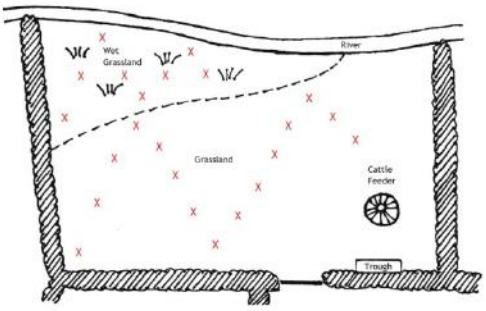
Soil Testing and Assessing Soil Texture

Assessing the nutrient status and texture of the soil is very important to determine whether the site is suitable for restoration or creation of wildflower grassland. Carrying out the soil assessment in the correct way is essential to make sure that the results are not misleading.

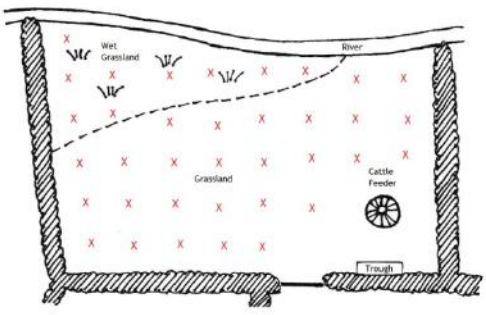
Sampling method

At least 25 samples should be taken evenly spread across the area. The sampled soil should be collected and bulked together, thoroughly mixed and sub-sampled to send approximately 500g for testing (500g is approximately the amount that fits into a jam jar). A 'w' or grid pattern should be followed for taking samples.

'W' Sampling Pattern



Grid Sampling Pattern



Sampling pattern avoiding areas that have been trampled, such as gateways or near water troughs, and areas with unusual history, including around cattle feeders. The wet and dry areas of the field are surveyed seperately.

Avoid sampling areas that have an unusual history such as places where livestock have been regularly supplementary fed, old bonfire sites, around electricity pylons or on manure heaps – these places will have very different nutrient and pH states to the rest of the field. The field margins should also be avoided as they tend to have a greater level of activity, including livestock congregating in these areas, leaf litter from hedgerows and missed or double fertiliser applications.

Take separate soil samples for discrete areas of the field such as slopes, wet areas, any historical sub-divisions that may have been managed differently and variations in soil depth and texture.

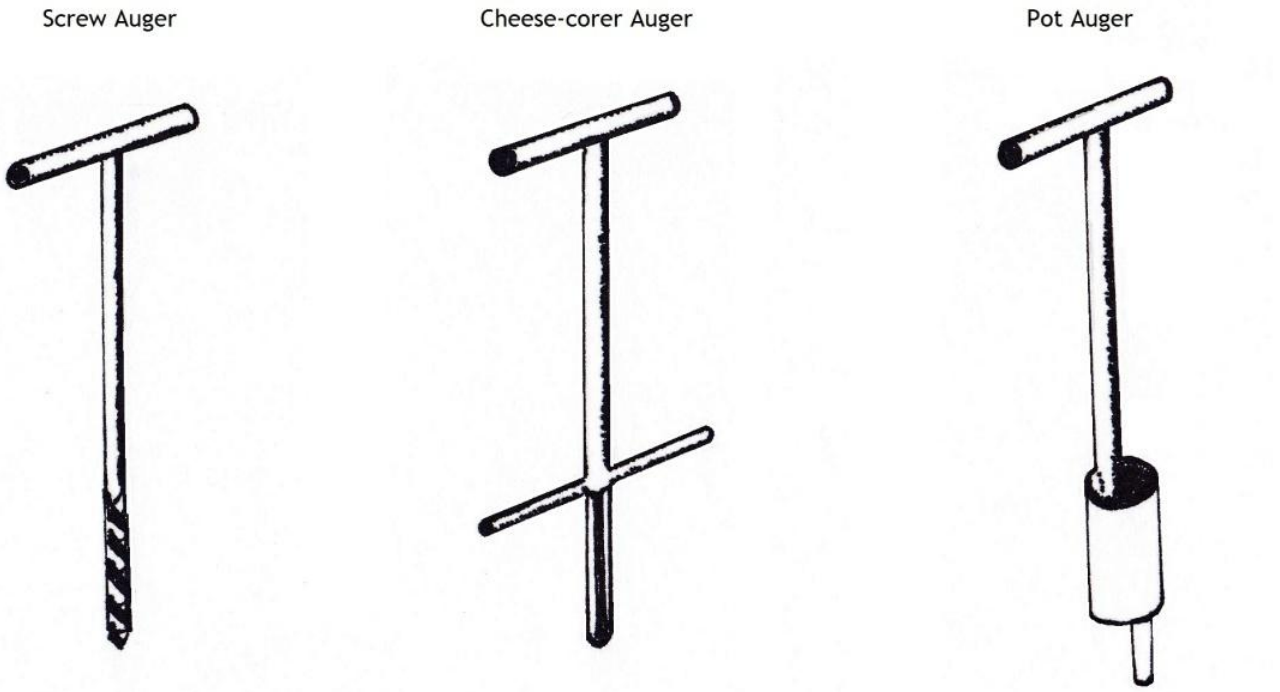
Soil sampling in February may give more reliable nitrogen results than at other periods of the year.

Do not sample within three months of an application of inorganic fertiliser, or six months of an application of lime or slurry/manure.

It is very important to use all of each soil sample, including the very top of the soil, to make sure it is representative of the whole topsoil profile. Occasionally the bottom of the sample may not be taken cleanly out of the ground or the top falls away - if this happens the sample should be discarded and another taken close by. Firming up the soil by stepping on it prior to taking the sample may prevent this from occurring. Samples from each area should be bulked together in a clean, labelled plastic bag.

Equipment

There are specialised soil augers suitable for taking soil samples. Using a trowel or spade may give misleading results as different amounts of the soil layers will be taken with each shovel of earth.



Sampling soil on arable land

Use a screw or cheese-corer auger that samples to a depth of 0–20 cm. Deeper samples may be required in fields that have been direct drilled, under minimum tillage (where the very top layer of soil has been turned over) or in a short-term ley. This type of auger is screwed into the ground and lifted out containing a soil core.

Screw or press the auger into the ground. Lift the auger out and inspect the soil core. If there are missing portions of soil, discard the sample and repeat within 1 m of the sample point. Place the sample into a labelled sample bag and move onto the next sample point and repeat.

Sampling soil in grassland

Use a pot auger that samples to a depth of 0–7.5 cm including the very top surface of the soil, but excluding any vegetation. A pot auger is a useful tool specifically for sampling the topsoil of grasslands and contains a cutting tool with a pot on top to collect the soil.

Press the pot auger into the soil until the bottom of the pot rests on the ground. Twist the auger and pull it out of the ground. Move to the next sampling point and repeat. After around six samples, collect them into a labelled sampling bag and repeat the process until all of the points are sampled.

Soil texture

Soil texture is an important consideration. The particle size has a big impact on physical soil properties such as water retention and availability, workability of the soil and nutrient retention (table 1).

Clay and silt soils have a small particle size and tend to be more water retentive. As a consequence, they retain nutrients, and are usually potassium rich, releasing the mineral continuously even without the application of this element. The soil has a smooth appearance, soapy feel and is very slightly sticky. Sandy soils, in contrast, tend to have a lower potassium level but may have a higher phosphorous. The grains of sandy soils can easily be seen, even the smaller sand particles. Other particles can affect the feel of a soil - for example, unusual mineralisation in the form of iron oxides and calcium carbonate (such as chalk particles) (table 2). A soil key to identifying the type of soil you have can be downloaded from the Floodplain Meadows Partnership.

Table 1: Soil particle size

Particle Size	Particle sub-class	Particle size (mm)
Silt		0.002 – 0.06
Clay		<0.02
Sand		0.06 – 2.0
Sand	Fine	0.06 – 0.2
	Medium	0.2 – 0.6
	Coarse	0.6 – 2.0

Table 2: Soil texture description

Particle Size	Soil Texture	Description
Small	Silty clays	Adheres to fingers and is very sticky when wet. Has a 'buttery' appearance.
	Clays	Form solid balls when wet and can be rolled into long threads. The soil smears to give a polished surface and is very sticky but does not cling to fingers. Clays do not feel smooth or soapy.
	Sandy clays	Deformation of the ball is difficult when wet and sand grains can clearly be seen on the surface. Very sticky when wet.
Large	Sandy silt loams	Mould easily due to the silt but feel gritty and soapy. The wet mixture will cling to fingers.
	Sandy loams	Feels gritty and breaks into short threads when rolled out. It will form a deformed ball when moulded together. Slightly sticky when wet.
	Loamy sands	Not sticky but will form a weak ball when wet, which collapses easily. Feels gritty but will retain a 'glistening' wet look after water has been applied.
	Sands	Feels gritty and cannot be moulded into a ball when wet, lacking cohesion. Moisture quickly disappears and the surface dries to a matt finish.

To identify the texture of the soil, take a spoonful and wet it, kneading it thoroughly until the crumbs break down and the soil balls into one mass. Enough moisture is needed for the soil to reach its maximum stickiness, and it should be rolled between fingers and thumb to detect the particle sizes.

Soil analysis

Samples should be sent to a laboratory for analysis as soon as possible. Nitrogen degrades quickly and delays may give misleading results. If soil analysis cannot be undertaken immediately, the soil samples should be stored in a cool dark environment.

The types of tests that should be applied include:

- Extractable phosphorous (using the Olsen method), potassium and magnesium quoted in milligrams/litre – this is the amount of each nutrient available for plants to use;
- total nitrogen (using the Dumas method);
- pH (in water).

Example commercial laboratories include:
Mole Valley Farmers
http://www.molevalleyfarmers.com/
Forestry Commission Soil Analysis Lab
http://www.forestry.gov.uk/fr/INFD-79MDEX
NRM www.nrm.uk.com
Eurofins http://www.eurofins.co.uk/

Phosphorous (P)

Soil phosphorous is a major plant nutrient taken up in small amounts but has a major affect on plant growth. It directly favours more competitive varieties of grasses that are better at taking-up phosphorous rather than wildflowers and it is often added as a fertiliser to make land more agriculturally productive. Most arable land and grassland that have received fertiliser inputs have a moderate phosphorous of around Index 2. Semi-natural grasslands that are flower-rich are naturally low in phosphorous (Index 0-1). Phosphorous is not soluble and does not tend to be leached from soils unless high levels are reached (an index of 5 or more).

Wet grasslands may be particularly prone to higher levels of phosphorous, which have been deposited on soil particles during raised water levels or flood events. This can significantly increase the amount of phosphorous in the soil and affect restoration and creation of wildflower grassland on land regularly inundated by water.

Nitrogen (N)

Nitrogen is particularly important for plant growth and is usually bound with organic matter in the soil. Nitrogen can be measured in several different ways, and total nitrogen expressed as a percentage is the measurement that is useful to determine whether the land is suitable for restoration or creation of wildflower grassland. Generally, older grasslands have high soil nitrogen - 1% or more - as the organic matter and fertiliser has been allowed to build-up. Soil nitrogen is considerably lower on long-term continuously-cropped arable land, although it may have been replaced using fertilisers, which will also be indicated by the higher levels of phosphorous and potassium.

Nitrogen is very mobile. It will be leached by water and taken up by plants. It can be very difficult to get an accurate measure of nitrogen. Nitrogen can be indicative of how successful restoration or recreation will be along with the level of extractable phosphorous. For example, there may be weed issues on sites with low nitrogen and high phosphorous, which can result in grassland dominated by white clover. As clover fixes atmospheric nitrogen it can aid the establishment of competitive grasses and perennial weeds such as docks, thistles and nettles. Sites with high nitrogen and low phosphorous are the most suitable for wildflower grassland restoration and creation. However, considering the difficulties in accurately measuring nitrogen, sites with low phosphorous should be selected even when nitrogen is also low.

Table 3: Phosphorous index

Index	Olsen's mg/l (dry soil)	Resin mg/l	Modified Morgan mg/l	Status	Interpretation
0	0-9	320 - 19	0.5 < 1.8	Very low	5-15mg/kg phosphorous is very suitable for the restoration or creation of wildflower grasslands.
1	10-15	20 - 30	1.8 - 4.4	Low	This range is perfect for restoration and creation of wildflower grasslands.
2	16-25	31 - 49	4.5 - 13	Moderate	Wildflowers may struggle to compete against grasses and plants that like higher levels of soil nutrients. In soils with phosphorous levels above 20mg/kg and the plants used should be considered in terms of their ability to cope in high nutrient environments.
3	26-45	50 - 85	14 - 30	High	Reducing the level of phosphorous is recommended if levels are over 25mg/kg. Methods to achieve this include growing a cereal crop (such as barley) with nitrogen added but no phosphorus if the land is arable. If the land is already under grass, take one or two years of grass cuts and then re-measure phosphorous. An early grass cut (June), followed by a second cut in August/September or several silage cuts in one year may also reduce the load. Take the cut grass away as leaving it on the ground will let it decompose and add nutrients back to the soil. Phosphorous may take a long time to reduce in heavy clay soils and more drastic methods such as removing the topsoil may be required. See soil nutrient stripping for more information.
4 - 9	46 ->290	86 - >132	>30	Very high	Values above 50mg/kg are probably too high to consider species rich grassland restoration without drastic measures such as topsoil stripping, deep ploughing or chemical amendment. See soil nutrient stripping for more information.

Table 4: Nitrogen index

Index	Arable land	Long-term grassland
Low	< 0.25%	< 0.5%
Medium	0.25 - 0.5%	0.5 - 1%
High	> 0.5%	> 1%

Potassium (K)

Soil potassium is a naturally derived element from the weathering of clay-rich minerals. Clay soils tend to have a greater amount of soil potassium compared with sandy soils. Higher levels of potassium are not as restrictive to the restoration and creation of wildflower grassland compared with phosphorous. A wider range of potassium levels are considered suitable, centred on Index 1. Many agriculturally improved grasslands and arable land have an index above 2 which does favour competitive grasses which can out-compete wildflowers restricting their growth. Soils with potassium Indexes of 0 may not produce much herbage, and future management may need to include the application of fertiliser (usually in the form of well-rotted farm-yard manure) to maintain levels of potassium.

Magnesium (Mg)

Magnesium is essential for animal health. It is inversely related to potassium levels, with high potassium depressing magnesium and vice versa. Magnesium can be supplemented through water or forage/mineral licks for livestock, or through the application of magnesium lime.

pH

Many soils are more acidic than calcareous except those on chalk, limestone, calcareous bolder clays and sands derived from seashells. Even in these situations, there may be overlying acidic topsoil, which can create conditions for special communities of plants such as limestone heath - a mixture of calcareous grassland and acidic heathland species mixed together. Lime is often spread on agricultural land to neutralise the acidity to a pH of 6-6.5, which is the optimum for plant growth and soil organisms. Low soil pH (acid) enables magnesium to become mobile, limiting plant growth and causing a special type of calaminarian grassland to develop, which is can be associated with mining activities. pH may also vary according to the depth of soil, and may be more acidic at the bottom of slopes on deeper earth, making the ground more neutral.

Interpretation of the results

A phosphorous Index of 0 or 1 is required to restore or create wildflower grassland. It is not advised to undertake wildflower grassland restoration or recreation if the index is higher than 3. If the phosphorous index is 2-3 there is the possibility of stripping soil nutrients through management that may create suitable conditions for restoration or creation, or the use of a reduced suite of wildflowers that may be able to compete with the grasses and nutrient-lowing flowers.

Low phosphorous should be prioritised over low nitrogen as it may be difficult to get an accurate measure of nitrogen. However, if nitrogen is high, it can be reduced to create suitable conditions for wildflower grassland restoration or creation.

Potassium levels at Index 1 are recommended for grassland restoration or recreation and clay soils may have higher potassium levels. Low potassium levels in sandy soils may mean that it needs to be added in the future to support plant growth.

Magnesium can be supplied for livestock in their food and water and is not a restrictive factor for wildflower grassland restoration or recreation. However, it is a factor to consider in regards to the future management of the grassland.

Suitable seed sources should be based on the soil pH as plants differ according to soil alkalinity and acidity. Choosing the wrong seed sources and plants for the soil pH will affect the success of the restoration or recreation. A small group of wildflowers that can tolerate slightly higher nutrient levels could be used if soil nutrients cannot be stripped. Alternatively, an initial seeding using yellow rattle may help open-up the grass sward, enabling the addition of other wildflowers in the future.

Table 5: Potassium index

Index	Ammonium nitrate mg/l (dry soil)	Modified Morgan mg/l	Status	Interpretation
0	0-60	<40	Very low	This level of potassium is very low resulting in low herbage yields. Replacement of this essential nutrient may be required in future management.
1	61-120	40-75	Low	This range is perfect for restoration and creation of wildflower grasslands.
2-	121-180	76-200	Moderate	Wildflowers may struggle to compete with more competitive grasses and weeds in soils with higher potassium level.
2+	181-240			
3	241-400	201-400	High	As potassium is very soluble, the nutrient may be leached out of soils. However, in clay-based soils this may be difficult to achieve. Other restoration work to counteract the effects of high phosphorous and nitrogen may also lead to a decrease in potassium and soil tests should be undertaken to determine potassium levels.
4-8	401-3600	>400	Very High	

Table 6: Magnesium index

Index	Mg/l
0	0-25
1	26-50
2	51-100
3	101-175

Table 7: pH

pH range	Description
< 5	Acid
5 – 5.4	Acid – Neutral
5 – 6.5	Neutral (mesotrophic)
> 6.5	Calcareous

Adapted from Natural England's TIN 035 Soil sampling for habitat recreation and restoration, TIN 036 Soil and agri-environment schemes: interpretation of soil analysis and TIN 037 Soil texture. Please see these documents for further guidance.