



The Institute
of Quarrying



Good Practice Guide for Handling Soils in Mineral Workings

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

Published in the UK by:

The Institute of Quarrying

McPherson House
8a Regan Way
Chetwynd Business Park
Chilwell,
Nottingham
NG9 6RZ

www.quarrying.org

© 2021 The Institute of Quarrying

All rights reserved. No portion of this publication may be reproduced, stored in a retrieval system or transmitted at any time or by any means mechanical, electronic, photocopying, recording or otherwise without prior, written permission of the publisher.

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.

First Edition published 2021.

For over 100 years the Institute of Quarrying has been supporting people working in the mineral extraction industry. It is the only international professional body for quarrying, construction materials and the related extractive and processing industries. IQ's focus is to be the global leader in standards for the sector, to push innovation and operational best practice, to support the industry in driving healthy, sustainable workplaces and to promote the positive impact of the industry and profession. Being a member of IQ means being part of a global community of industry professionals committed to sharing knowledge and improving industry standards.

GOOD PRACTICE GUIDE FOR HANDLING SOILS

In Mineral Workings

PART TWO: Model Methodology

- Sheet M -

Release of Stones and Non-Soil Debris
by Bulldozer Drawn Tines

Author: Dr R N Humphries CBiol CSci FRSB FBSSS FIQ
- Blakemere Consultants Ltd & Celtic Energy Ltd

Supporting artwork was provided by R Shelton (H J Banks & Co)
and D Fisher (Blue Room Graphics Ltd).

Preface

The purpose of Sheet M of the guidance is to provide a model method of best practice where bulldozer drawn tines are to be used to release stones and non-soil debris from replaced soils and the basal layer.

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

The purpose of this Guidance Sheet is to provide a model method for best practice where stones and/or non-soil debris (e.g. wire rope, concrete blocks) are to be released using bulldozer drawn tines from the basal layer and/or soils during replacement. The methodology can be deployed in combination with the machinery and practices presented in Sheets D, H, J and K.

Advantages & Disadvantages

The advantages are:

- i) It is an efficient means of removal of damaging materials
- ii) It is quick to deploy
- iii) It can be an effective means of decompaction (if it follows **Sheet O**).

The disadvantages are:

- i) The method requires excavators to load the collected stones/materials and to gather released stones the deployment
- ii) The need for excavators and dump trucks add another level of complexity and discipline needed in the soil replacement procedure
- iii) Ripping with tines is not an efficient means of releasing buried stones at depth (the tines tend to push them aside)
- iv) Effective release of stones from clayey soils is dependent on the soils being in a sufficiently 'dry' condition
- v) The depth of release of damaging material will be dependent on the effective length of the 'tines' (see **Sheet O**)
- vi) The size of stones dislodged is limited to the spacing of the 'tines' and pattern of ripping (see **Sheet O**)
- vii) There is a risk the removal of stones with dump trucks will result in the recompaction where trafficking the soil layers.

Suitability

The occurrence of large hard stones and non-soil debris can affect the agricultural potential of the restoration through interfering with/preventing cultivations and installation of underdrainage.

The SRMP will have specified the need and particular requirements, within the soil replacement procedures. The bulldozer drawn tines practice is the most commonly used method to release large stones/damaging materials for a wide range of after uses and ecosystem services where the content is to be reduced. It can be deployed on steep and complex landforms.

Alternative methods to that described below can be considered. For example, there is often a preference to use agricultural tractor drawn stone rakes for the topsoil. There may be circumstances that it is economically viable to use soil screens to remove large stones and debris, particularly when the soils have been stockpiled.

Many former mineral workings have been backfilled with inert waste. Remedial treatments of the infill, by digging or ripping, may not be advisable where these are not to be part of the replaced soil profile and this should be covered in the SRMP. The treatment of former silt lagoons needs careful consideration and consultation with a geotechnical specialist where there is a possibility of breaking through the dewatered and stabilised upper material into the saturated underlying lower material.

MODEL METHODOLOGY

The Release & Removal Operation

M.1 The key operational points to minimise the risk of severe soil compaction and soil wetness are summarised in Boxes M.1 and M.2.

Box M.1 - To minimize compaction:

- Wherever possible the bulldozer, excavator and dump trucks receiving the released stones/damaging material to operate on the basal layer
- The bulldozer used to release the stones/non-soil debris is only to work when soil conditions enable efficient operation
- If compaction is caused, then measures are required to treat it (see **Sheets N & O**)
- The operation should only be carried out when the soils are in a 'dry' condition.

Box M.2

- The soil profile within the active strip should be completed to the topsoil layer before rainfall occurs and before replacement 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.

M.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 M.3).

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

M.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.

M.5 The operation should follow the detailed replacement plan set out in the SRMP showing soil units to be replaced, haul routes and the phasing of vehicle movements. 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

Box M.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:

- Impossible 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 M.4 - Rainfall Criteria:

- In light drizzle soil handling may 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 restart, provided that the ground is free from ponding and ground conditions are safe to do so.

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.

M.6 The excavator and dump trucks used to collect and dispose of the material, are to stand, work and travel on the soil or basal/formation layer according to the SMP and soil replacement practice being used (i.e. **Sheets D, H, J & K**).

M.7 Ripping with bulldozer drawn tines can be used to release large stones (typically >150mm) and damaging materials (wire rope, tree roots, drums, concrete lintels etc) from the replaced soils and basal/formation layers. Where the stones to be removed are less than 150mm, but greater than 20mm, a specialist stone-rake or stone picking machine will have to be used. The use of the latter equipment is generally only applicable to the topsoil layer. The removal of these smaller stones should be part of the cultivation phase for cropping and is outside the scope of this guidance.

M.8 Where large stones and non-soil debris are damaging to aftercare operations (e.g. cultivations, underdrainage installation) they are to be removed, the equipment and practices set out here (Figure M.1) can be used and integrated into the procedures listed in **Sheets D, H, J and K**.

M.9 On completion of each soil layer or as required by the SRMP), and prior to the replacement of the

next layer the surface (as a strip/layer) available according to the handling methodology being used (see **Sheets D, H, J & K**), the area to be treated is ripped (**Figure M.1**) and where necessary with overlapping passes (**Figure O.4, Sheet O**). Generally, effective release is only achieved from the 300mm of the soil/basal layer (i.e. the height of the 'heave' above the pre-ripped ground surface caused by the ripping tool).

M.10 Bulldozers with closely spaced (0.3-0.5 m) 'stub' tines (400 mm from tip to tool bar base) are often more effective in releasing stones than deep ripping equipment designed to alleviate severe compaction at depth. Where non-soil debris is to be removed, straight legged tines without wings (see **Sheet O.2**) are the most suitable equipment; particularly in the case of basal/formation materials. Alternatively, high powered rubber-tyre tractors pulling heavy duty multi-tine cultivators can be used (depending on soil texture and moisture content).

M.11 Traditionally, large (>150 mm) stones released are collected by hand and loaded into tractor-drawn trailers travelling and standing on the soil/basal layer. Where there is a quantity of stone to be removed, the excavator with stone-rakes methodology may have to be deployed (see Sheet L) thereby, possibly negating the need of this methodology using tines.

M.12 The tines are used to release and lift non-soil debris to the surface and drag them to the edge of the strip for collection and disposal. Any equipment/machinery used for the latter is only to travel and stand on the basal/formation layer.

M.13 Where the soil is a very fine texture (clayey) and has a relatively high moisture content, it can be difficult to break down soil clods and release the stones. In these circumstances the soil layer being treated may require cultivation with a bulldozer/tractor drawn heavy duty discs slightly offset to run along the axis of travel.

M.14 Stone removal from the topsoil layer can be delayed until the whole area has been restored. A shallower ripping (300mm) and/or discing with heavy duty disc cultivators of the topsoil will be needed to

release the stone followed by removal of the stones by a specialist stone removal machine. If they are only few and large stones, these may be hand-picked and loaded into a tractor drawn trailer. If this option is adopted, trafficking of the topsoil layer will take place during the collection of the stones and remedial treatment of the recompaction will be required.

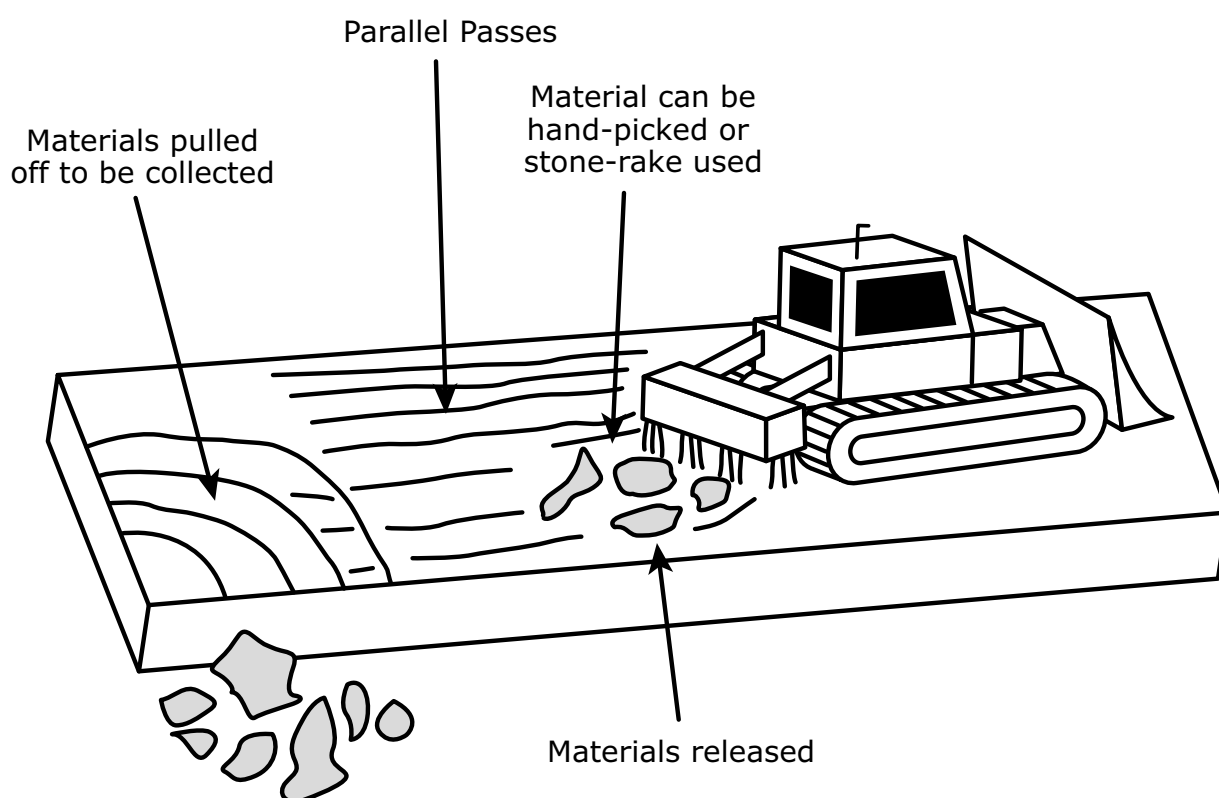


Figure M.1 Ripping with tines to release large stones and damaging materials.

