all contractors tendering (those at meeting and those who were not able to make it) - issue the specific parts from the amended tender documents
- give plenty of time for tenders to be completed and returned, three to four weeks should be a minimum for larger projects. If insufficient time given, it may cause contractors to put in higher prices due to not giving enough time to consider the works and your project management requirements thoroughly whilst pricing
- if queries from contractors or discussions during the pre-tender meeting result in significant changes to the design, the tender document, you can extend the tender period to give you time to update and send out the revised documents.

Tenders received from contractors:

- tenders returned by the date and time stated on the tender document should be assessed
- any tenders arriving after the deadline, you do not have to accept them, but you should have the discretion to assess them if there are valid reasons for the delay
- all returned tenders should be opened together, assess each one fairly, and treat the information with care and attention - remember that the contractors have spent time and effort responding to the tender. Local authorities or national park authorities will have specific procedures for opening tenders. For other organisations who do not have procedures in place, the lead person should ask someone else to be present when tenders are opened. You should consider recording the following information:
    - time when tenders are opened
    - names of those opening tenders
    - details of tenders received after the deadline
    - contractor names of tenders not returned at all.

Tender assessment:

- assess all opened tenders together with two or three people present and involved in the assessment process
- creating a tender assessment sheet will help you to assess each tender individually in a consistent way. This will then demonstrate that you have been objective in the selection process. The sheet should include the key selection criteria that you are looking for in a contractor - use the criteria that you gave in the tender document. You should note whether the tender includes that information and how well the contractor matches the criteria. If some of the information required is missing, you or the project manager should contact the relevant contractor to request it and provide a reasonable time for response
- assess each tender for completeness and meeting the minimum selection criteria requirements, you will need to compare the tenders to decide who will provide best value for money. By looking at the returned bill of quantities, you should be able to see whether the contractor has understood the work. Look for items of work priced particularly high or low compared with other bill of quantities, and ‘hidden’ costs of provisional sums, which might make a seemingly cheap tender more expensive, if those sums are required
- check previous work experience for similar pathwork in order to judge the contractor’s skills, knowledge, experience, and organisational capability. The most useful thing to do is speak to previous clients of a contractor who appear to score well in the tender - find out whether the previous client was happy with the quality of contractor’s work. It

is a good idea also to find out from previous clients whether there were any problems with communication, working and management arrangements, or health and safety on site. Remember, the aim is to deliver your project on time and budget, so a cheap contractor who is difficult to work with could end up costing more than a contractor who is more expensive 'on paper' but requires minimal direction and site supervision

- check that each contractor has an adequate construction health and safety management knowledge and experience. Look at their accident record. If a contractor's accident record shows lots of injuries, even minor ones, it may be because they were cutting corners with health and safety management on site
- if you have not already done so, check financial security of each contractor to avoid the appointment of a contractor with poor financial history. You do not want a contractor to run into financial problems when they are half way through the work - your project will stop
- final decision to appoint a preferred contractor will be based on a range of selection criteria factors so select your preferred contractor based on reaching the minimum quality standards and then on price.

Deciding to contract the preferred contractor:

- before a decision is made to enter in to contract with your preferred contractor, make sure you have adequate funding in place first.

Awarding the contract to the preferred contractor:

- once you have made the final decision, contact the preferred contractor to ask them to take on the work. If the contractor is happy and agrees to take on board the contract, you should then schedule the start-up process for the construction stage
- if the construction phase is going to involve more than one contractor to undertake the work, you should advice the contractor of their appointment as principal contractor - advise them that they must fulfil the principal contractors CDM Regulation 2015 responsibilities, before starting any work on site, e.g. preparing construction phase plan, and during the construction stage
- award the contract to the contractor (or principal contractor) in writing with the award of contract letters signed by you and them
- if your project is notifiable to the Health and Safety Executive (HSE), you must inform HSE of who the contractor (or principal contractor) is by updating and resending the original F10 form
- you, or the project manager contacts all unsuccessful contractors in writing to inform them of your decision. These contractors will find it helpful to know how well they did compared with the other contractors, particularly on price - one useful way of providing 'anonymous' feedback is to list the contractor's names in alphabetical order, then the prices in ascending order, so the contractor's names and prices are not linked together. The successful contractor should also be highlighted with their tender price shown - this is important if you have not gone for the lowest price.

4.3 Starting the construction phase

The construction phase is the period during which the contractor (or principal contractor where more than one contractor on site at any one time) takes control of the construction site to carry out the pathworks. When the works are complete, the contractor (or principal contractor) hands the site back to you.

The construction phase does not tend to involve the client as much on a day to day basis, and the majority of actions and responsibilities, lie with other people you have appointed. Like, the project manager, designer, principal designer (if you need them still to be involved), and the contractor or principal contractor, and if required sub-contractors appointed by principal contractor.

Once the contractor (or principal contractor) has been appointed, they will commence the mobilisation stage of construction phase, if required appointing sub-contractors to complete elements of work, and commencing site set up (welfare facilities, etc). At this point, you or the project manager will arrange the pre-start meeting.

The contractor (or principal contactor) will prepare the construction phase plan and make sure welfare facilities are in place before any work begins.

One of the most important jobs for the client, although they have no legal obligation to, is to make sure that the pathworks are properly supervised. Even the best contractor (or principal contractor) will find that they need some guidance whilst on site, and a good works supervisor/ manager, or clerk of works, can make the difference between mediocre and top-quality work. Works supervisor needs to be able to get on with the contractor (or principal contractor) but also to make sure they are working in the best interests of the client (you) - it can be a tricky job, particularly for a technical path project, so this aspect should not be left to chance. If you are the client and have limited experience of managing path construction projects, make sure that you appoint someone who is suitably skilled and experienced at site management and working with contractors on the ground. Instead of appointing a works supervisor, you could ask the designer to supervise the construction phase - they will be familiar with the specification and will have a good understanding of the construction methods being undertaken.

Pre-construction preparations

Pre-start meeting

Before the contractor (or principal contractor) starts on site, hold a pre-start meeting, around two weeks before pathwork starts, to which all relevant parties will attend. The purpose of the meeting is to introduce all parties to each other, review the requirements of the project's construction phase, and to make sure that everyone knows their responsibilities, and all queries are answered - so everyone is happy!

After the meeting, the designer (or principal designer if still involved) will mark out the pathwork on the ground, and indicate where the different types of work are required along the route, e.g. where piped culverts need installing.

The contractor (or principal contractor) needs to be aware of site access points, one-way routes, material storage areas, welfare facility locations, restricted site areas, site boundaries, nature conservation or historic site issues, and environmental site issues. Most of this information will have been available to the contractor in the pre-construction information provided at the tender stage, but it is good practice to go over it all again with them before they actually start any work on the ground. It is important that everyone is clear and understands what it is that they have to do.

Before the contractor (or principal contractor) starts the construction phase, make sure it is clear that extra works must be agreed before they are done, and costs must be agreed before they are incurred.

Appointing a clerk of works

You may wish to appoint clerks of works who will be the eyes and ears on the construction site. This appointment should happen as soon as possible before the pathwork starts so that the person is involved in the pre-start meeting. They will also carry out the following tasks:

- reviewing method statements making sure they provide a safe method of working
- resolving technical queries and liaising with the contractor (or principal contractor) and designer (or principal designer)
- inspecting the quality of work to ensure the required levels of workmanship are achieved and the specification is being complied with
- monitoring the contractors (or principal contractors) progress and level of resources being deployed.

Health and safety considerations

For all path projects, the contractor (or principal contractor) must prepare a construction phase plan. On projects where there is more than one contractor, the principal contractor must provide a copy of their construction phase plan, or the relevant parts, to other contractors under their direct control.

Construction phase plan

Construction phase plan is a practical and live document which describes the project and how the pathworks including any site preparation work will be undertaken and managed on site safely.

Construction phase plan also identifies construction site hazards and remaining design risks and how they need controlling to prevent harm to those carrying out the pathwork, but also to others who will be visiting the site, or should not be accessing the site, e.g. members of the public. The information in the plan should be proportionate to scale and complexity of the work and level of risks involved in the path project.

Construction site considerations

Welfare facilities requirements

For all path projects, regardless of whether the project is notifiable or non-notifiable and how many contractors are working on site at any one time, the contractor (or principal contractor) must provide adequate welfare facilities on site before any pathwork, including site preparation, begin. The welfare facilities must remain on site (and be maintained) until all pathworks have been completed and signed off.

Site supervision

Once the pathwork has started, the designer (or principal designer, clerk of works, or works supervisor if any of these appointments are involved) should be on site at least once a week, or more. They should track progress of the work against the design (specifications), and guide the contractor (or principal contractor) with regard to the standards required on an ongoing basis.

Any discussions or requests that might have a bearing on the specifications, quantities, or 'out-turn' costs should be recorded and shared with you (the client). The contractor (or principal contractor) should keep a record of all completed work, which must be made available on request. This will be of great assistance in the event of claims or disputes.

For complex projects, it is useful to hold a progress meeting at regular intervals throughout the construction phase with everyone involved. Discuss work progress, problems, health and safety, design changes/ modifications, etc. Someone present should take minutes, which should be logged and circulated to everyone in attendance.

To assist with site management, the following table sets out some things to lookout for.

Site management considerations	
Quality and tidiness	check that all path and related feature/ structure works are of a sufficiently high quality – e.g. piped culvert headwalls are neat and stable with no plastic pipe ends protruding out past the stonework make sure the contractor (or principal contractor) responsibly disposes of all packaging, geotextile sheet or geogrid off-cuts, rubbish and litter in line with good waste recycling practices
Materials and alterations	make sure supplied materials are in accordance with the specification – e.g. if DTp Type 1 granular sub base is required, make sure that the quarry has dispatched the right aggregate inspect all materials before installation. Any supplied materials should be rejected if, in the opinion of the clients' site representative, they do not meet specification or are defective in any way. The contractor (or principal contractor) needs to be informed and is then responsible for making sure the materials are replaced any alterations or variations to the specification must be agreed verbally on site – however, this must be confirmed in writing in advance of the work being completed significant design alterations that result in concealed or unusual risks being present must be noted, preferably on as-built drawings. In the case of a project with more than one contractor, they must be placed in the health and safety file for future reference
Quantities	make sure the correct amount of material is used as stated in specifications or on drawings measure the path base and surface layer depths and widths, and ask for them to be topped up or widened if less than specified the contractor (or principal contractor) should inform the clients' site representative of any situations where additional depth or widths are required so that the bill of quantities can be amended as with changes to the design, any variations to materials or quantities that affect the bill of quantity work item must be agreed verbally on site, and then in writing in advance of the work being undertaken

A quality finish

Before signing off any completed work, check the following:

- is the path surface even (is the surface regularity in line with the specification) and free of high and low points and hollows?
- is the crossfall or camber to the specification?
- is the path surface free of roller marks? Noticeable roller marks on the surface are an indication that materials have not been compacted enough and require more rolling with a heavy roller
- are landscaped edges / verges finished level with path surface and not higher than the finished surface level?
- are ditches free of obstructions that could cause water to overflow onto the path?
- are ditches running in right directions?
- are piped culverts and other drainage features built to the specification?

Invoicing (payments)

For small path projects, payment to the contractor is issued after the works are completed and signed off.

For medium or large-scale projects, the terms of payment should be agreed in the terms and conditions of contract - by law, any construction contract lasting more than 45 days must have an interim payment scheme. Generally, the contractor (or principal contractor) is paid on issue of interim invoices throughout the construction phase. The contractor (or principal contractor) should submit an invoice with a measurement of completed works. This measurement should relate to the bill of quantities and note the total amounts for the various work completed.

You or the project manager should check the measurements and totals to make sure the works have been done, and to specification. The measurements and totals should be signed off prior to payment. Good record keeping is essential to keep control of what payments have been made for works completed to your satisfaction.

4.4 Ending a path construction project

There are three phases to completing a path construction project, which are set out below.

Phase 1. Snagging phase (pre-finish stage)

A week or two before the projects due to finish hold a snagging meeting to inspect the pathwork and site. This should preferably include your clients' site representative as well as the contractor (or principal contractor).

The purpose of the snagging meeting is to identify all outstanding works, or even extra works to be completed before the construction phase is finished. This is also the time to note any visible problems with the pathworks and wider site. For additional works, negotiate a price using existing bill of quantities rates if possible, rather than simply using the daywork rates.

Look for:

- untidy verges along either side of the path
- borrow pits not filled in or not landscaped over

- rubbish not cleared up
- track or wheel marks from plant on adjoining ground
- roller marks on new path surface
- landscaped verge edges higher than finished path surface
- exposed base layer stone or geotextile sheet (if one was specified to be used) along path surface edges
- any other signs that the works have not been completed to specification and/ or good practice.

This process is called 'writing a snagging list'.

On site, with the contractor (or principal contractor), agree a time scale for outstanding and snagging work, as well as any extras to be completed. Make sure full list of snagging items are agreed before issuing, making sure the contractor (or principal contractor) is aware that invoices will not be processed until the list of snaggings is signed off.

Phase 2. Practical completion phase (final finishing stage)

Once the contractor (or principal contractor) has completed all the agreed works a final site visit should be held on site. Measure and check all works, and agree everything has been completed to a satisfactory standard for signing off and handing over. If necessary, the contractor (or principal contractor) may need to finish off specific unsatisfactory works. It is important that all specified work is completed, and payments are not made until the work is actually done to a satisfactory standard. However, it is unfair to ask a contractor (or principal contractor) to do work that was not originally specified without their agreement.

The work should be signed off by issuing a practical completion certificate. This certificate is usually a simple checklist of various elements of work completed with final total quantities shown. The contractor (or principal contractor) and clients' site representative should sign it, as well as the client or the project manager. This forms a record of agreement if there are later problems. It should be noted that in contract law there is some ambiguity over the meaning of 'practical completion' and potential liabilities to rectify defects, so some care needs to be taken that all parties are in agreement.

The contractor (or principal contractor) can issue the invoice once all parties sign the practical completion certificate. Providing that it has been included in the terms and conditions of contract a retention sum, usually 3 - 5% of total contract price, is then held back by the client for a given period. This is known as the 'defects period'.

Phase 3. Final completion phase (defects period stage)

The defects period stage commences from the date the practical completion certificate was issued and is effectively a guarantee of workmanship. During the 'defects period', which is usually 6 months to 1 year depending on the scale of the project, any defects in the completed path or related feature work should be rectified by the contractor (or principal contractor). It is important to note that defects in the design, which may also be highlighted in the first year of a path's use, are not covered by the defects retention. It covers things like surfacing breaking up due to insufficient compaction, Type 1 emerging through the whin dust surface, but not, for example, surface scouring if there was insufficient drainage specified - that is the clients fault and should have been resolved when pathworks were first carried out during construction phase.

At the end of the defects period, the client can hold another path inspection meeting on site with the contractor (or principal contractor) to view and make sure all defects have been dealt with to a satisfactory standard. If all the work has been carried out to the satisfaction of the client, the withheld retention sum with final certificate can be released for payment to the contractor (or principal contractor).

Final certificate

The final certificate is certification by the client that the fixed price contract has now been fully completed. It is issued at the end of the defects period and has the effect of releasing all remaining money due to the contractor (or principal contractor), including any retention sum.

Claims

Unforeseen circumstances often mean that extra works will be required to complete a path project. Ideally, the provisional items in the bill of quantities will cover all possible extra works. This means that prices are already agreed, and it is just a matter of verifying quantities.

If the contractor (or principal contractor) claims for extras not included in the bill of quantities, then it is essential to find out exactly what they are requesting, and why. If extra works are a result of the contractor (or principal contractor) not having allowed enough time to complete the work, or due to their own actions, then it is important that the contractor (or principal contractor) covers their own costs.

In the event of a claim, good recordkeeping of all works, such as site visit records are invaluable. It is difficult for a contractor (or principal contractor) to claim for works when no one has a record of its completion.

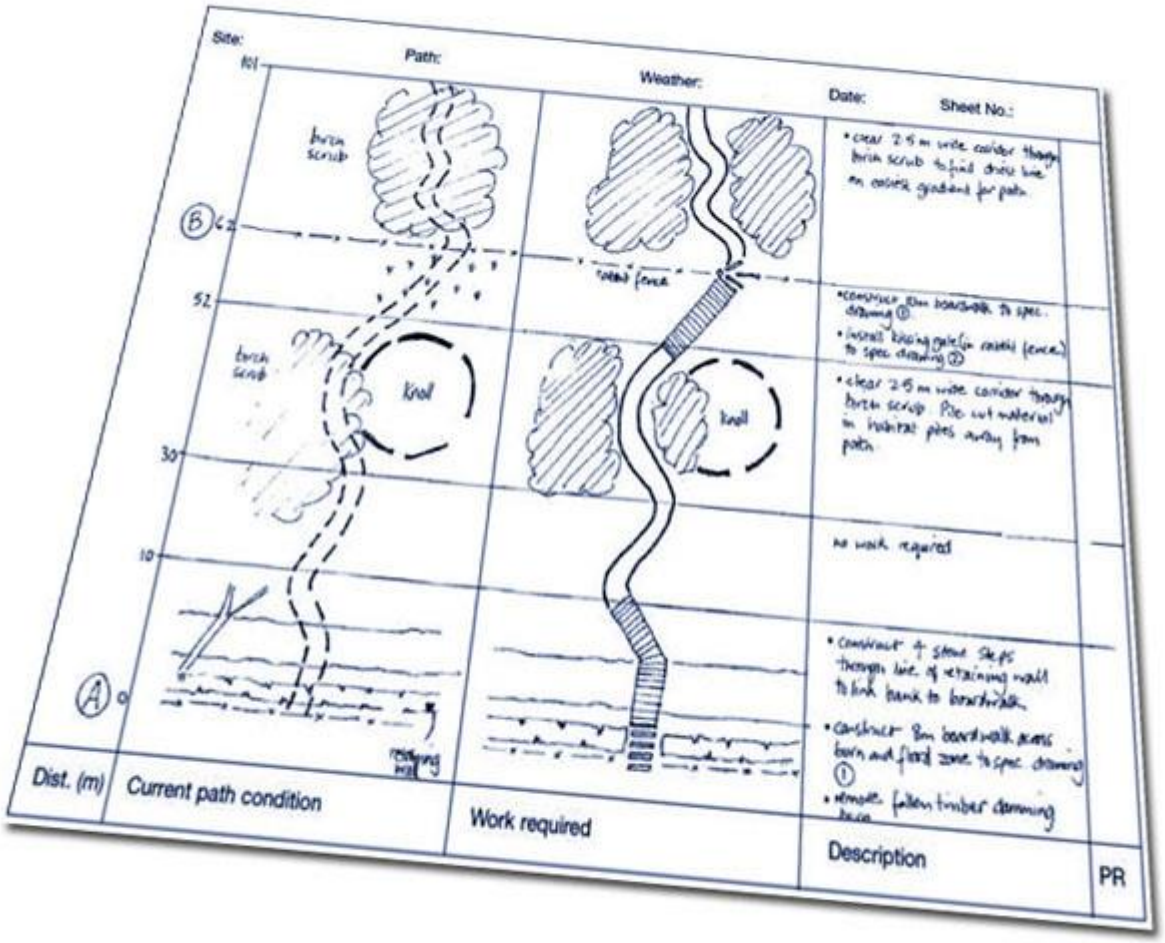
Health and safety file

If your project will, or is expected to, involve more than one contractor working on site at any one time, a health and safety file must be produced for you as the client. This is a legal requirement under the Construction (Design and Management) Regulations 2015.

The health and safety file provides health and safety information about the constructed path and any other structures installed at same time on site, e.g. bridge. The file is a live document that informs those tasked to maintain the structures about remaining or unobvious health and safety risks. It is also of value to those who will dismantle, replace or upgrade the path and other structures in the future - as they will need to know about the risks.

The principal designer starts to develop and prepare the health and safety file during the pre-construction stage of project. If the principal designer is still involved through to end of project, they are responsible for finishing the file off, or updating original file if one already exists. If the principal designer is not involved, they must hand the part prepared file over to the principal contractor, who will finish it and pass it to the client for keeping.

The client, designer, principal contractor, and other designers or contractors if involved, will need to provide any relevant information such as 'as-built drawings' to the principal designer or principal contractor for the health and safety file. The client, who retains the health and safety file, keeps it up to date and makes it available to those who need to know about remaining or unobvious health and safety risks, e.g. volunteers maintaining the path or a contractor replacing or upgrading the path surface, or other structures on it.



5 Path Maintenance

Maintenance needs to be seen as an integral part of the management of a path network – the time spent planning, designing and constructing paths will be severely compromised without maintenance being done. Maintenance can be easy to plan and cheap to implement and should be incorporated at the planning and design stages of path projects, rather than 'tagged-on' as an afterthought after a path has been constructed.

Regular maintenance will help to avoid large repair costs, compared to paths that have been neglected. This chapter gives guidance on what is maintenance and how to plan, implement and resource maintenance to get the best long-term value from a path network:

5.1 Maintenance – what is it?

We think of maintenance as just being inspections and routine or minor repair works. However, maintenance is much more. To help you understand the bigger picture of what

maintenance actually is, here are number of key terms that are commonly used to describe maintenance within the context of path management.

Key management terms	
Repair	making a path suitable again after minor or major damage or failure e.g. re-building a pipe culvert or short section of path after being damaged by flood waters from the nearby burn
Replacement	a complete path needs replacement when it has reached the end of its design life, or worn beyond the point of repair e.g. a path needs complete re-surfacing as the surface has worn through exposing the base layer along most of its length
Planned maintenance	regular tasks done on a routine basis, as part of a maintenance schedule, to prolong the life of a path and to make sure it remains in a reasonable condition e.g. the verges are mown or strimmed twice a year to control vegetation growth and loss of path surface from encroaching ground vegetation
Upgrade	improving a path surface or changing its purpose to allow access by a wider range or greater number of path users, or to correct a defect in a path that is causing repeated failure e.g. a whin dust path surface changed to bitmac surface as the path has become a popular route by children walking and cycling to school - upgrading the surface with bitmac will make the path more suitable for walking and cycling to school every day
	Note - maintenance is a type of construction work and the CDM Regulations 2015 apply

5.2 Maintenance planning

The objective of maintenance planning is to allocate resources and keep paths in a condition suitable for the users to use safely. Whether it is an individual path, a path network or an area access strategy, maintenance requires planning from the outset. If we find ourselves trying to plan a maintenance programme after a path has been constructed, it will be too late to minimise the long-term cost of managing the path – some aspects of design can be used to help manage paths more efficiently.

For each feature including the path surface, there should be define an acceptable condition or wear limit, which is used to assess whether items need to be repaired, replaced or upgraded. Most complex structures, such as bridges, should have these conditions as part of their design. There may need to be a judgement call for other items, such as drains, to decide how much change to the original condition is acceptable. For example, some ditches may still function adequately in normal conditions at half capacity if they were designed to cope with ‘extreme flooding’ events, and an acceptable wear limit for a whin dust path could be 25% exposure of base layer showing through the surface.

It can be helpful to assess the maintenance needs of individual paths and then combine the data to make a maintenance schedule for the network as a whole – this will probably make

completing some maintenance tasks more cost effective and reduce the number of visits required to maintain paths within an area. This will also provide an opportunity to take a strategic approach to path maintenance. Although it can be difficult to find time to undertake this planning work if you are accustomed to working reactively to path maintenance, it will improve the decision making process and provide managers or funders with clear criteria to assess any requests for resources.

It is helpful to consider two distinct approaches to path maintenance:

- **planned maintenance** – carry out tasks to a regular routine, to prevent problems before they occur.
- **reactive repairs** – look for potential problems and deal with them – inspection and correction.

Generally, it is best to use a combination of the two approaches, based on what maintenance tasks are needed and what resources are available. To be effective you must do planned maintenance when you can, but also have the capacity to react to unforeseen circumstances. Avoid waiting for things to go wrong before they get attention.

The worst-case scenario is to neglect a path completely until it is no longer usable, and then have to carry out a major repair. The cost of one major repair could fund planned maintenance and will cause inconvenience to the people who want to use the path. It is also a risky 'strategy' as funders may not be particularly sympathetic to picking up the cost of previous neglect, so you are left with a damaged path and no way of securing the funds to repair it, or replace or upgrade it in the future when the time comes.

For more information have a look at these sections:

5.2.1 Maintenance schedules

5.2.2 Inspection

5.2.1 Maintenance schedules

A maintenance schedule identifies planned maintenance for each path or path network. It includes an inspection regime and planned maintenance tasks. The schedule will also include responsibility, budget and reporting procedures.

Maintenance scheduling can be assisted by geographic information systems (GIS). They can be used to locate paths and also features on paths which require maintenance. This enables a comprehensive database to be set up to identify what is on the ground and what maintenance is required. Computer based management systems, such as CAMS (Countryside Access Management System), can then be linked to GIS to plan maintenance tasks and monitor works and expenditure. However, before investing time, training and resources in a monitoring system, make sure it will be suited to your needs – a simple spreadsheet and a paper map could be enough for your situation.

When preparing a maintenance schedule, consider the following aspects:

- responsibilities (who has to do what)
- inspection regime (what to look for, where and when to inspect)
- schedule of routine tasks (what to do, how often and who is to do them).

Also, consider:

- reporting procedures (what is the problem, what to correct and what further action is required if any)
- provision and action plan for emergencies and repairs.

The table below is an example schedule covering all the maintenance tasks as well as inspections. A schedule like this can be adapted for one path or network of paths. This must be done with care, as each path is different.

Path Maintenance Schedule					
Network: Luss	**Location**: Loch Lomond	**Prepared by**:	**Date**:	**Amended by**:	**Date**:
Path: all paths			**Grid Ref**: NS 360 928		
Feature	**Location**	**Task**	**Frequency**	**When**	**By Whom**
Fibredec path	Riverside to old A82	Inspection	Weekly		Ranger
Whindust path	Old A82 to pipe culvert	Inspection	Fortnightly		Ranger
Woodland path	Pipe culvert to Glen Luss road	Inspection	Monthly		Inspection
Entrance gate	Start of riverside path	Grease pins, check latch, clear self-closer tracks	Bi-monthly		Maintenance squad
Entrance gate	Old A82 access	Grease pins, check latch, clear self-closer tracks	Bi-monthly		Maintenance squad
Field gate	A82 overbridge	Check latch, grease pins	Bi-monthly		Maintenance squad
Fibredec surface	Riverside to old A82	Clear worst loose chips, branches, twigs, litter	On inspection		Ranger
Whindust surface	Old A82 to pipe culvert	Fill in and rake any ruts, potholes or other rough areas; clear branches, twigs, litter	On inspection		Maintenance squad
Natural woodland path	Pipe culvert to Glen Luss road	Clear fallen branches and obstructions to keep route passable	On inspection		Maintenance squad
Verges	All paths	Cut back overhanging branches	Annually	May	Tree surgeon
Verges	All paths	Remove dangerous trees	On inspection		Tree surgeon
Verges	Fibredec/ whindust paths	Mow/ strim verges, minimum 500 from surface edge to 50mm height	Bi-annually	May, Sep	Contractor
All bridges	Luss water, old A82	Check for loose deck boards, loose handrail timbers, slinters, trip hazards	On inspection of adjacent paths		Ranger
All bridges	Luss water, old A82	Full structural inspection	Annually	Nov	Structural engineer
Seats and signs	All paths	Check for damage, splinters, loose timbers or posts	On inspection		Ranger
Fences	Riverside path	Check/ repair wires and posts	On inspection		Ranger

5.2.2 Inspection

Inspection is an essential part of path maintenance and is the means to monitor the condition of the path and identify minor repairs that may be necessary. Inspection is also essential to assess hazards and their risks to path users. The person doing the inspection must be competent to carry out the task, i.e. they must have the knowledge, experience and skills, relevant to what they are inspecting. The inspection will help to confirm that the planned 'preventative' maintenance is effective, or to make adjustments as necessary.

What to look for

As well as looking for damaged or worn items, the inspection should include early indications of problems to come. This will help with prioritising repairs as you may be able to estimate how long a particular problem might take to require action - your defined wear limits should help determine the length of service remaining.

When to inspect

Inspections should be carried out to a fixed routine. This is important for record keeping and will assist in minimising inspection costs and planning maintenance expenditure. Emergency inspections should also take place in response to adverse weather or serious complaints. Some items can be visually inspected by staff or volunteers, but may require more detailed inspection by an engineer on a longer cycle.

How to record and report

The findings of each inspection should be recorded, which means that the system you use needs to be simple to administer – there is little point spending time inspecting a path and then having no way of ensuring that the problems are reported and can be rectified. Over a period of years, you will build up a picture of how a path ‘performs’ – these records are vitally important, especially where different people are involved in the inspections and repairs, you can avoid losing knowledge ‘inside someone’s head’ if individuals are unable to continue to manage the path.

If possible, divide the path into sections that relate to the original specification of the path, or divide into easily identifiable lengths of similar character. You can then record an overall impression of each section as well as the condition of specific items.

A standard form can be useful to make sure that the condition of each item on the path is recorded. This can generate a lot of paperwork, so think carefully about the level of detail you need – you may, for example, wish to report on the overall state of drainage features, but be able to pinpoint problems with individual drains. Complex structures, such as bridges, will need a dedicated form detailing each component to be inspected. Taking the previous year’s report out on the path can be useful to check whether problems were resolved, or if they are recurring (and therefore require more substantial action).

You may find it useful to define categories of problems to help with prioritising action as a result of the inspection. However, anyone inspecting or dealing with reports must have a consistent understanding of each category. A serious problem may warrant urgent repair whereas less serious problems can be built into the planned maintenance programme. Inspections may also highlight features requiring upgrading and will assist resource management. More detailed descriptions and photographs of condition will be helpful in

deciding whether repair or replacement is necessary. Some examples of reporting categories that could be used are shown in the table below.

Category	Typical problem or condition
Good condition	item is 'as specified' or at least 75% of original condition / capacity
Fair condition	item showing minor signs of wear 50 – 75% of original condition / capacity
Poor condition	item showing signs of wear or 25- 50% of original condition / capacity
Dangerous condition	item not fully functioning or less than 25% of original condition / capacity
Minor damage – stable	leaf litter on path surface
Minor damage – dynamic	culvert blocked, drain overflowing
Major damage – affecting accessibility	surface scoured exposing base layer with geotextile visible
Major damage – risk to health of users	broken handrail on bridge
Potential damage – minor	loose bolts on bench
Potential damage – major	ditch capacity reduced by 50% and running close to full in normal conditions

Path users may be the first to encounter a problem. They must be able to report problems easily. A telephone answering machine, dedicated email address or online website form can be used for this purpose, providing that they are monitored. It is also a good idea to produce a pro-forma for recording phone calls so that all relevant information is obtained. Publicise the contact details on path promotion tools - orientation board or leaflet. Try to respond to reports quickly to maintain public goodwill - and get in touch with those who have reported problems to let them know the problem is fixed.

Inspecting drainage features

The state of the drainage system is probably the most important indicator of the resilience of a path. An inspection will highlight the scale of routine maintenance required and should provide a warning of potential problems that could be avoided by early intervention. The following checklist will help to identify specific problems that will lead to path damage or risk to path users if they go unrectified.

Drainage Inspection Checklist	
Feature	**Potential problems**
Ditches	• blockage or obstruction restricting water flow along the ditch • scouring and undercutting of the channel base and sides
French drains	• standing water and build-up of debris, leaf litter and vegetation growth on drain stone surface
Culverts	• loose or missing stones on headwalls • blockage in the pipe, inlet and outlet ditching • exposed pipe or path settlement over the top of culvert • damaged or loose handrails (if fitted)

Cut off drains	• build-up of debris and leaf litter on grating • silt in the drain channel • blockage of the outlet restricting water flow out of drain
Cross drains	• loose channel side walls or liner base • undermining of the liner base • blockage in the stone channel, inlet/outlet ditching restricting water flow • path surface washout behind side wall stone
Water bars	• loose shedding bar and liner channel stone • undermining of the liner channel stone • blockage of the bar channel, silt trap (if installed) and outlet restricting water flow • water erosion on the path surface above and below the water bar • path settlement below top edge of shedding bar and liner channel stone

Inspecting structures

Structures, such as bridges and retaining walls, need more detailed inspections. It is good practice to carry out a full and detailed inspection of structures annually. The table below details some points to look for.

Structure Inspection Checklist	
Feature	**Potential problems**
Bridges	• loose or missing timbers, splinters on handrails, loose joints • corrosion on steelwork, broken welds, buckling of sections • eroding abutments, settlement, cracks • trip and slip hazards, unevenness, movement of decking boards • vegetation growing on the structure
Gabions	• broken wires • excessive bulging, especially if gabions are in a wall • settlement and toppling (wall may be collapsing)
Retaining walls	• decaying materials, cracks and differential movement • bulging and toppling • seeping water
Stone walls	• loss of pointing • loose or missing stones • bulges and settlement
Boardwalks	• loose deck boards, trip and slip hazards • cracks in substructure, decay and settlement • erosion around posts

Large bridges and other complex structures should be inspected by a qualified engineer on a defined inspection cycle – this could be every three years, with routine inspections by a trained person on an annual basis.

Responding to inspections and reports

Once identified and reported, a problem must be rectified. If an immediate repair is not possible, carrying out temporary repairs may enable a path to be partially re-opened until a full repair can be done. Provide warning signs, and inform users if accessibility is reduced.

It is good practice to set out response times and action plans for carrying out repairs. Ensure repairs are carried out to a satisfactory standard and comply with health and safety requirements.

If an immediate repair is not required, inspections can be used to monitor the problem and decide when a repair is needed. Washed out surfaces (unbound or semi-bound) can often be levelled out and re-compacted using the material washed out. The temporary surface may not enable all users to access the path, but at least the path will be open and safe. It can be repaired when other works are being done in the vicinity, to avoid bringing plant in for one small job.

Some maintenance problems or faults may present a hazard to the public, such as a failure on a structure such as a bridge. You may need to erect warning signs, seek expert help to assess the fault or even close the path. The responsibility rests with the path manager to assess the risk, and take appropriate action.

5.3 Maintenance tasks

Routine, planned maintenance needs to cover the path surface and any related features to ensure that they continue to function as intended and are safe. It may be possible to extend the life of some features, or prevent damage to other items by completing regular small-scale maintenance tasks, which will be cheaper than the cost of major repair or replacement – cross reference to the original specification and wear limits should help you to make this decision. The following maintenance tasks include a mix of routine work activities that need to be undertaken to a defined schedule, and some which will be required in response to changes in condition from wear and tear or the weather (i.e. as a result of inspections or reports from the public):

5.3.1 Vegetation management

Encroachment of vegetation can have a large impact on the accessibility of a path and the experience for the users. Managing the vegetation is probably the most frequent maintenance task required. It is important to maintain a clear corridor along the line of a path, often referred to as the ‘path corridor’. This is to ensure easy access, assist with sight lines and also to prevent possible injury to path users, such as visually impaired people, cyclists and horse riders. If a path is for walking and cycling only, the clear corridor should be kept at a height of 2.5-3m. If horse riders are expected to use the path, this should be extended to 3.5m. The

clear path corridor should extend at least 1m on either side of the constructed/ managed width. This can be reduced to 0.5m where the corridor is narrow.

Tall vegetation close to the path can make some users feel unsafe or at risk, particularly in urban situations. Users report feeling safer on paths with wide open verges and clear sight lines. Large trees close to the path will drop leaf litter onto the surface, causing mud formation, and will prevent sunlight and breezes from drying out puddles and muddy areas. Leaves falling on path surfaces, even bridges and boardwalks, can present a slip hazard.

Routine tasks

Mow or strim the path verges to keep vegetation below 150mm - 200mm height, for a width of 0.5m to 1m from the edge of the path. Depending on the location you can plan for between 2 and 4 cuts a year. Wayside shrubs and bushes will need to be cut back to retain the full width of the path.

Cut back overhanging branches to keep the specified clear path corridor, and remove trees that are in danger of falling. Follow good practice in tree care to ensure that limbs are safely removed and that cutting does not cause damage to the tree itself.

Remove leaf litter from path surfaces and structures (use a rake or leaf blower). This may need to be done twice in the autumn and winter. This is most easily achieved when leaves are dry and they should be moved so that there is minimal chance of them being blown back onto the path or in to open ditches.

Applying herbicide

It is good practice to spray weeds on path surfaces to reduce encroachment. However, care is needed to make sure that there are no undesirable effects or impacts on the vegetation and wildlife. Ensure that anyone applying herbicide is qualified to use the equipment, chemical and understands the management objectives of the path. Excessive application of herbicide can sterilise verges, making them visually unattractive and exposing them to potential for soil erosion. Regular verge mowing will reduce encroachment of vegetation, reducing the need to apply herbicide. If weeds appear through unbound, semi-bound or bound surfaces use spot applications of herbicide rather than treating the whole area.

Take extreme care in choice of amenity herbicide. This is particularly important if you are planning to treat drainage features where vegetation growth is dense. The herbicide may affect local burns and could cause damage to important flora and fauna. Check the safety information sheets for the amenity herbicide that you plan to use to see if it can be used near or in watercourses.

Make sure that path users are aware that herbicide spraying has been carried out. People will be reassured to know which herbicide has been applied and where on site. This is particularly important for people out walking their dogs.

5.3.2 Drainage system

Keep your drainage system clear! Drainage system failure inevitably results in extensive damage to a path requiring expensive major repairs.

Silt, debris and vegetation cleared from drainage features, such as open ditches, must be disposed of carefully. Ensure materials do not re-enter the drainage feature again or block other drainage features e.g. culverts.

Drainage System Maintenance Checklist	
Type	**Action**
Ditch	• clear out silt, debris, leaf litter and vegetation that will block the ditch • remove any obstructions restricting water flow along the ditch • deepen and regrade bottom of ditch where water is standing and not flowing • avoid removing side wall vegetation if possible • widen and re-batter side walls where undercutting has occurred • you will need to comply with the Controlled Activities Regulations (CAR) when clearing ditches – most path operations will be covered by General Binding Rules, but larger ditches (those over a metre wide) may need a licence before being cleared
French drain	• empty catch pits, clear leaf litter, vegetation and debris from drain stone surface • replace blocked drain pipe and stone • install a catch pit in the repaired drain section to prevent it happening again • install geotextile to prevent siltation
Culvert	• clear out silt, debris and vegetation blocking pipes, inlet and outlet ditches • re-firm loose headwall stone where there is movement or large gaps • replace any missing headwall stone • top-up and re-compact surface over the top of culvert if the pipe is exposed or where there is any path settlement
Cut-off drain	• clear debris and leaf litter from grate openings • clear out silt and debris from the drain channel and outlet end • replace broken grate

5.3.3 Path surfaces

Natural surfaces

Strim or mow surface to define the line – this may need to be fortnightly from May to July and less frequently for the rest of the growing season. At the beginning of the cutting season, cut a wide enough area to include path edges, which can then be cut less frequently than the line of the path itself.

Monitoring of surface conditions will determine if additional drainage or upgrading to a constructed surface is necessary. Some improvements can be made by sowing amenity grasses in spring along the path line where heavy wear has resulted in loss of vegetation, providing that this will not have a negative impact on the existing habitats and species.

Unbound and semi-bound surfaces

Routine tasks include clearing leaves to prevent mud formation and treating weeds that emerge through the surface layer. Depending on the quality of the finish and drainage on the path you may find scoured ruts and potholes on the surface. Attend to water scouring on unbound surfaces quickly, to prevent it becoming a hazard or developing in to a pothole. Hide a small stock pile of surface material near problem areas. One person can easily shovel dust into the ruts, rake it out, and compact it to leave the repaired path surface smooth. However, look for the cause of the scouring and prioritise solving the problem. If a surface washes out frequently, it may be more cost effective to carry out an upgrading project by installing more effective drainage or even providing a bound surface.

A ‘quick fix’ for a rough or worn out unbound surface is to re-compact it. This will allow use for at least another season before re-dusting is required. Re-dusting should be done when a significant amount of base layer stone becomes exposed and loose. Surfaces on slopes less than 1:20 (5%) should last around 7 to 10 years. Slopes between 1:20 (5%) to 1:10 (10%) should last for 3 to 5 years.

Bound surfaces

In recent years bound surfaces have been suggested as a ‘maintenance free’ option. However, there are a number of routine tasks that are required to retain the original specification and accessibility levels. These include weed treatment to prevent the surface from breaking up, and removal of leaf litter which, on bitmac and asphalt surfaces, can be a serious slip hazard for users, especially pedestrians and cyclists.

In the longer-term frost, vehicles and water will eventually break up a bound surface. Expect 10-15 years from surface dressing (tar spray and chip surface), 15-20 years from a bitmac surface and 20 plus years from a hot rolled asphalt surface.

Surface dressing (tar spray and chip surface)

Re-chip exposed areas of bitumen, sweep off loose chippings and seal up cracks with bitumen. Treat weeds with spot application of amenity herbicide. Where extensive surface wear is experienced you can resurface with a new surface dressing layer laid on top of the old surface.

Bitmac and asphalt surfaces

Clear leaves in the autumn or winter and treat weeds before they have a chance to distort the surface. In winter, occasional salt and grit application may be necessary, where weather conditions dictate road salt or grit treatment. For major flaws, bitmac and asphalt surfaces can be ground up, re-mixed with bitumen and re-laid in one process. Rough bitmac surfaces can be rejuvenated by surface dressing with a new single or double layer of surface dressing (tar spray and chip surface).

5.3.4 Furniture and structures

The following table highlights what to look out for when maintaining furniture and structures associated with a path.

Furniture and Structures Maintenance Checklist	
Type	**Action**
Signs, gates and other furniture	• ensure signs are standing upright, firm in the ground, pointing in the right direction and readable. Repaint as necessary (the sign manufacturer should be able to recommend the frequency), including the lettering • when a gate or stile is in need of replacement, consider whether it can be removed altogether, leaving a wide enough gap, or replaced with a less restrictive design to allow easier access for a wide range of users • ensure catches and self-closing hinges on gates work and hinges are greased at least once a year • if signs are being vandalised frequently consider using different materials or locations. For generic signs across a path network, keep a stock of spare signs available to allow quick replacement • broken fences could allow stock to stray. If the fence is your responsibility, repair it promptly to avoid damage or injury as this could jeopardise future relations with the landowner. Do a temporary repair, if a full repair is not possible immediately • repair damaged access controls promptly to ensure legitimate users can use the path, and to prevent unauthorised vehicles causing damage
Bridges and other structures	• paint steel work when required to prevent deterioration, re-treat timber, replace broken, rotted or missing elements, such as decking boards • most structures will have a ‘design life’ based on materials and use. At the end of this life they must be fully assessed to determine if they need to be replaced
Clearing litter	• litter strewn paths will quickly become unattractive for users – an instant failure under the ‘fit for purpose’ criteria. Litter attracts litter – keeping on top of litter clearance and removing fly-tipped rubbish promptly will help to discourage people from using paths as unofficial dumping grounds. If done regularly, litter clearance can be a simple task • clearing broken glass is particularly important but avoid the temptation to sweep it onto the verges. This will quickly render them ‘no-go areas’ for dogs, children, horses and anything with pneumatic tyres • small sweeper machines (as used by Council Environmental Services) are the most effective and cheapest way of clearing litter from bound surfaces • litter needs to be cleared from verges and adjacent vegetation, as well as from the path itself
Removing graffiti	• graffiti can be removed using a pressure washer. However, these are expensive and cumbersome • a simpler solution for bitmac is to paint over the graffiti with bitumen paint. This will fade to match the colour of the existing surface and will quickly wear back down to expose the original texture • graffiti on structures can also be painted over – various commercial anti-graffiti coatings are available which aid removal

5.4 Resourcing maintenance

Resourcing path maintenance is one of the major issues that affects lowland path management. More than any other factor, it has the potential to prevent or restrict the development of path networks. The claim `nobody is willing to fund maintenance' is often heard and results in no maintenance being carried out. Local path groups are often best placed to provide volunteer labour, so when planning the path project consider who might be prepared to 'take ownership' of maintenance. There are many good examples of volunteer management of paths and working in partnership to deliver path maintenance across Scotland.

Estimating maintenance costs

You should calculate the requirements for routine, planned maintenance at the project's planning and design stages. You will need to work out what maintenance works are needed, how long they will take, how many people are required and what tools and materials are needed. Try to forecast a 3 or 5 year maintenance programme so that you include less frequent tasks such as minor repairs to surfacing or other path related features.

Allow for the cost of management and supervision, as well as inspection in the maintenance budget. If volunteers are to be used, it is reasonable to assume that labour costs will be reduced, but allow for increased management and supervision. Encourage volunteer groups to take charge of maintenance planning and support them in estimating any costs for materials, equipment or specialist contractors.

Delivery options

Many different people and organisations may be involved in maintenance. Whoever does the work, standards must be clearly defined and measurable in order to achieve best value. Maintenance is often viewed as a menial task to be carried out once the path construction, replacement or upgrading work is finished. This view of maintenance is unlikely to engender enthusiasm or help to secure long term resources, and does not fully reflect what affects a user's experience of a path. Complaints from the public are most likely to arise from lack of maintenance, so the people undertaking that work play an important role in achieving 'customer satisfaction' for your organisation.

In-house teams

In-house teams provide a flexible way to get all sorts of maintenance tasks done. They can respond very quickly to emergencies and are able to work to a fixed routine. Keeping a dedicated team in constant work can be difficult, although this is essential for cost effectiveness. One team could be used for maintenance on several path networks and for new path construction works. There are varying opinions on the long-term productivity of in-house maintenance teams, so effective management is vitally important.

Beyond access officers, in-house staff who have been trained in what to look for on a path, can make effective inspectors. They can work to a fixed schedule and will become familiar with paths, being able to anticipate where and when the problems are likely to occur. Rangers or wardens, for example, can carry out inspections and could have a wider role in managing routine maintenance and supporting contractors or volunteer groups.

Contractors

Contractors have been used in a variety of ways, either for single tasks, or with a wider remit to carry out most or all maintenance work. Management and supervision are essential to ensure high standards.

Most contractors will have a full work programme so you may need to allow plenty of lead-in time for a one-off job. They may not be able to ‘drop everything’ in order to clear a landslide that has closed the path or even to come out as a one-off to mow the verges. Rushing contractors can mean higher prices and poorer standards of work.

An ongoing framework contract or service level agreement can be beneficial all round, reducing the cost of commissioning work, and providing some security to allow the contractor to offer better value rates. Building long term relationships with contractors is desirable as they will become familiar with the area and supervision requirements may reduce. Provide enough security for a contractor to be able to resource a maintenance contract, but do not be afraid to re-tender the work on a 3 or 5 year basis to maintain best value.

Not-for-profit organisations

Not-for-profit organisations, such as the Outdoor Access Trust for Scotland, National Trust for Scotland work together to manage upland path maintenance on a partnership working agreement in the Cairngorms area. The path maintenance work is resourced by the organisations involved and carried out by combination of contractor, seasonal path maintenance worker, seasonal rangers and trained volunteers.

Fife Coast & Countryside Trust carry out path maintenance works in the Fife area with their own 'in-house' maintenance team. The Fife Coast Path and paths across the Lomond Hills are inspected by the Trust's Operations Supervisor and the works are completed by skilled maintenance workers.

Land managers

Land managers can help to carry out path maintenance in their local areas. They may have staff and suitable plant and equipment available to do the work. Working with land managers in your area can strengthen relationships and assist future access planning and development. Like contractors, land managers can be paid by retainer sums or for each task. Land managers can also help with path inspections, but will probably require some training. Such arrangements are most likely to work by fitting inspections around their normal tasks, and so the schedule should be flexible. A simple reporting system will help to plan repairs and account for any contractual requirements.

Training organisations

Training organisations have been used for maintenance although the costs and quality of work can vary. Privately run training companies often require a higher price and Council run teams may be better value. Training organisations look for discrete programmes of work linked to opportunities for skills enhancement. An effective way of using them is to bring them on site after an inspection to deal with a number of identified problems. This option may not be as useful for routine maintenance tasks.

Volunteers

Volunteers have been used for path maintenance across Scotland. They may require management, training and support for continued motivation and their contributions need to be valued in order to secure their labour in the long term. This may mean adapting processes to be more responsive to their needs, rather than being convenient to a path manager. Health and safety obligations apply to volunteers as well as contractors, so they may appreciate help in complying with health and safety legislation. Public liability insurance may be required, although some local authorities have volunteer schemes that cover this aspect.

Inspections are a common task for volunteers. Set out a simple reporting procedure, train them on how to record the information and try to get them to work to a routine to avoid a constant stream of minor comments. In some cases, volunteers have carried out many small tasks such as lopping overhanging vegetation, picking up litter or clearing small blockages in drains.

Community groups

They will have a strong local identity and can be highly motivated. The main issues relate to maintaining a pool of labour, skills and training. They can do inspections once given training, and may also will be willing to carry out physical works. In some cases, they will be capable of taking on the management of a path network and will look to the public sector to help fund their activities. This is usually far more cost effective than any other management arrangement. Often, there is one key member of a community group who motivates the others, so understanding the dynamics of a group is important to long term success.

Volunteer organisations

Various volunteer organisations provide practical volunteering days. Midweek practical volunteering days can be cost effective approach to getting maintenance tasks done on path networks. A team of volunteers lead by a trained supervisor can be an effective way to do planned maintenance tasks as well as minor repairs. The organisation usually provides all training and supervision, but you will need to be able to provide clear instructions about the nature of the maintenance tasks or repairs, and the expected standards to be met. One such organisation is 'The Conservation Volunteers' (formerly the British Trust for Conservation Volunteers (BTCV).

paths for all

FOR A HAPPIER, HEALTHIER SCOTLAND

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
nature.scot

Paths for All

Office 8, Forrester Lodge,

Tullibody Road,

Alloa FK10 2HU.

Tel: 01259 218888

Fax: 01259 218488

Email: info@pathsforall.org.uk

Scottish Natural Heritage Headquarters

Great Glen House,

Leachkin Road,

Inverness IV3 8NW.