Yorkshire Peat Partnership Technical Specification 3

Flat or gently sloping bare peat Stabilisation and Re-vegetation

1. Introduction

Peat as a land surface without a vegetative cover is unstable to the extent that the erosive forces of wind, water and livestock poaching easily facilitate the rapid stripping off of peat, often down to the subsoil/mineral/bedrock. Eroded peat is usually washed into watercourses along with silt from any mineral base material that has become exposed as the peat is removed. Peat is a very important carbon sink, once it is in solution in a water body the carbon becomes dissolved and may eventually be released into the atmosphere, probably contributing to the build-up of greenhouse gases in the atmosphere. Peat in upland watercourses also causes problems for water supply companies as large quantities of peat have to be removed from drinking water supplies at very great cost to them and ultimately the consumer. Silt getting into streams as a result of erosion is settling out in reservoirs and presenting serious problems for water companies as the siltation depths build up. There is also a widely held view that siltation of watercourses is damaging aquatic habitats for some species and is a major contributory factor when floods occur in areas downstream of the uplands.

Exposed bare peat in upland regions is caused by a number of factors including; livestock poaching and overgrazing, vehicle damage, peat extraction for fuel use and the most widespread cause – fire. These factors can lead to areas where exposed peat continually erodes away due to the combined effects of freeze-thaw action followed by desiccating wind erosion during drier periods. In many cases, the erosion is so severe that the peat is completely removed down to the mineral layer below leaving a bare and inhospitable surface. In many areas flat or gently sloping bare peat often combine with eroding hags and gullies to create extensive areas of heavily degraded eroding peatland.

Actively eroding and exposed bare peat creates an extremely hostile environment for plants to grow and it needs to be stabilised before vegetation can then be re-established. This document sets out a range of methods for restoring bare peat to a stable, re-vegetated condition to prevent further ongoing erosion and eventually to restore hydrological conditions that enable active peat-forming habitats to be re-established.

2. Stabilisation

2.1. Bare peat classification

The Yorkshire Peat Partnership has classified bare peat erosion into the following 2 categories:

(i) Peat pans often with shallow rills/incipient gullying and sheet wash (See Figure 3.1).

(ii) Micro-eroded sites (generally with patches of vegetation interspersed with patches of bare peat and evidence of cracking) (See Figure 3.2).

2.2. Stabilising exposed surfaces

2.2.1. Reducing water flow and wind erosion

2.2.1.1. Water flow and wind erosion across exposed bare peat can be reduced by breaking the area of bare peat or micro-erosion into smaller cells using bunds made from turf-covered peat, heather bales or coir logs as follows:

(i) Divide the area up into smaller units, no more than about 10m x 10m across but based on maximising the use of existing vegetation.

(ii) Create barriers (see Figure 3.3) across all small gullies and areas where water is flowing to create sub-units of about 10m apart using either:

(a) coir logs staked using 1m long, wooden stakes (e.g. chestnut paling) at 0.5m intervals (see Figure 3.3a), or;

(b) a row of 1.2m long x 0.8m high heather bales along the base of the gully and staked into the slope using 1m long, wooden stakes (e.g. chestnut paling) at 3 stakes per bale (see Figure 3.3b), or;

(c) low peat bunds covered with turf (see Figure 3.3c).

(d) Untreated timber planks - suggested dimensions of 25cm wide, 3.75 cm thick). Ideally, these should be western red cedar, elm, oak, alder or larch from FSC certified sources. Use up to two 25cm planks per trap to create a maximum 0.5m high trap. The planks should be embedded into the sides of the gully and should be driven straight down to avoid creating an erosion crack in the gully side. The planks should be fastened to, and held in place by, supporting posts hammered into the gully at 1m intervals (recommended 0.75-1m long x 10cm thick). The planks should fit closely together to retain water during all flow conditions. Planking bunds will require a spill plate placing down-stream to prevent

turbulence erosion as water comes over the top (e.g. stone, timber, baled material, turves etc.). A notch 15cm deep and 20cm wide should be cut into the middle of the bund to channel water in high flows through the middle of the trap to reduce edge erosion.

(e) Where the slope is not uni-directional the bund should be arranged in a “fish-scale” pattern to stop water and sediment moving in more than one direction,

(f) Bale, peat and coir bunds need to be compressed to maximise contact with the surface and prevent undercutting by water. Bales are placed as close together as possible and, where practicable, dug in to about a third of their own depth to create stability.

(g) Barriers may need to be replaced if re-vegetation (see below) has not occurred before the barriers disintegrate.

The sediment that builds up behind the barriers may re-vegetate naturally. However, this process can be enhanced by planting with common cotton-grass plugs. The plugs should be planted to achieve a density of 1 per 1m^2. When planting in proximity to existing cotton grass there should be a margin of 2m between planted and existing cotton grass. YPP’s preferred method of planting would be by hand rather than mechanically as this would will ensure the planting is targeted correctly as described above.

2.2.2. Covering with geotextiles (see Figure 3.4)

2.2.2.1. For eroding or re-profiled 45° sloping gully edges and/or stable slopes that are exposed to the prevailing wind geo-textiles should be applied to stabilise the peat surface.

2.2.2.2. The main materials used are Geo-jute which is manufactured by a number of different companies. It is an open weaved bio-degradable “net” with a weight of 500-600g/m^2 and should degrade within 2-5 years on moorlands. It is usually supplied in cuts 1.2 metres wide and 50 or 70 metres long. There are between eight and ten cuts per bale which is 500 or 560 linear metres or 600 or 672metres^2.

2.2.2.3. The net is fixed directly to the bare peat areas or gully sides using a variety of different types of pegs. Yorkshire Peat Partnership recommends the use of timber pegs from an FSC approved supplier. The net should be fixed using at least 3 pegs per linear metre with additional pegs needed for securing around topographical features. The whole net should be walked over and pressed down into depressions and any protruding lumps of peat stamped down into the net. The top and side edges of the net should ideally be secured underneath existing vegetation.

2.2.2.4. Geo-textiles should be applied in the autumn/winter after reprofiling and prior to seeding to ensure that seed lime and fertiliser are trapped in the net to enable rapid vegetation establishment.

2.2.2.5. The area of geo-textile required is calculated using a Geographical Information System (GIS) through analysis of aerial photographs.

2.2.2.6. Table 3 gives the number of widths required for each type of gully/hag.

2.2.2.7. Pegs are forced from the ground in winter due to frost heave. They should be inspected in the spring and reinstalled if necessary.

Table 3 Number of geo-textile widths required to stabilise different hag/gully slope dimensions

Depth (m)	Slope angle	Length of slope (m)	Widths of geo-textile (n)
≤1m	33º	1.84	2
	45º	1.41	2
>1m≤2m	33º	3.67	3
	45º	2.83	3
>2m≤3m	33º	5.51	4
	45º	4.24	4
>3m≤4m	45º	5.66	4
>4m≤5m	45º	7.07	5

2.2.3. Spreading bryophyte rich heather brash to stabilise bare peat surfaces

2.2.3.1. For less exposed bare peat that does not need Geo-jute a bryophyte-rich heather brash (double-chopped) cut from a suitable donor site (which must be as local to the restoration site as possible and will be inspected and approved by YPP staff) is spread after the bunds are installed (see Figure 3.5). The brash must be spread as soon as possible after cutting and should not be left in bags for longer than 2 weeks as any heather seed or bryophyte material is unlikely to be viable after this.

2.2.3.2. The brash is delivered in builders dumpy bags (see Figure 3.6). 1 hectare of bare peat with brash spread to a depth of 5cm requires 780 bags.

2.2.3.3. Brash can be spread manually using forks or by specially equipped very low ground pressure vehicles to a depth of 5cm (see Figure 3.7).

2.2.3.4. If there is suitable access the brash can be cut close to the restoration site and the dumpy bags can be transported by suitable low ground-pressure vehicles.

2.2.3.5. If brash has to be brought-in from further afield it must be delivered to the site by helicopter to avoid significant ground damage. (see Figure 3.6)

2.2.3.6. When the bags are emptied they are rolled and parcelled together for removal from the moor. For airlifting, as many bags as possible should be parcelled together to ensure adequate weight to prevent the bags causing helicopter instability.

2.2.4. Establishment of a grass & cotton-grass sward to bind the surface peat

To provide longer-term stability of the bare peat a grass seed mix is applied. The grass roots bind the peat surface into a stable turf that then forms the basis for other moorland species to colonise into or, where these are absent, for brought-in plants to become established. This is done in several steps:

2.2.4.1. Application of lime:

(i) Eroded peat is very acidic and provides a hostile environment for seeds to germinate. Therefore, granulated lime is applied in late February early March at a rate of 1t/ha ideally 6 weeks, but at least 2 weeks prior to adding grass seed to raise the pH to about 5 (See Figure 3.8)

(ii) Bulk lime is usually spread using large self propelled spreaders. The use of such spreaders on peat may be inappropriate due to the likelihood of them getting stuck or damaging habitat on, near or en-route to restoration areas. For small patches of bare peat with reasonable access lime can be spread with small spreaders mounted on ATVs or very low ground pressure tractors or otherwise manually.

2.2.4.2. Application of grass seed:

(i) Grass seed should be heat treated to reduce the instances of pathogens.

(ii) Grass seed (see Table 1 for seed mix) is applied at the same time as a dwarf-shrub seed mix in early to late March at least 2 weeks, preferably 6 after the application of lime at a total seed rate of 10kg/ha depending on the site (see Figure 3.9).

(iii) For small patches of bare peat with reasonable access seed can be spread with small spreaders mounted on ATVs or very low ground pressure tractors or otherwise manually.

2.2.4.3. Application of fertiliser:

(i) Peat is naturally very nutrient poor and damaged peat even more so. In order to establish the grass sward and provide favourable conditions for initial dwarf-shrub growth it is necessary to provide a short-lived low dose of nutrients using artificial fertiliser applied in July once the grasses are actively growing.

(ii) Phosphate fertiliser (P_2O_5) should be applied at a rate of 20kg/ha.

(iii) For small patches of bare peat with reasonable access fertiliser can be spread with small spreaders mounted on ATVs or very low ground pressure tractors or otherwise manually.

Table 1 Moorland grass mix species composition.

Species (Latin)	**Species (English)**	**% of seed mix**
Agrostis capillaris	Common bent	**20**
Festuca ovina	Sheep's fescue	**20**
Deschampsia flexuosa	Wavy hair grass	**30**
Eriophorum vaginatum	Hare's-tail cotton-grass	**30**

2.3. Re-establishing blanket bog vegetation to stabilised bare peat

2.3.1. Dwarf-shrub seeds

2.3.1.1. In some circumstances it will be desirable to introduce dwarf shrub seed to the stabilised bare peat. YPP recommends using a dwarf-shrub seed mix of 50:50 *Calluna vulgaris:Erica tetralix* applied at a rate of 1.5kg per hectare.

2.3.1.2. Small amounts of other species (e.g *Vaccinium myrtillus*, *Vaccinium vitis-idaea* or *Empetrum nigrum*) can be added if required although these are generally better applied as plug plants as they require additional seed treatment to ensure decent germination rates.

2.3.1.3. Seed should be heat treated to reduce the instances of pathogens.

2.3.1.4. For small patches of bare peat with reasonable access seed can be spread with small spreaders mounted on ATVs or very low ground pressure tractors or otherwise manually.

2.3.1.5. The dwarf-shrub seed should be applied in March at the same time as the grass seed.

2.3.2. Dwarf-shrub & cotton-grass plugs.

2.3.2.1. Young Cotton-grass and dwarf-shrub plants are available from a limited number of suppliers as “plugs”. These are used by YPP to increase the long-term stability of the bare peat through targeted planting in areas that are similar to the natural conditions these species are normally grown in.

2.3.2.2. The plugs are usually planted by hand using a standard manual tool.

2.3.2.3. Common cotton-grass (*Eriophorum angustifolium*) or if not available Hare’s-tail cottongrass (*Eriophorum vaginatum*) plugs should be planted in blocks in wetter areas at 1 plug per m^2 (See Figure 3.11). If cotton-grass is naturally colonising within 1 metre of the stabilised bare peat no additional plugs are needed.

2.3.2.4. Crowberry plugs should be planted in blocks in drier areas at 1 plug per m^2 (See Figure 3.11). If Crowberry is naturally colonising within 1 metre of the stabilised bare peat no additional plugs are needed.

2.3.2.5. In the driest areas and shallow drier peat Bilberry or Cowberry plugs should be planted in blocks 1 plug per m^2 (See Figure 3.11). If Bilberry is naturally colonising within 1 metre of the stabilised bare peat no additional plugs are needed.

2.3.3. Sphagnum harvested from donor sites.

2.3.3.1. One of the main objectives in restoring bare peat areas is to re-establish a *Sphagnum* moss layer as this provides the long-term stability the peat needs and re-starts the peat-forming and carbon sequestering processes that restoration is trying to achieve. Where appropriate donor sites are available Sphagnum propagules can be harvested and transported to the restoration site for planting in two forms.

2.3.3.2. *Capitulum fragments harvested from a suitable donor site (see figure 3.12)*:

(i) These are cut using specialist low ground pressure machinery from a suitable donor site approved by YPP staff prior to cutting.

(ii) The donor site must not suffer long-term damage as a result of harvesting. YPP recommends that less than 10% of the donor site should be harvested and donor sites will be inspected and agreed with the landowner/game keeper.

(iii) The donor site is surveyed by a suitably experienced botanist prior to cutting to determine the species composition which should be as close as possible to the ideal mix outlined in Table 2.

(iv) If there is suitable access the *Sphagnum* can be cut close to the restoration site and the dumpy bags can be transported by suitable low ground-pressure vehicles keeping damage to an absolute minimum.

(v) For large areas or remote areas with difficult access and to avoid significant ground damage the *Sphagnum* must be delivered to the site by helicopter.

(vi) When the bags are emptied they are rolled and parcelled together for removal from the moor. For airlifting, as many bags as possible should be parcelled together to ensure adequate weight to prevent the bags causing helicopter instability.

(vii) Fragments are spread by an adapted low ground pressure machine at a rate of 80-100 capitula per m^2.

(viii) There is currently no evidence-based information on the best times to spread the capitulum fragments so it is suggested that they should be spread on bare peat before brash is spread on top soon after.

(ix) At the time of writing only one contractor was providing *Sphagnum* in this format.

2.3.3.2. *Clumps (small sized handful) of Sphagnum harvested from a suitable donor site (see figure 3.13):*

(i) Clumps of *Sphagnum* are harvested (preferably by hand) from a suitable donor site approved by YPP staff prior to harvest.

(ii) The assessment requirement for the donor site and delivering clumps to the restoration site is the same as 2.3.3.1. (ii-vi).

(iii) Clumps are heeled into the bare peat surface in wetter areas at a rate of 1 clump per m^2.

(iv) Clumps should be planted at the same time as seedis spread in March.

(v) A number of contractors provide clumps of *Sphagnum* from regular donor sites.

2.3.4. Sphagnum grown under horticultural conditions.

2.3.4.1. Where these is a lack of a suitable donor site Sphagnum propagules are now available from a single horticultural supplier (Micro-propagation Services(E.M.) Limited) under the BeadaMoss® brand which have been grown using micro-propagation techniques from fragments of locally sourced material. All of the species listed in Table 2 can be provided in these products. These come in several forms for use in a range of moorland restoration conditions:

2.3.4.2. BeadaMoss beads® - 2-5mm gel “beads” that contain juvenile Sphagnum propagules. Micropropagation Services Limited specification for this product is:

(i) Supplied ready-to-use in 15 litre bags (which need to be spread within 2-3 weeks of production) and delivered to site in returnable rigid crates.

(ii) Works best if bare peat has already been re-vegetated (therefore YPP would use this product 1-2 years after re-vegetation). Although, if applied to bare peat a brash/mulch cover is acceptable.

(iii) Application rate for restoration recommended by the supplier is 100-200 litres/ha (7-13 bags/ha).

(iv) Currently applied by hand.

(v) Beads will be hard to find after spreading and the supplier suggests that first growth will be visible after 12-18 months with good results after 2-3 years.

(vi) YPP have not used this product extensively and are assessing its success rate on one site before rolling it out on a wider basis.

2.3.4.3. BeadaGel™ - protective gel matrix with water holding capabilities and nutrients containing large numbers of *Sphagnum* plantlets 1-20mm long with juvenile "innovations" (new capitula). (See Figure 3.15). Micropropagation Services Limited specification for this product is:

(i) Supplied in 2 parts for mixing on day of use (which needs to be spread within 4-5 days of production and within 3-6 hours after mixing). Delivered to site in returnable 20litre tubs and 2litre or 5litre tubs.

(ii) Works best on bare peat where water table can be controlled within 10-15cm of the surface to prevent flooding or drought (eg. lowland bogs). If applied to bare peat a brash/mulch cover is acceptable. (Therefore it may not be as effective on bare peat on YPP upland sites as water tables cannot be easily controlled).

(iii) Application rate for restoration of bare peat recommended by the supplier is 0.5 litres/m^2.

(iv) Applied by a backpack "blobber" (see Figure 3.16) or specially designed machine towed by Softrak (therefore, unless this equipment was available for purchase (by YPP or its contractors) YPP would have to use Micropropagation Services Limited to apply this product).

(v) In lowland areas BeadaGel™ is visible after 4-6 weeks with good coverage after 4-6 months.

(vi) YPP have not used this product extensively and are assessing its success rate on one site before rolling it out on a wider basis.

2.3.4.4. BeadaHumok™ - micro-propagated Sphagnum grown on to produce dense clumps containing many Sphagnum strands several centimetres long (See Figure 3.17). Micro-propagation Services Limited specification for this product is:

(i) Supplied ready-to-use in rolls of 20 in plastic bags of 20 rolls in returnable rigid crates (need to be planted within 7 days of delivery).

(vii) Works best in vegetated or sparsely vegetated areas (therefore YPP would use this product 1-2 years after re-vegetation). Although, if applied to bare peat a brash/mulch cover is acceptable.

(ii) Minimum application rate for restoration of bare peat recommended by the supplier is 0.25-1 plug per m^2.

(iii) Planted by hand, ideally with a dibber but can also be heeled in. Must be bedded into the peat after planting.

(iv) Should establish immediately and show significant growth within a few weeks.

(v) YPP have not used this product extensively in bare peat restoration but have had good initial results where planted into existing sparse vegetation (areas cut for brash in between blocked grips).

	Species	**%**
Base composition	*S. capillifolium* *S. papillosum* *S. palustre* *S. subnitens*	30 30 30 10
Additional species depending on conditions (adjust base composition % accordingly)	*S. inundatum** *(S. tenellum**)* *(S. magellanicum***)*	5 10 5

***bare peat only. Adjust the content of other species to accommodate it.*
****not for general use but may be worth adding in specific circumstances where it has been found on nearby moors. Adjust the content of other species to accommodate it.*

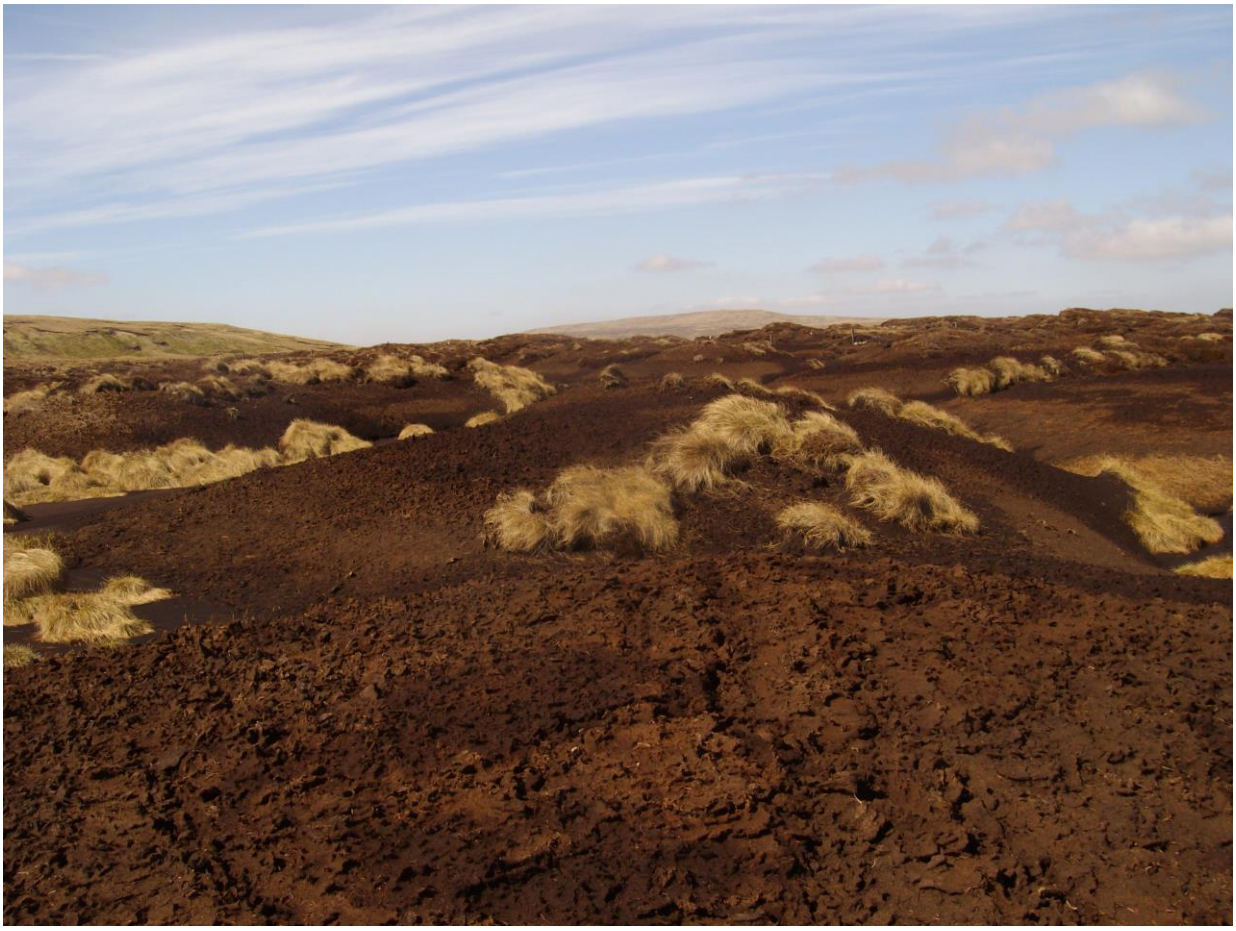
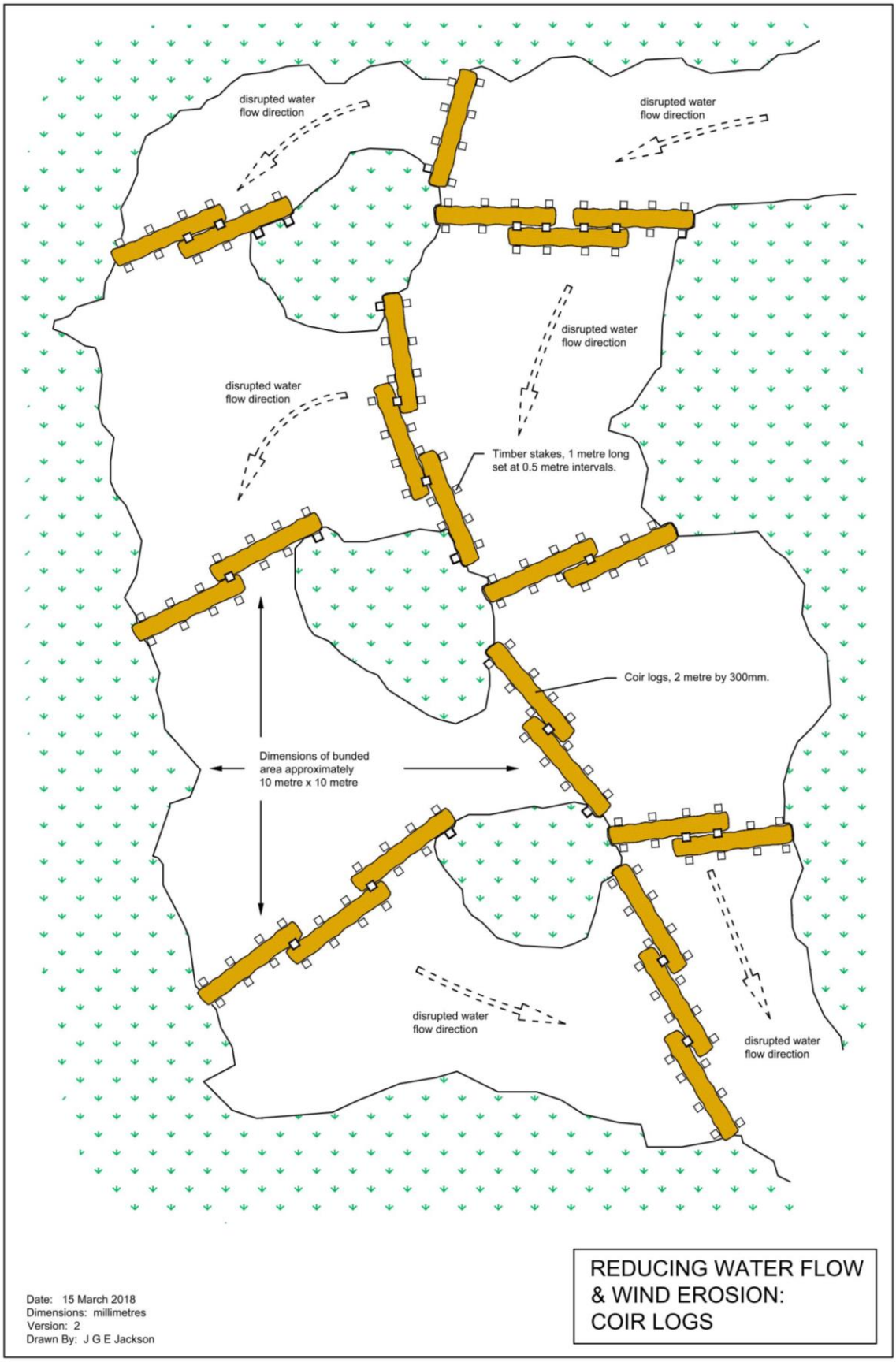


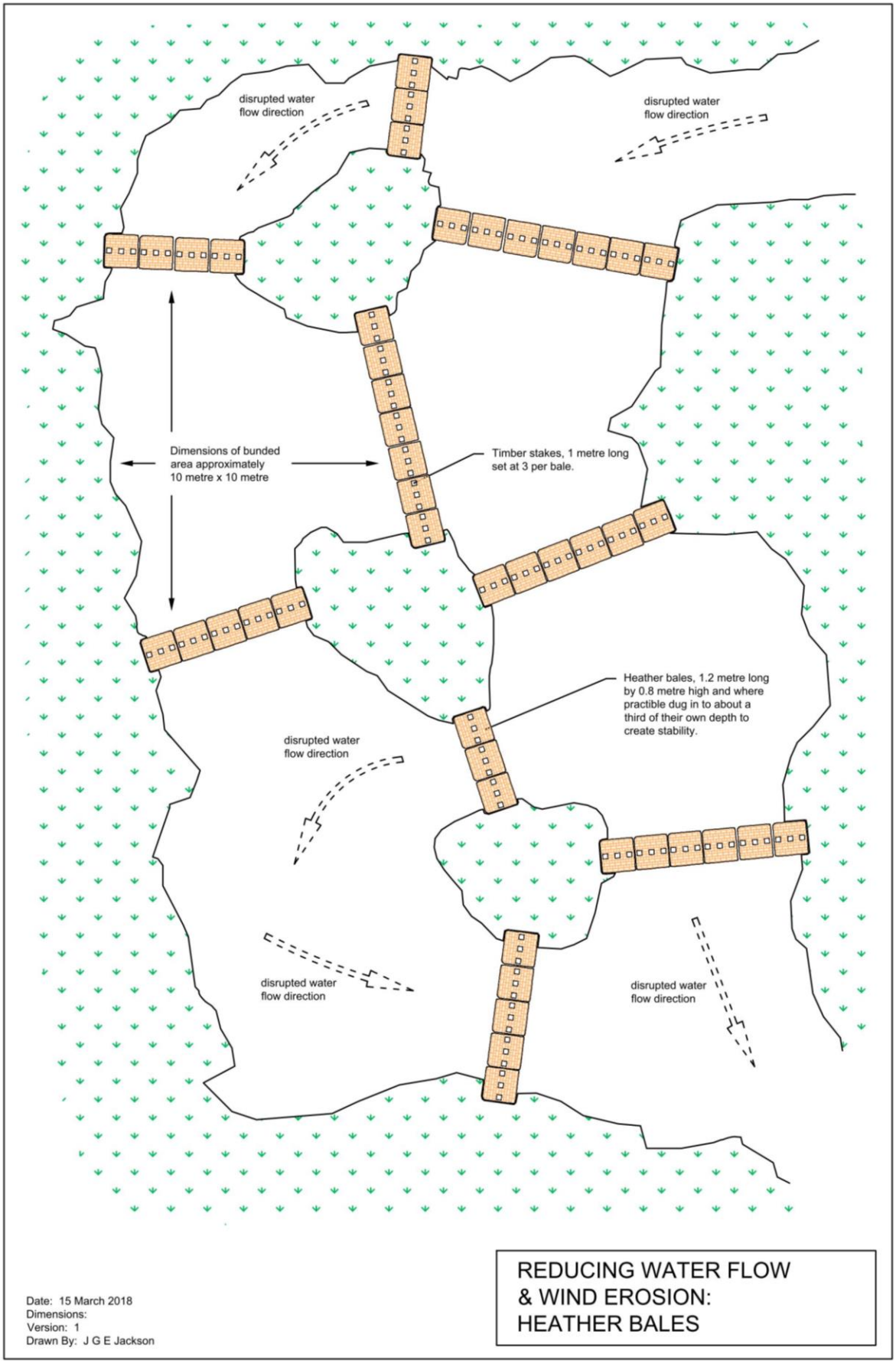
Figure 3.1. Photograph of bare peat

Figure 3.2. Photograph of micro-erosion

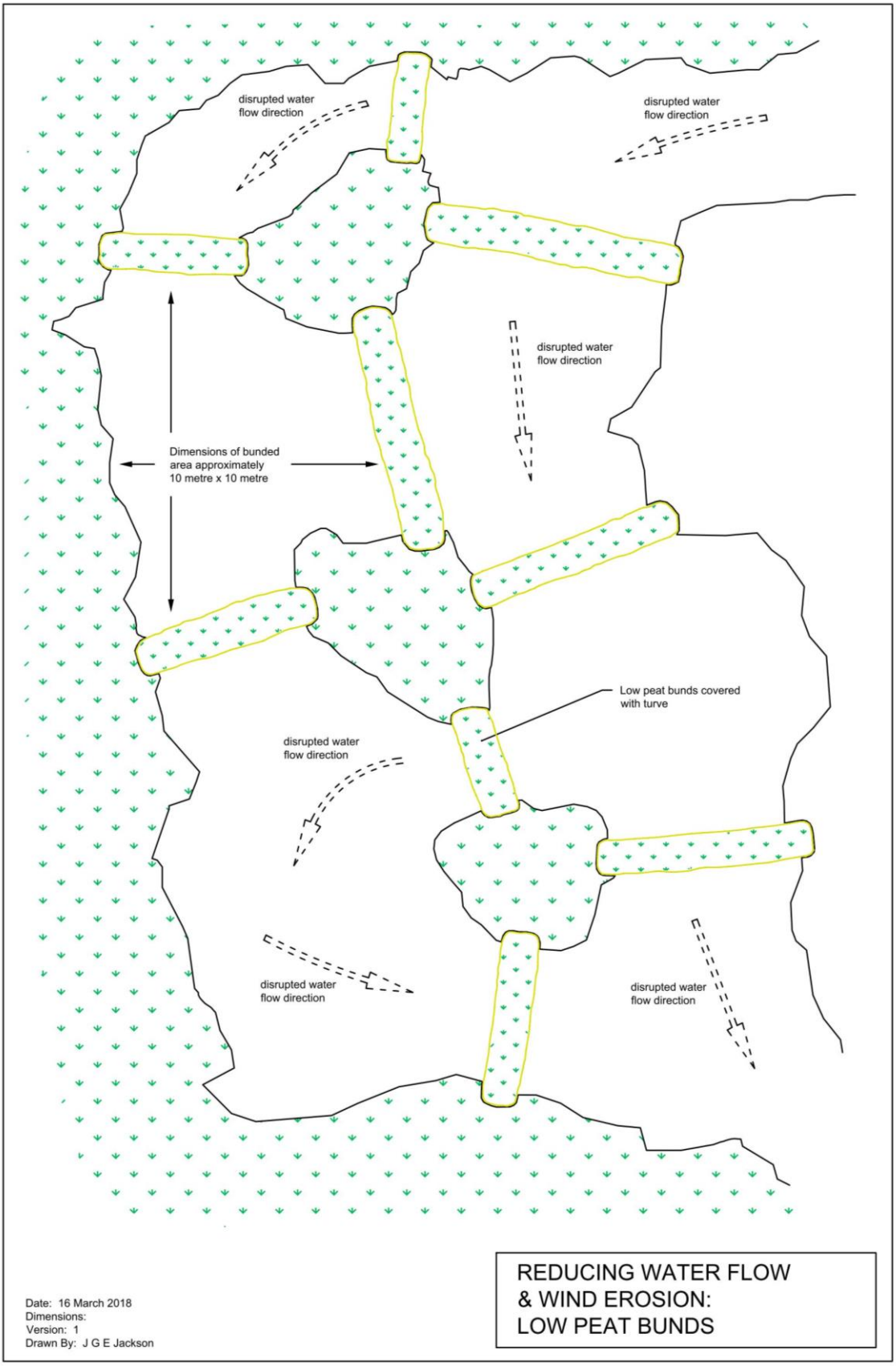
Figure 3.3 Bare peat bunding



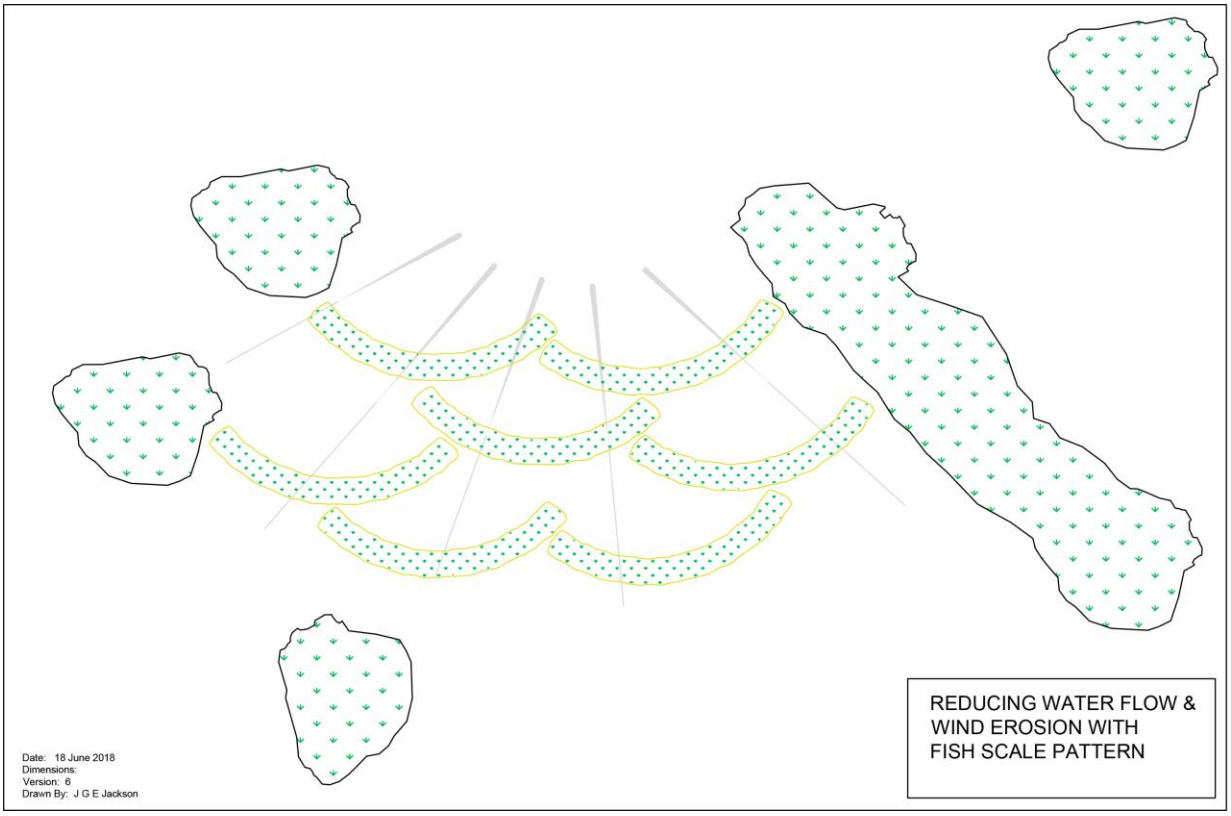
(a) Using coir logs



(b) Using heather bales



(c) Using turfed peat bunds



(d) Fish scale bunding

Figure 3.4 photo of a geo-textile

Figure 3.5 Photo of a well-brashed bare peat area

Figure 3.6 Photo of brash dumpy bag being lifted by heli

Figure 3.7 Photo of brash being spread to correct depth

Figure 3.8 Photo of lime either being applied or on the ground

Figure 3.9 Photo of germinating grass seed

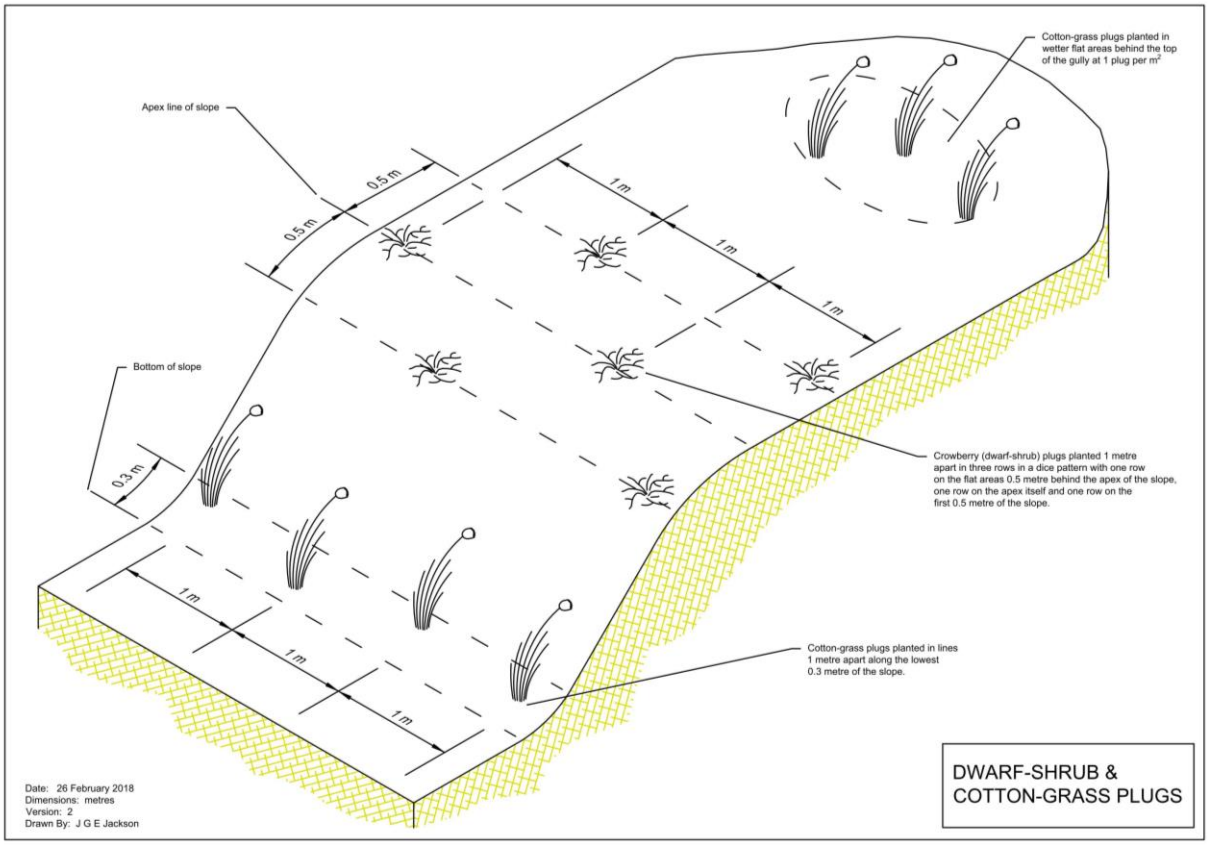


Figure 3.11 Diagram of plug-planting zones on gully sides

Figure 3.12 Photo of capitulum fragments

Figure 3.13 Photo of planted Sphagnum clumps

Figure 3.15 Photo of BeadaGel™

Figure 3.16 Photo of BeadaGel™ backpack blobber

Figure 3.17 Photo of BeadaHumok™

(a) Delivered

(b) Planted