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The Institute of Quarrying

Good Practice Guide for Handling Soils in Mineral Workings

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

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The information in this publication is general guidance on the best practices and approaches to soils guidance.
Specialist advice should always be sought if you need more details about what action to take in your own circumstances.

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GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Methodology

- Sheet A -

Soil Stripping with Excavators and Dump Trucks – Sequential Bed/Strip Practice

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Preface

The purpose of Sheet A of the updated guidance is to provide a model method of best practice where excavators and dump trucks are to be used to strip soil using the sequential 'bed'/strip by strip practice.

The guidance is intended for use by planning officials, statutory consultees, mineral operators and their supporting teams and specialist consultants, and earth-moving contractors, their site supervisors and machine operators.

Successful soil handling schemes are dependent on the soil resources being clearly identified and the conditions in which they are to be handled. This information should be contained in the Soil Resource & Management Plan (SRMP) and communicated to those involved in its implementation.

Key issues to be addressed are:

i) Avoiding conditions when soils are wet/ plastic during handling
ii) The minimisation of soil compaction caused by trafficking and soil wetness
iii) Using appropriate remedial treatments where these are necessary
iv) Minimising soil loss, and mixing of soil layers or different soil types.

The SRMP should specify the type of earth-moving machinery and soil handling practice, and the soil wetness condition (see Part One of the Guidance) to be deployed to achieve the planned after use, soil functioning, and the environmental and ecosystem services. It is to be communicated in full to all involved and in particular to the supervisors and machine operators by appropriate means; including tool-box talks and site demonstrations. Supervision by trained supervisory staff is essential, as are monitoring and reporting.

The guidance does not specify the size or model of equipment as this is left to the mineral operator and contractor to specify and provide. The machines must be of a kind which are appropriate for the task and the outcomes required, and to be able to carry out the work safely and efficiently.

Should the agreed methodology need to be modified or changed significantly, this should be agreed in advance with the mineral planning authority. The SRMP should include a mechanism whereby unexpected less significant changes can be quickly resolved through consultation between the operator, the planning authority and statutory consultee, and soil specialist.

All persons involved in the handling of soils must comply with all relevant legislation with respect to Health and Safety, in particular the Health and Safety at work Act 1974, and in the case of mineral extraction operations, The Quarries Regulations 1999 and its relevant statutory provisions; in particular those aspects which relate to the construction and removal of tips, mounds and similar structures. These requirements take preference over any suggested practice in this Sheet and the SRMP should have taken these into account.

The users of this guidance are solely responsible for ensuring it complies with all safety legislation and good practice, including the manufacturer's specifications for the safe operation of the specific machines being used, and that all machines are in a good condition and well maintained and are suitable for the task. It is important that those involved in the operation of earth moving machines are competent and have the necessary training and certification.

Introduction

In this soil handling option, back-acting excavators are used to lift the soil resources and load them into dump trucks for the direct transport to the area being restored or to storage until needed.

The stripping practice involves the sequential separation and removal of the individual layers of soil identified in the Soil Resource & Management Plan (SRMP). It takes the form of advancing vertical slices through the soil profile as successive strips across the soil being removed. Hence the practice is often referred to as the 'Strip' or 'Bed' method.

The upper layer (topsoil) in the strip being removed is lifted first within the safe and efficient operational reach of the excavator boom (which defines the width of each strip). For each subsequent soil layer, if it is to be recovered, the process is repeated until the basal layer (usually overburden or the economic mineral layer) is reached. When the soil resource/ profile sequence within the strip is completely removed, the process is repeated on the abutting area to be stripped of soil. The method can also be adopted where only a single soil horizon is to be recovered.

Normally the excavator operates only from on the soil surface with the dump trucks travelling on the exposed lower non-soil layer. This the preferred operating mode of the excavator as there is a better recovery of the particular soil layer on handling. In some circumstances, such as where, i) the topsoil/ surface layer has a particularly low baring capacity and is prone to compaction (such as peat or organic soils), ii) a thin soil layer lies directly on the mineral layer, or iii) access is limited from the bottom of steep gradients, the excavator will need to operate from the exposed 'basal' mineral/overburden layer or a raised access strip.

Similarly, the normal operation of the dump trucks is on the exposed non-soil basal/overburden layer. In cases where the soil horizon has i) a particularly low baring capacity or ii) where there needs to be enhanced protection of potential archaeological features, the dump trucks may have to operate upon the topsoil which may have to be surcharged.

Advantages & Disadvantages

The advantages of this machinery combination and handling practice are:

i) When the excavator operates only from on the soil surface, compaction is largely confined to the top-soil (which is ultimately more easily treated) and potentially reducing the risk of severe compaction of the subsurface soil layers where the soil is to be directly placed without storage
ii) It is easier to see and react to localised changes in soil types and variation in horizon depth
iii) It is suited to the stripping of thin and 'patterned' soil layers
iv) It offers the most flexibility in respect of short soil drying periods and likely wet weather as it is less susceptible to stoppages due to soil rewetting as a transpiring vegetation cover can be retained later into the stripping programme. It is particularly suited to northerly and western, and upland locations, and particularly when there are uncertain weather patterns.

The disadvantages are:

i) It requires skill and discipline in its deployment, and a high level of supervision, being suited to experienced operators
ii) Without care the bed system may result in a greater mixing of soil horizons
iii) Steep gradient/complex topographies may limit the safe and practical deployment of this machinery combination and handling practice.

Suitability

The excavator-dump truck combination with the bed/ strip handling practice methodology is considered as 'best practice' by Natural England and the Welsh Government for agricultural soils and preferred for all soils. In particular, it is the most suitable of any of the methods available where:

i) The soil is prone to compaction and where decompaction treatments cannot be relied upon to be effective (this incudes peat)
ii) The intended after use, environmental and ecosystem services are dependent on

maintaining (as far as it is possible) the soil functional characteristics such as, porosity and hence drainage and aeration, plant available water capacity, and low resistance to plant root growth. This includes productive agricultural, horticultural and forestry land, but also some natural habitats, and where water storage/infiltration is of importance for risk of flooding. Where the soils are stored prior to replacement some remedial treatment may have to be relied upon.

ii) The bed/strip soil handling method is not suitable where an archaeological surface needs to be investigated as a whole. Subject to approval by the planning authority the method can be used with care where there is a 'watching brief' by an archaeologist, but may have to be abandoned for another approach where important artefacts are detected. However, trafficking may be restricted to the topsoil surface until the subsoil has been approved for removal and taken away.

iii) The placement of the stripped soils into stockpiles is likely to result in compression and compaction and may negate this particular benefit of the handling practice.

iv) As the benefit of the practice lies in the direct placement of the stripped soil it calls for the mineral extraction scheme to be organized to minimize the need for soils storage.

MODEL METHODOLOGY

A.1 Key operational points to minimise the risk of severe soil compaction and wet soil conditions are summarised in Boxes A.1 and A.2.

A.2 The timing of soil handling operations should only take place when the soils are in a 'dry and friable' condition (ie when it breaks and shatters when disturbed rather than smears and deforms) (see **Part One, Supplementary Note 4**). Prior to the start or recommencement of soil handling, they should be tested to confirm they are in suitably dry condition (see Box A.3).

Box A.1 - to minimise compaction:

- The dump trucks should normally only operate on the 'basal'/non-soil layer, and their wheels must not run on to the soil layer/s
- The excavator should normally operate on the topsoil layer
- The adoption of a bed/strip system avoids the need for the trucks to travel on the soil layers
- The machines are to only work when ground conditions enable their efficient operation
- Soils are to be in a 'dry' condition.

Box A.2 - to minimise soil wetness and re-wetting:

- The bed/strip system provides a basis to regulate the exposure of lower soil layers to periods of rain and a means of maintaining soil moisture contents The soil profile within the active strip should be stripped to the basal layer before rainfall occurs and before stripping is suspended
- Measures are required to protect the face of the soil layer from ponding of water and maintain the basal layer in a condition capable of supporting dump trucks
- The area to be stripped is to be protected from in-flow of water, ponding etc. Wet sites should be drained in advance
- The maintenance of a transpiting crop is important, and an appropriate cropping regime should be established for the year of soil stripping
- Before stripping, excess vegetation should be removed; in the case of grassland it should be cut or grazed short and arable crops should have been harvested.

A.3 Soil handling is not to take place during rain, sleet or snow and in these conditions should be prohibited due to unsafe machine operating conditions. Prior to commencing operations, a medium/long term weather forecast should be obtained which gives reasonable confidence of soil handling being completed without significant

Box A.3 - Test for Dry and Friable Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations on the soil handling area and at each soil horizon to the full depth of the profile to be recovered/replaced. The tests shall include visual examination of the soil and physical assessment of soil consistency.

i) Examination

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place**
- If the sample is moist (i.e. there is a slight dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place**

ii) Consistency

First Test

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means soil handling can take place
- Impossible because the soil is too loose and wet means no soil handling to take place
- Possible - GO TO SECOND TEST

Second Test

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossibe because soil crumbles or collapses means **soil handling can take place**
- Possible means **no soil handling to take place**

NB: It is impossible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

Box A.4 - Rainfall Criteria:

- In light drizzle soil handling many continue for up to four hours unless the soils are already at/ near to their moisture limit
- In light rain soil handling must cease after 15 minutes
- In heavy rain and intense showers, handling shall cease immediately

In all of the above, after rain has ceased, soil tests shall be applied to determine whether handling may re-start, provided that ground conditions are safe to do so.

interruptions from rainfall events. The soil based criteria set out in Box A.4 are to be used to determine whether soil handling should cease or be interrupted with the occurrence of rain.

A.4 All machines must be in a safe and efficient working condition at all times. The machines are to only work when ground conditions enable safe and efficient operation. Otherwise the operation is to be suspended until suitable remedial measures can be put in place.

A.5 The operation should follow the detailed stripping plan set out in the SRMP showing soil units to be stripped, haul routes and the phasing of vehicle movements. The different soil units to be kept separate are to be marked out and information to distinguish types and layers, and ranges of thickness needs to be conveyed to the operational supervisor/operator. The haul routes and soil storage areas must be defined and should be stripped first in a similar manner. Detailed daily records should be kept of operations undertaken, and site and soil conditions.

A.6 Within each soil unit the soil layers above the base/formation layer are to be stripped in sequential strips with the topsoil layer stripped first, followed by the subsoil layers; each layer stripped to its natural thickness without incorporating material from the lower layers. The next strip is not started until the current strip is completely stripped to the basal layer. The system involves the progressive stripping of the soil in strips (**Figure A.1**).

Box A.5

In doing so, compaction by the excavator is largely restricted to the upper layer of soil, which is more easily treated after the soil has been relaid. The degree of topsoil compaction will depend on the machine's ground pressure, its mode of operation and soil wetness. Smaller wide tracked excavators may cause less compaction.

Box A.6

For hard/stony soils toothed buckets are needed. Where the mixing of soil layers at their interface is to be minimized, a bucket with a 'blade' is preferable where the soil is 'soft' and free of large stones or stone free. Where there is a watching archaeological brief, the use of bladed buckets will normally be required.

Similarly the choice of bucket type, whether it is a standard 'digging'/bulking or wide ditchingtype will depend on the soil strength and stoniness.

A.7 Unless specified in the SRMP, the excavator is only to work on the topsoil layer and the dump trucks are only to travel on the basal/formation layer (Box A.5).

A.8 Stripping is to be undertaken by the excavator standing on the surface of the topsoil and digging the topsoil to its maximum depth, and it loading into dump trucks. The dump trucks draw alongside the exposed soil profile, standing and travelling only on the basal layer (**Figure A.2**). The type of bucket to be used largely depends on the nature of the soil (Box A.6).

A.9 The initial strip width and axis should be demarcated. The strip width is determined by the length of the excavator boom less the stand-off to safely operate; typically, about 3-4m (Box A7). Excavators with long booms ('long reach') can be used, but may be more restricted by gradient limitations, and require skilled and experienced operators.

A.10 Topsoil should be recovered to the full width of the strip without mixing with the underlying subsoil (not more than 20% of the lower horizon should be exposed at the layer junction within the strip). The thickness and identification of the horizon junction must be verified before and during stripping. The full thickness of the topsoil horizon should be stripped progressively along the strip before the underlying subsoil horizon(s), if present, is to be started (**Figure A.2**).

A.11 The (upper) subsoil in the current strip is then to be stripped and monitored in the same manner. The final 25cm of the subsoil layer should be left as a step to protect the adjacent topsoil layer from local collapses. On completion, the process is to be repeated if there is a lower subsoil, and then any other lower layer to be recovered as a soil material (**Figure A.3**).

Box A.7 - Orientation of the Excavator

Usually the excavator is orientated and operates with its tracks at 90^{O} to the axis of the bed being stripped as this is the most stable position.

Whilst the reach of the boom and hence the width of the bed/strip can be significantly increased and the excavator traffickiing over the soil surface decreased by orientating it with the tracks parallel to the soil being stripped, this may affect the stability of the excavator, particularly on a gradient or where soils have a low bearing capacity. Hence its safe deployment needs to be checked before its adoption.

A.12 On completion of the strip, the procedures are repeated sequentially for each subsequent strip until the soil to be stripped is completely removed.

A.13 Where the soils are to be directly replaced (without storage in mounds), the initial strip of the upper horizons will have to be stored temporarily to

release the lowest layer and enable the sequential movement of materials. The stored initial soil material would normally be placed on the lower layer removed from the final strip at the end of the programme or on partially completed profiles if rain interrupted the operation.

A.14 Where the stripping operation is likely to be interrupted by rain, or there is likely to be over-night rain, remove any exposed subsoil down to the basal layer before suspending operations. Make provisions to protect base of current or next strip from ponding/runoff by sumps and grips, and also clean and level the basal layer. At the start of each day ensure there is no ponding in the current strip or operating areas, and the basal layer is to level with no ruts.

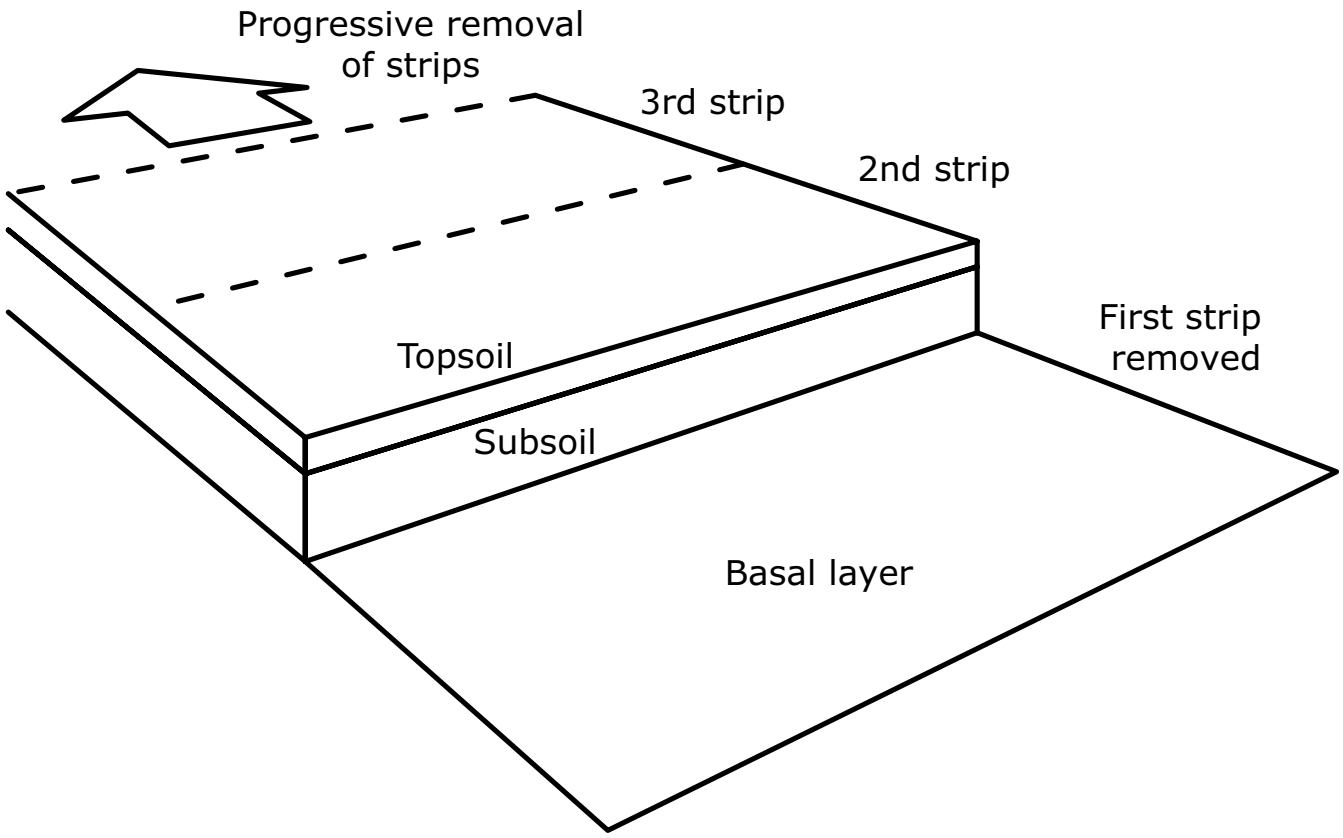

Figure A.1: Soil stripping with excavators and dump trucks: The bed system.

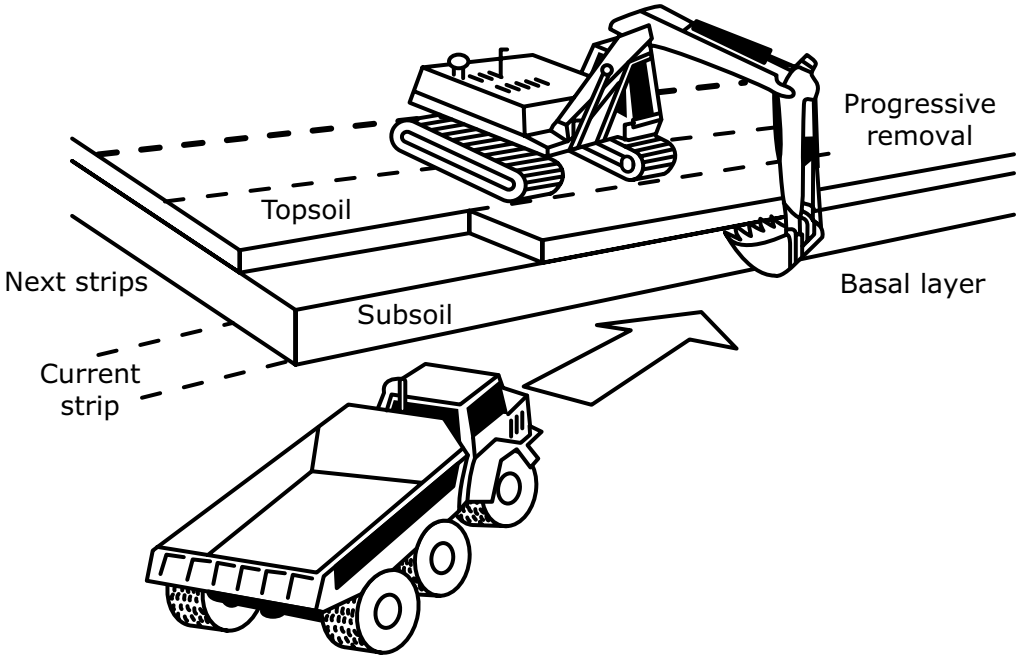

Figure A.2: Stripping with excavators and dump trucks: removal of topsoil from a strip.

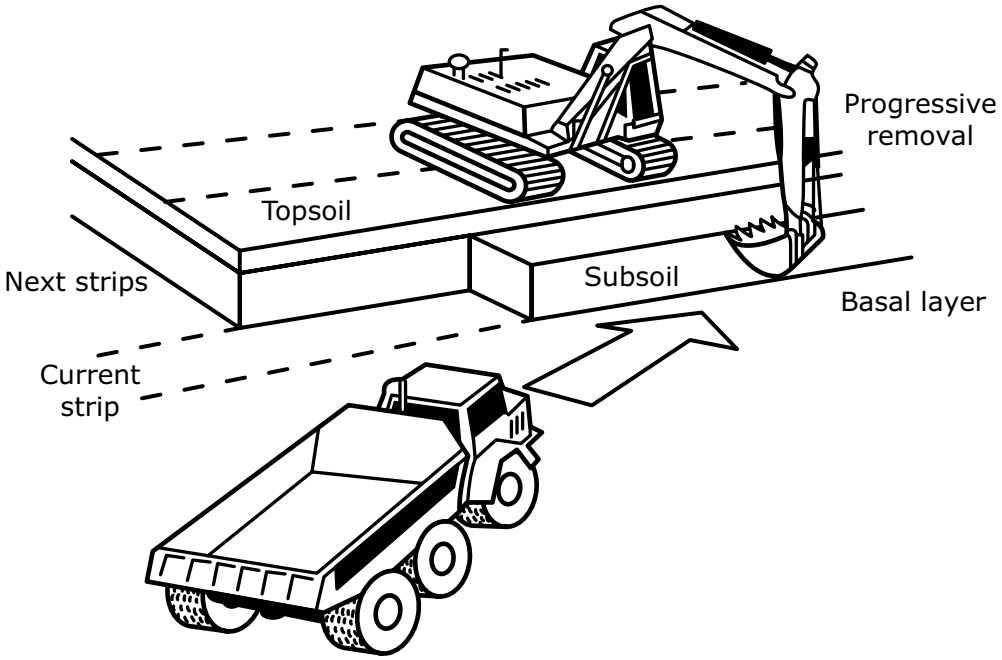

Figure A.3: Stripping with excavators and dump trucks: removal of subsoil from a strip.