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Information

Windbreaks

Introduction

One of the earliest methods of improving the climate for growing crops must have been the use of windbreaks. They have an important part to play in horticulture today by providing shelter from the ill effects of wind on plants, soil, buildings and people.

Windbreaks may be grouped as:-

Living	- trees or shrubs which are semi-permanent.
	- sown plants which give temporary shelter for a specific short period.
Artificial	- timber fencing, netting etc.

Types of Wind

The strongest winds, particularly gusts, cause damage to the structure of buildings and plants. Deformed growth results from a mean annual wind speed of 4.5 metres/second (m/s). Serious deformation results where the wind speed is greater than 6.8 m/s. See table 4.

Damaging winds cause damage when plants are at a sensitive stage e.g. fruit blossom.

Prevailing winds are no necessarily the most damaging winds. The name refers only to the direction from which the wind most frequently blows. In this country the prevailing winds come from the south and the west. The greatest benefit may come from providing shelter from these prevailing winds, although in some situations protection from the cold winds from the north and east is more important. The local lie of the land (topography) can modify wind direction appreciably and must be taken into account.

The effect of wind

Structural damage

Modern structures are designed to withstand quite high wind loadings but damage does occur, particularly in exposed situations. Even in a well designed and well built structure, damage can start from the failure of a single sheet of glass, tunnel sheet or ventilator and its impact on others can set up a chain reaction of breakage. The risk of wind damage increases as structures and tunnel films weaken with age.

As well as having to pay for repairs, the grower may suffer direct crop losses from flying glass and subsequently weather damage. His cropping schedule may be delayed resulting in consequential losses long after the original wind damage. Some multiples insist on glass-free crops and some but not all of these losses can be covered by insurance.

Plastic structures have proved to be particularly vulnerable to wind damage. It is possible to reduce the risk of failure to a very low level by the provision of stronger structures but this could prove to be costly on very exposed sites.

Heat loss

The rate of heat loss from a structure depends on

a) The difference in temperature between the inside and outside of the structure

b) The wind speed; heat loss doubles as wind speed increases from 0 to 15mph

The figures of fuel consumption in Table 1 show the relative importance of these 2 factors in maintaining 21°C (70°F) in average January conditions in a typical glasshouse near Birmingham. The estimated fuel total has been apportioned into the amounts which would have been used in differing combinations of wind and temperature. <u>The amount used in frosty weather is much less than the amount used in windy weather, because the latter goes on for much longer.</u> It is clear, therefore, that there is much to be gained by tackling the wind problem.

TABLE 1: Weather Conditions and Fuel Consumption, %

Total	Light Winds Frosty	"Wind Frosts"	Light Winds No Frost	Windy No Frost
100	16.4	7.6	33.2	42.8

"light winds" = 10mph or less

The use of a thermal screen will virtually eliminate the effect of wind speed on heat loss at night. Depending on the temperatures being maintained, some 60% of heat loss may occur at night so the use of a thermal screen would considerably reduce the need for, and benefit from a wind break. Unfortunately, it is not practicable to install thermal screens in all glasshouses. New heated glasshouses should be designed to accommodate thermal screens.

The effect of a wind break

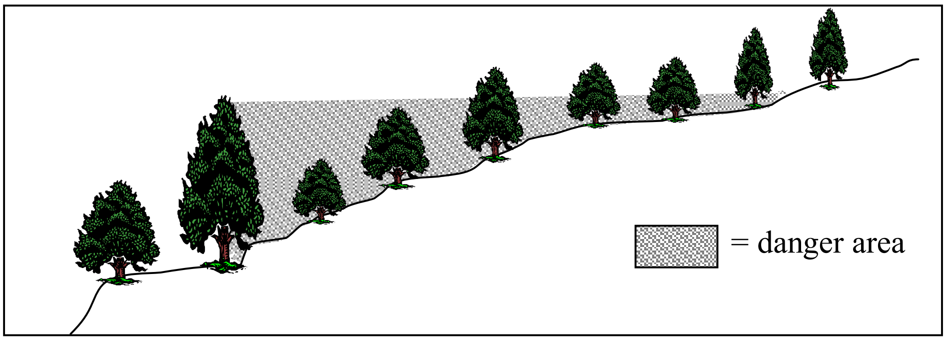
The main effect of an efficient wind break is to reduce the speed of the wind, not to stop it. A well placed wind break can reduce the risk of damage and reduce the heat loss, particularly at night and in the winter months but it is with the heated houses that the greatest benefit is obtained. Figure 3 shows the effect of a wind break on wind speed. Although this does not show the modifying effect of the structure on the wind run, it is clear that an overall reduction approaching 30% can be achieved whenever the wind is blowing from the direction for which shelter has been provided. On the exposed end the wind speed is reduced to 70% or less. Since physical damage is proportional to the SQUARE of wind speed, when the latter is reduced to 70% the wind pressure is reduced to 49% and the sheltering effect is quite pronounced.

Orientation and siting of a windbreak

All round shelter would be ideal, but expensive both in terms of materials and space. Attention should first be given to the prevailing wind, which in most cases will be between South-West and West. It would be an advantage if the wind break could also protect from the North-West. Winds which cause structural damage are most likely to be from the West or North-West.

The direction of the surface of the wind is influenced by topography of the ground and funnelling is often very noticeable along valleys. Windbreaks across a valley have maximum effect as the wind is most likely to beat a right angle to the windbreak. Windbreaks sited across sloped can impede air drainage on cold nights and so increase the risk of frost damage. This is particularly important at fruit blossom time and for sensitive crops such as runner beans. In such situations a gap of 0.3-0.6m should be kept open at the base of the windbreak to allow cold air to drain away (see figure 1).

Figure 1. Frost pocket created by a dense windbreak



Length of Windbreaks

The length of a windbreak is also important. If it is too short, wind is deflected around it, leading to increased wind speed at certain points. Since wind speed is never constant the ratio of length to height must be at least 12:1 to take full advantage of the protection given by the windbreak.

Design and layout

1. Too solid a barrier causes turbulence and may even increase the risk of damage down wind. Too thin a barrier will fail to slow the wind down sufficiently. Best results are obtained when about 45% of the frontal area consists of holes or small gaps, evenly distributed.
2. The wind break should be nearly as high as the structure or crop. To be fully effective, over a large area, it would need to be higher.
3. The shelter should extend well sideways beyond the area it is to protect. The further it is away, the longer it needs to be.
4. For economy, a space of up to 1m may be left at the bottom of tall artificial wind breaks without much loss of efficiency. This space can soon be filled with live shelter.
5. Gaps in wind breaks should be avoided. Where it is necessary to provide an opening, the wind should be prevented from blowing through it by staggering, i.e. overlapping, the shelter belt.
6. A major disadvantage of wind breaks can be the shading effect. A good compromise between loss of light and loss of shelter efficiency is obtained when a 50% permeable wind break is 4 times its own height from the glasshouse. Unfortunately, on many sites this cannot be attained because there is insufficient space available. Whether it would be worthwhile to site a wind break less than 4 times its own height from the structure of crop would depend on individual site factors such as exposure, temperature to be maintain, size, age and strength of glasshouse to be protected.

Natural windbreaks

A wind break of trees is not expensive to provide but does take several years to establish and eventually occupies a lot of space. Deciduous trees are leafless in winter and early spring when shelter is most needed and unless they are very twiggy they fail to flow the wind speed sufficiently. Evergreen trees tend to be too dense with a risk of increased turbulence down wind. Because of their greater density, evergreens are more likely to be blown over. Light penetrates deciduous trees in winter, reducing their shading effect compared with evergreens. Leavers from deciduous trees may black gutters.

An ideal shelter belt would consist of several rows of trees 25m tall containing a mixture of deciduous and evergreen species. On most glasshouse nurseries there is insufficient space and a single row of trees is all that can be contemplated. In this case, a good compromise is to alternate a deciduous with an evergreen species, planting at 1.5m centres.

The birch (Betula alba) is one of the best deciduous species. The grey alder (Alnus incana) and various bush willows (Salix caprea, cinerea, viminalis and their hybrids) are alternatives but tend to be less twiggy. All are relatively cheap to establish, are quick growing and will thrive in exposed positions and on most soil types. The common alder (Alnus glutinosa) is less suitable, being slower growing and requiring abundant soil moisture.

Poplars, eg Populus 'Eugenii' and P. 'Robusta' are only suitable where space permits a very tall, broad, branchy wind break (up to 25m more fastigiated poplars like 't x t' willow) and Dutch selections of S. alba are also suitable for tall windbreaks.

Leyland Cypress (x Cupressocyparis leylandii) is the most suitable evergreen. It is quick growing and when unclipped, stands salt winds well. Container grown stock should not be used as in some situations this does not produce well anchored trees. Lawsons Cypress (Chamaecyparis lawsoniana) and Western Red Cedar (Thuja plicata) are very similar and as easy to establish at a fraction of the cost. They are slower growing and need good soil conditions. Lawsons Cypress may not be as hardy as Leyland and Western Red Cedar may not take kindly to regular trimming and will not thrive in areas of low rainfall.

Establishment

Since trees for wind breaks are planted in exposed situations, it is essential that they are encouraged to develop a good, deep root system which will provide strong anchorage. Where necessary, under-drainage should be provided but pipes should not be if necessary and any lime or nutrient deficiencies corrected.

Young trees make rapid root growth early in their life and for firm anchorage as much of this growth as possible should be made in the permanent situation. The roots of young trees in containers soon become restricted and distorted, while the roots of plants grown on in nursery beds are likely to be damaged at transplanting. Suitable sizes for transplanting are 30-60cm for the evergreens and 60-90cm for the deciduous species although the willows and poplars, being easier to establish, can be planted up to 1.5m. It is a common fault to plant bigger, older and more expensive trees which establish badly giving disappointing results.

October is the best month for planting, allowing the roots to become established before the soil temperature falls. Avoid planting in the late spring, as the trees leaf out before the roots are established and losses can be high. Irrigation is likely to be necessary in the first season and possibly beneficial in the second and third until the trees are well established. It will be much less important if a black polythene mulch is used for weed control.

Evergreens need to be individually staked and tied as they are easily blown over in the first few years. Stakes should be driven into the planting holes before planting to avoid root damage. They need to be at least 2.5m long and driven 0.6m into the ground. States should be pressure treated and have a minimum diameter of 5cm to at least 2 ties/tree will be needed when they reach the tops of the stakes. In the early years the ties need to be loosened annually to allow the main stem to expand without constriction.

Staking of deciduous trees is less critical and on many sites it is sufficient to strain a 10 gauge galvanised wire between 7cm posts every 3m. The posts should be 1.5m long with at least 0.6m in the ground. The wire should be on the up wind side of the trees and the trees tied to it so that they are secure and cannot chafe against it. Rabbit guards around individual trees may be necessary.

Weed control

Weed control is necessary in the first 2-3 years after planting otherwise the small trees will be smothered. Before cultivating the soil, glyphosate (Roundup) may be used to clean it of weeds, providing they are in active growth when sprayed and a 2 week interval is left between spraying and planting.

Weed control after planting is best achieved by laying a strip of black polythene, about 0.6m wide on each side of the tree stems and stakes. The 2 strips of polyethylene can be joined by special 8cm wide adhesive tape made for this purpose and the outside edges buried 15cm into the soil. This plastic mulch will give a100% control of weeds and conserve moisture, ensuring that the trees get a good start and continue to thrive, quickly producing an effective windbreak.

Herbicides can be used instead, but it is important to remember the correct timing and to accurately measure out and apply the right quantities. Apply 2.5kg of Butisan S plus 8 litres/ha of Ronstar liquid in February each year until the trees are established. In October each year, apply Butisan S alone. Any weeds that survive this treatment can be "burnt-off" with carefully applied Paraquat. Weeds do more damage to the trees than is likely to result from scorch due to drifted Paraquat.

After the third year, most wind breaks are dense enough to suppress weeds and the presence of a little grass has definite advantages in promoting deeper rooting which improves anchorage and discourages the production of suckers.

The 2 weedkillers mentioned above are safe to use in the vicinity of glasshouses and in sprayers which are also used to apply pesticides to the crops provided that reasonable precautions are taken, ie avoid spray drift by using a coarse, low pressure jet and by not spraying in windy weather; thoroughly wash out sprayer after use.

Trimming

The ultimate height of the wind break will be determined by the distance from the area to be protected and very rarely will it be so far away that the trees can be allowed to grow upwards indefinitely. To avoid excessive shading, the trees should not be allowed to grow taller than a quarter of the distance between them and the area. If they are to be trimmed mechanically, the ultimate height is dictated by the available machinery. Conventional machinery can not operate much above 4.5-5m. Annual trimming is recommended or the wood becomes too large for the machine and th shading effect may become unacceptable between trims. The sides also need trimming depending on the space available. Leaf-bearing twigs on deciduous trees tend to be concentrated near the edge of the canopy. Because of this, the wind breaking effect may not increase much after the trees have reached a width of 1m. If they are allowed to get much beyond this width, drastic pruning is necessary to reduce them which increases the labour content and, by removing much of the twiggy material, seriously reduces their effectiveness as wind breaks. Trimming the sides in the early years results in a better shaped and effective wind break.

Constructing a Windbreak

A badly constructed or poorly maintained windbreak is worse than useless e.g. gaps in the barrier cause wind funnelling at increased speed and if the windbreak is sparse or does not come fairly close to the ground, the result is local acceleration of wind.

A windbreak facing the prevailing wind (or at least 50% of the prevailing wind) gives the most protection. Even a thin windbreak will give a reduction in the destructive value of wind, but 50% permeability has been found to be best, both experimentally and in practise.

Distance Between Windbreaks

Reduction of wind speed occurs up to a distance of 20-30H (H being equal total height of the windbreak) to the leeward of a windbreak with 50% permeability. At this distance the wind will have almost regained its original speed. Maximum benefit to crop yield occurs at a distance of up to 10H from a windbreak.

Single rows of trees 7-9m high every 70-90m therefore provide a good shelter without making too much land unproductive. In very windy situations it may be necessary to use windbreaks much closer than this, or to use double staggered rows of one or more species.

Artificial Windbreaks

Artificial windbreaks have the advantages of giving immediate protection with constant permeability and they take up little space. They do not compete with crops for water and nutrients and can be used wither as temporary or permanent shelter. They are ideal for protecting units of container grown nursery stock. They are also useful for protecting crops and living windbreaks until the living windbreaks become established.

The most efficient materials are those with a hole are a of about 50%. More dense materials reduce wind speed more markedly at first, but this effect extends over a much shorter distance downwind. Those with greater hole area give protection over a longer distance, but there is a smaller reduction in wind speed.

Supports for Artificial Windbreaks

These are normally round timber posts of Sweet chestnut, Larch or Douglas fir, placed at approximately three metre intervals. Although the methods of support are similar for most artificial windbreak materials, site exposure and prevailing wind speeds, height of the windbreak, soil type and method of anchorage must be considered when determining the size and length of supports.

Post size, i.e. the diameter of its thinnest end, is mainly determined by the height of the windbreak and exposure to wind. The depth of embedment in the soil is largely determined by the soil type and anchorage used. If the posts are embedded in concrete, a depth of 0.8 metres suits most situations shown in the example specifications for a 2 metre and a 3.5 metre high windbreak in Tables 2a and 2b.

When embedding in the soil, the type of soil and anchorage it affords greatly affects the depth of embedment required for stability of the windbreak. The soil types in Table 1 are described in engineering terms – the nearest agricultural classification does not indicate the anchorage potential.

Table 1. Definition of soil types for Tables 2a and 2b

Soil Grouping	**Visual Assessment**
Type 1	Compact, well graded sand and gravel. Well graded fine and course sand. Stiff clay. Stiff sandy clay. Should be well drained and in locations where water will not stand.
Type 2 (average)	Compact fine sand. Loose course sand and gravel. Compact well drained sandy loams and loamy sands. Firm clay. Firm sandy clay. Should drain sufficiently well so that water does not stand on the surface.
Type 3 (poor)	Loose sand. Soft clay. Clay loam. Loose clayey sand. Soft silty clays. Soft silty clay loam.

Notes:

Compact	- requires pick for excavation - 50mm square peg is hard to drive
Loose	- can be excavated by spade - 50mm square peg can be easily driven
Stiff	- difficult to mould by fingers - requires pick for excavation
Firm	- can be moulded with strong finger pressure - can be excavated by hand
Soft	- can be easily moulded with finger pressure - requires pick for excavation
Well-graded	- contains wide range of well distributed grain sizes.

Table 2a. Specification for erecting 2m high windbreak – depth of embedment necessary when backfilling with either soil or concrete.
Distance between supports = 3m

		Soil type 1		Soil type 2		Soil type 3	
Wind speed (m/s)	**Post diameter. (mm)**	**Soil backfill**	**Concrete 450 or 600 mm**	**Soil backfill**	**Concrete 450 or 600 mm**	**Soil backfill**	**Concrete 450 or 600 mm**
40	110	0.8	0.8	1.0	0.8	1.5	0.8
42	110	0.8	0.8	1.0	0.8	1.6	0.8
44	115	0.8	0.8	1.1	0.8	1.7	0.8
46	120	0.9	0.8	1.1	0.8	1.8	0.8
48	120	0.9	0.8	1.2	0.8	1.9	0.8

Table 2b. Specification for erecting 3.5m high windbreak – depth of embedment necessary when backfilling with either soil or concrete.
Distance between supports = 3m

		Soil type 1		Soil type 2		Soil type 3	
Wind speed (m/s)	**Post diameter. (mm)**	**Soil backfill**	**Concrete 450/600 mm**	**Soil backfill**	**Concrete 450/600 mm**	**Soil backfill**	**Concrete 450/600 mm**
40	150	1.1	0.8/0.8	1.4	0.8/0.8	2.2	1.1/0.9
42	155	1.2	0.8/0.8	1.5	0.8/0.8	2.3	1.2/1.0
44	160	1.2	0.8/0.8	1.5	0.8/0.8	2.4	1.2/1.0
46	120	1.2	0.8/0.8	1.6	0.9/0.8	2.5	1.3/1.1
48	120	1.3	0.8/0.8	1.6	0.9/0.8	2.6	1.4/1.2

For erection of windbreaks a tractor, trailer and a post hole borer of 600mm diameter and/or post driver are needed. A fork-lift attachment with a bulk bin can be used as a platform: two people are usually needed. The marking out must be done carefully to be certain of the correct spacing between each support. The material of the windbreak should be attached to the sides of the posts facing the prevailing wind.

When using a lightweight material the position of the horizontal supporting wires must be marked on the uprights with care, as allowance has to be made for the material to fold round the top and bottom wires.

Wind Speed

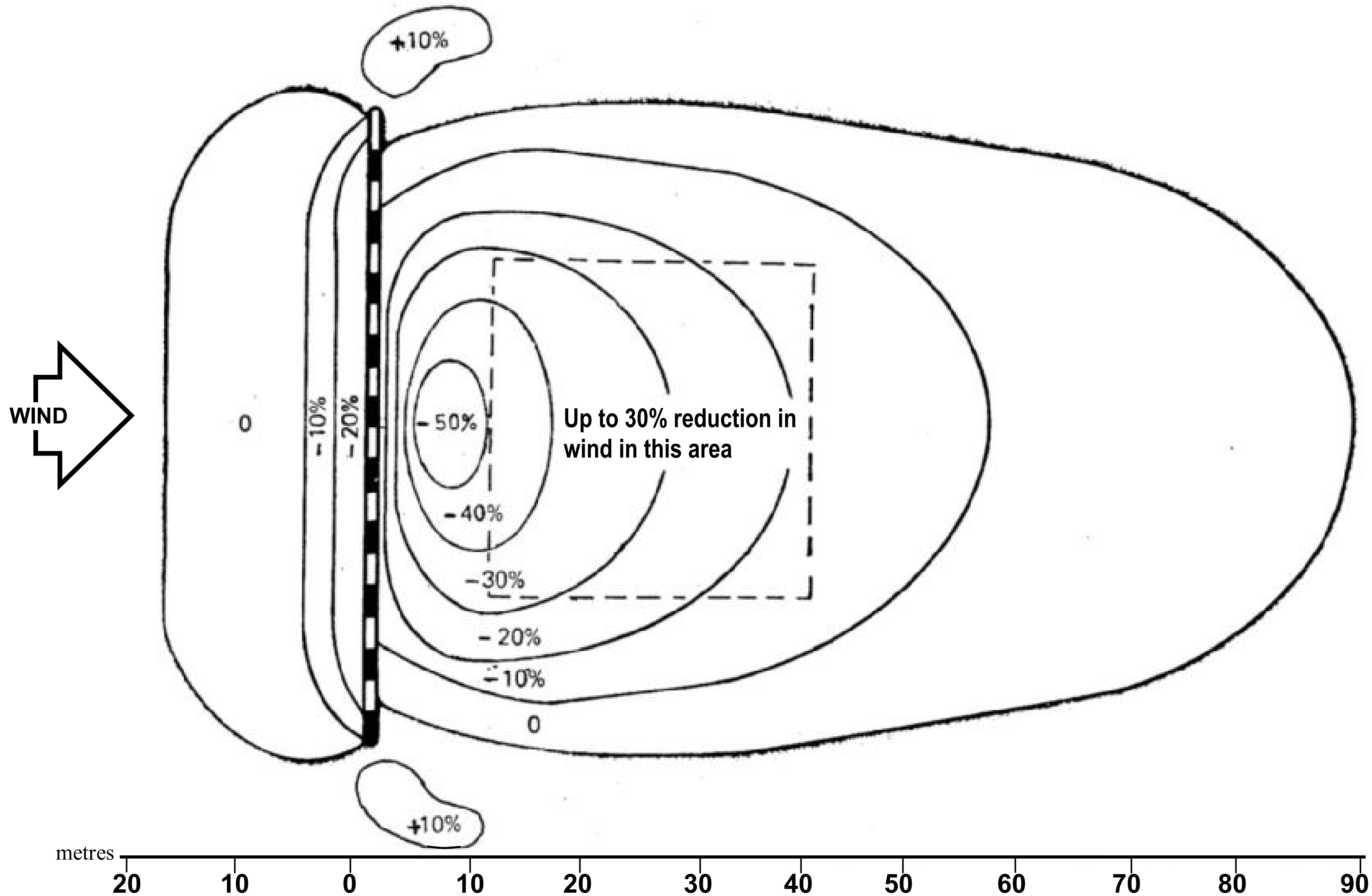
Local wind speeds can be found on page 5. These apply to open country with no obstructions. Ground surface unevenness will deflect wind and may cause gusts of wind of the height of the windbreak, which should be taken into account. Wind speeds of the area largely determine the size of the posts (see Windspeed information sheet). Where anchorage is good, wind speed is a minor consideration in determining the depth of embedment.

Figure 2. Local wind speeds throughout the UK

Maximum gust speed (metres per second) likely to be exceeded on average only once in 50 years at 10m above the ground in open, level country.

Figure 3. REDUCTION OF WIND BY A SHELTER BELT
(BELT 2.5m HIGH – MODERATELY PERMEABLE)

MEASUREMENTS 2m ABOVE LEVEL GROUND



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