| Eskom Transmission | **Guideline** | **Document Classification : PUBLIC** |
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Title: **EROSION GUIDELINE**

Reference: **TGL41-337**

Revision: **0**

Effective date: **November 2006**

Total pages: **1 Of 13**

Revision date: **November 2009**

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| DATE: 30/11/06 | DATE: 30-11-2006 | DATE: 30/11/06 |

## Content

## 1. Introduction

Soil erosion is a problem that could be labelled as one of the more serious environmental problems that South Africa faces. The production of fertile topsoil that will support good plant growth and prevent soil erosion is an extremely slow process. Van Heerden (2000) states that it takes between 12 to 40 years to produce one millimetre of topsoil whilst the loss due to soil erosion is estimated at 0.7 ton per hectare per year.

Soil erosion is a natural process resulting from the dynamic character of the earth. Of the three natural patterns that dominate the earth, namely climate, vegetation and soil, climate is perceived as the principle component shaping the other two (Schultze, 1997). Periodic droughts that destroy plants and subsequent heavy rains lead to soil erosion. But poor farming practices, mechanical exposure of soils and the building of poorly planned roads that are the most important causes of soil erosion (Van Heerden, 2000). He further states that the importance of plants in the prevention of soil erosion cannot be over emphasized.

This document does not discuss specific remedies but looks rather at erosion as it pertains to overhead lines and the problems caused by erosion. Proper remedies will have to be planned and implemented by experts.

## 2. The threat of soil erosion in the servitude.

Erosion may affect a transmission line in the following three ways:

- In the first case, erosion in the vicinity of the tower could threaten its structural integrity. Failure to remedy the situation may lead to the collapse of the tower and line.

**Figure 1:** The photo on the left shows the foundation of a tower exposed by erosion. The photo on the right shows the extensive and costly remediation by using gabions and reno matresses. Also note the use of good topsoil that will permit the re-establishment of vegetation around the tower (photos Jorge Correia).

- Secondly, erosion in the area between towers may not threaten the towers directly or initially, but will prevent access for maintenance or emergency repair purposes.


**Figure 2**. Examples of erosion in the servitude, which hampers access during maintenance and emergencies.

- Thirdly, the causing of erosion is a contravention of the Conservation of Agricultural Resources Act No. 43 of 1983. This stands in the face of Transmission's ISO14000 certification and environmental policy. It further leads to poor relations with landowners.

## 3. Soil erosion and the life cycle of the servitude

During the construction phase of a power line, the impacts of vegetation clearing and the formation of roads for large vehicles has probably the most profound effect on erosion, if the necessary care is not taken.


**Figure 3.** Extensive measures taken to prevent erosion, during the construction of access roads for a new power line. Continuous cellular mat (left) and gabions (right) are some of the measures used during the building of access roads during the construction phase of a power line. (Photos: Jose Clara).

The stabilisation of soils, particularly in the vicinity of watercourses, requires special attention.

The access roads also require careful planning and regularly spaced berms are required to prevent erosion. The design and spacing of these berms will be discussed below.

The impact of the activities during the maintenance cycle of the servitude is relatively low as patrols in the servitude are carried out infrequently. The veld management practices of the land owner or land occupiers would have the dominating effect on soil erosion during this phase.

# 4. Proposed solutions to combat soil erosion in the servitude.

## 8.1 Planning considerations of an erosion site

The implementing of successful measures to contain erosion would include in the first instance establishing of the cause of the erosion (Viljoen & Smalberger, 1974)(Brandt *et al.*1997). This could include factors such as over-grazing, alteration of the drainage pattern by the construction of dam walls or other interventions. Under these conditions the vegetation is often reduced or even destroyed, and the velocity and quantity of runoff is increased, with the resulting increase in erosion. Where highly erodable soils occur, the effect is more severe.

A number of aspects that should be considered in the planning phase are discussed in Brandt *et al* (1997). It includes the erosion and soil types, and topography. These aspects will influence the method of remedy to be implemented.

The main objective in the planning of erosion structures is achieved by channelling water through a structure of low erodability. Drop-inlets could be used here or slopes may be stabilised with biodegradable erosion control blankets. The placement of silt screens downstream retains silt and seeds and further encourages the re-growth of plant material. A number of solutions are available, which could be categorised as follows

The correct placing of these structures will be based on the expected volume of water, soil type and the slope of the terrain and should be carried out by a specialist. The Agricultural Research Council has developed a number of publications on this aspect. These documents are noted under references.

## 8.2 Preventing erosion caused by access roads

Roads are built to provide access for the construction of the line as well as to provide access for inspection and maintenance. During an emergency, the condition of the access road will have a major influence on the time taken to restore the line. Roads are also one of the major causes of soil erosion (Mathee & Russel,1998).

According to Mathee & Russel (1998) roads should be planned according to principles of water runoff and should ideally be positioned on a watershed or ridge. They state that the over-all slope of a road should not exceed 7% and may over short distances be increased but should never exceed 18%. During the design of a power line however, very sensitive soils may cause a change in route. Normally access roads run along the line and mitigation for runoff consists of the building of berms.

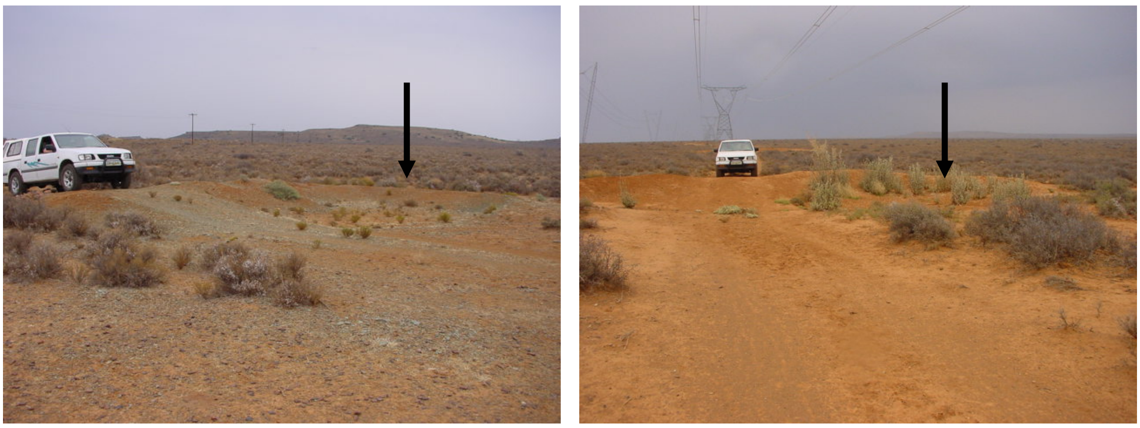


**Figure 4.** Examples of well constructed berms under the Hydra-Droërivier 1&3 lines. This design uses an overflow dam to spread water collected by the berm (see arrows). After ten years virtually no maintenance is required on these structures.

Regular spacing of berms will prevent the formation of erosion of the access roads. These should be spaced as follows:
Berm spacing (in Metres):

$$\frac{300m}{\text{Slope of the road (\%)}}$$

(Mathee & Russel, 1998).

Combrinck and Marais (2003) also refer to a number of important design aspects concerning access roads. Also refer to the TRANSMISSION LINE TOWERS AND LINE CONSTRUCTION specification for further design details.

Areas that have highly erodable soils as well as areas in the vicinity of watercourses require special measures as shown above in figure 3 above.

## 5. Erosion prevention structures.

These structures or systems are used in eroded areas and aim to control the flow of water, halt active erosion and re-establish vegetation.

Three categories of solutions are suggested by Suthers (2002). They are:

- **Heavy systems:** These solutions include concrete or brick structures and gabions and reno mattresses, etc. (refer to figure 1). Concrete or cement structures can be constructed on solid rock foundation or they could be floating structures. Several publications on the planning and design of these structures are available from the Agricultural Research Council as well as from commercial companies. The choice between gabions and concrete structures depends inter alia on the availability of rocks. Care should be taken not to disturb the environment where rocks are collected as this could result in the creation of new erosion problems.
- These structures are normally expensive and should be planned carefully by a specialist.
- **Light systems**: These systems include Silk screens (van Heerden 2000) erosion control blankets, turf reinforcement mats and geocells. The re-establishment of vegetation is also encouraged by using soil reclamation rolls (SRR), EcoLogs or seeded coir mats. Also referred to as small structures.
- **Soil Bioengineering techniques.** This refers to the use of a variety of plant species without any inert materials. (Suthers 2002), (Viljoen&.Smalberger,1974)

**Figure 5.** An example of an inappropriately designed gabion. No geotextile or apron was used in this case and erosion eventually occurred under the structure. No provision was made to prevent erosion at the overflow.

### 8.3 Small structures.

Recently the use of “small structures” has been suggested to combat the type of soil erosion typically found in the servitude (Van Heerden, 2000). These structures can be erected with minimal labour and at a low cost and have been shown to be effective in the re-establishment of vegetation in eroded areas.

#### 8.3.1 Silt-Screens


**Figure 6** shows the steps in the construction of a silt-screen. Girls from two schools in Pretoria on the Mabula Game farm carried out this exercise. In photo 1 the trench is dug across the erosion channel and Y standards are placed to form the main part of the structure. In photo 2 the Y standards are connected with stay wires and covered with wire mesh. The structure is then covered with a biodegradable geo-textile in photo 3. In photo 4 the structure is completed by adding an apron, made of geo-textile and wire mesh.

The silt-screen is used to trap small particles and seeds, whilst permitting the water to pass through. In this way the fertile trapped soil will permit the re-growth of vegetation and aid the stabilization of the soil. These structures are placed at intervals such that the re-growth of the one structure will reach the overflow of the previous one.

These structures are cheap to construct and the material that is used is a very strong knitted polyethylene, which is biodegradable and will not pollute the environment. The structures are spaced at intervals, which are determined by the slope, vegetation and soils present. (van Heerden 2000, p3-4). A typical design appears in Annexure A

### 8.3.2 Soil Reclamation Rolls (SRR)

In cases where all the topsoil was washed away and vegetation is absent, water penetration is low and runoff high. The rehabilitation of the vegetation is normally achieved by the removal of animals, the ploughing and planting of vegetation (van Heerden 2000). The success of these measures is also highly dependent on sufficient rain.

To overcome this problem, use is made of a silicate water-retaining mineral. This mineral absorbs water during rain and then retains it. The water does not evaporate but remains accessible to the plants.

Recently, the following procedure was suggested for soil reclamation. A mixture of soil, manure, seeds and a silicate water retardant mineral is mixed and placed in long bags made of a geotextile. These bags are then pinned to the ground, following the contour.

The soil and manure provides the growth medium for the seed that is mixed in. The plants chosen for this purpose should preferably be less palatable that the surrounding plants, else animals may destroy the efforts.

The silicate water retardant will absorb water during rains, but will then retain it for use by the plants during dry spells. Because the geo-textile material is biodegradable, it will decompose with time after the plants have established themselves.

**Figure 7.** The photo on the left shows an area without topsoil or plant material. The position of the contour is being determined. The photo on the right shows the silicate mineral after water has been added.

## 6. The land owner and soil erosion

In many cases soil erosion results from activities outside of the servitude and these can be linked to grazing, veld, and water management practices of the landowner or occupier.

The remedies, which involve the re-establishment of vegetation, will necessitate the co-operation of the landowner and his grazing cycles. Where possible, areas under rehabilitation should be fenced off, but this is often not practical for power line servitudes.

It is therefore vitally important for the successful rehabilitation of erosion, to involve the landowner in solving the problem.

In many cases, landowners have the means to implement some of the remedies suggested above, with their own equipment and labour. This work may be carried out during slack times and in this way contribute to sustainable job creation in the rural areas.

This approach is also certain to reduce any complaints about work quality and claims for gates left open by third party contractors. The landowner will also have a stake in ensuring success of the project.

Solutions such as the SRR's may also be manufactured by rural communities and supplied to a rehabilitation project.

**Figure 8**. The photo's show the mixing of the soil, the manure seed and silicate mineral before placing it in the geotextile bags.

## 7. Implementation strategy

Due to the extent of erosion on servitudes, the following strategy for controlling erosion is proposed to provide maximum protection at lowest cost:

- Maintain existing berms on servitude roads
- Repair any damaged berms
- Create berms according to the specifications of this document where necessary.
- Treat new erosion with small structures where possible.
- Restore large erosion structures according a formal and structures plan for each region.

## 8. Supporting Clauses

### Index of Supporting Clauses

## 8.1. Scope

The purpose of this guideline is to highlight the need for the control of erosion in Transmission servitudes and to introduce alternative methods for the prevention of erosion.

### 8.1.1. Purpose

The purpose of this guideline is to highlight the need for the control of erosion in Transmission servitudes and to introduce alternative methods for the prevention of erosion.

### 8.1.2. Applicability

This guideline shall be applicable to Eskom Transmission Division.

## 8.2. Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed below (list the references below):

### 8.2.1. Normative (means documents used to compile your document)

Conservation of Agricultural Resources Act No. 43 of 1983
TRANSMISSION LINE TOWERS AND LINE CONSTRUCTION- TRMSCAAC1

### 8.2.2. Informative (means documents listed as a further source of information)

Schultze, R.E., 1997: Climate In Cowling R.M., D.M. Richardson, S.M. Pierce (eds): **Vegetation of Southern Africa.** Cambridge: Press Syndicate Cambridge University, 421-446.

Van Heerden, J.P.J., 2000. *Versperrings en Klein Strukture om Gronderosie te bekamp*. Agricultural Research Council Institute for Agricultural EngineeringTechnical Brochure. ISBN 1-919685-89-8

Viljoen, L., L.J.B.Smalberger, 1974. *Herwinning van kaal kolle en yl bedekte veld deur progressiewe bewerkingsmetodes*. Bladskrif no. 108 Afdeling Landbou-ingenieurswese, Departement van Landbou-tegniese Dienste.Pretoria.

Brandt, D.J., S.W.Jacobs, A.T.van Coller, N.E.von Wielligh, E.C. Dreyer, H.E.King, A.J. Roets, J.J.van Staden, E.U.Koch. 1997. *Chapter 10.1 Introduction to soil conservation structures National Soil Conservation Manual*. Institute for Agricultural Engineering, Agricultural Research Council. Pretoria.

Mathee, J.F la G., W.B.Russel. 1998. *Chapter 12.4: Soil Conservation alongside Roads. National Soil Conservation Manual*. Institute for Agricultural Engineering, Agricultural Research Council. Pretoria.

Combrinck W., J.P. Marais, 2003. Ground erosion protection, rehabilitation and Maintenance. In **The Fundamentals and Practice of Overhead line maintenance.** C Cameron, E.Marshall,L Pilay, A.C.Britten, J Reynders (eds). Crown Publications. Johannesburg.
Appleyard, P.D. 2001. TRANSMISSION LINE TOWERS AND LINE CONSTRUCTION. Eskom Transmission Specification TRMSCAAC1.

Suthers, R. 2002. **Soil Bioengineering Training Manual**. African Gabions/ MACCAFERRI. Johannesburg.

## 8.3. Definitions

.none

## 8.4. Abbreviations

SRR- Soil Reclamation rolls

### 8.5. Roles and Responsibilities

Roles and responsibilities relating to the implementation of the document.

### 8.6. Implimentation date

The implementation date is __________ (Specify Implementation Date, date from which document is valid. May be the same as the Date in the header in the first page).

### 8.7. Process for monitoring

List and explain monitoring and maintenance processes and requirements.

### 8.8. Related/Supporting Documents

List the forms and records that you have referred to and which shall be maintained, if there are any OR omit, if necessary.

Also list related documents and documents superseded by this document.

## 9. Authorisation

This document has been seen and accepted by:
(i.e. The manager/s of the divisions who shall be affected by the content of this document)

| Name | Designation |
|---|---|
| W. Majola | GM (Services) |
| J.Machinjike | GM Grids |
| EN Matya | Managing Director (Generation Division) |
| PJ Maroga | Managing Director (Transmission Division) |
| MM Ntsokolo | Managing Director (Distribution Division) |
| JA Dladla | Managing Director (Key Sales & Customer Service Division) |
| NL (Nthobi) Angel | Managing Director (External Relations Division) |
| Dr SJ Lennon | Managing Director (Resources & Strategy Division) |
| ME Letlape | Managing Director (Human Resources Division) |
| PD Mbonyana | Managing Director (Corporate Division) |
| BA Dames | Managing Director (Enterprises Division) |

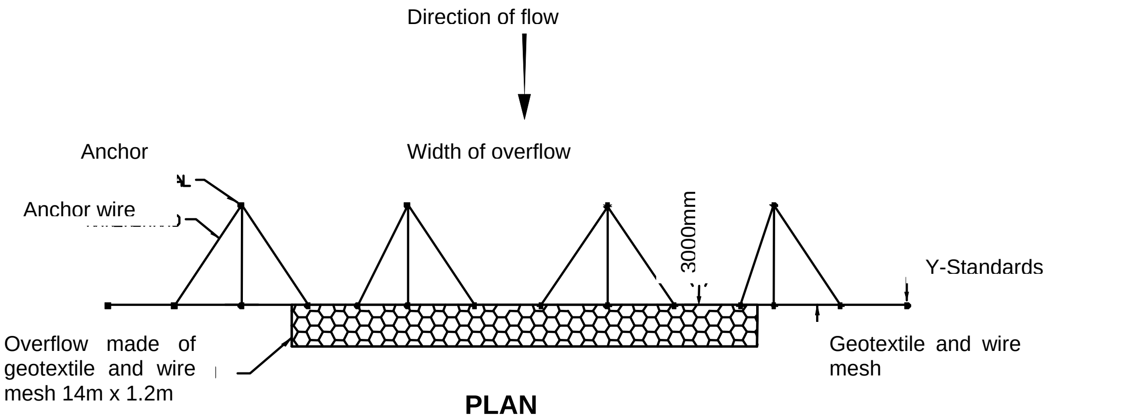
## 10. Revisions

| Date | Rev. | Remarks |
|---|---|---|
| November 2006 | 0 | Specify reasons for revision.<br>List all changes to the document, as well as authorities for these changes. Remain Rev.0 because of the new umber |

## 11. Development team

The author wishes to acknowledge the help and guidance received in compiling this document from: Mr. J.P.J. van Heerden, Institute for Agricultural Engineering of the Agricultural Research Council, Prof. Tertius Harmese, RAU department of Geography and Environmental Management, Mr. Piet Herselman, Alnet Pty. (Ltd) and Mrs. Ronel Suthers of African Gabions Pty. (Ltd).

## Annexures

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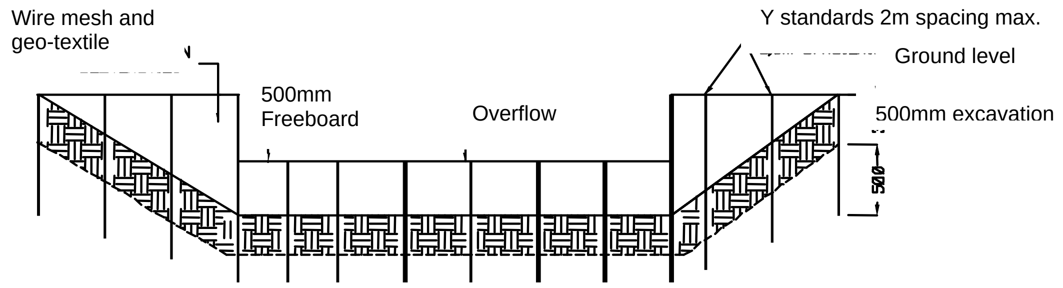


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**SECTION**

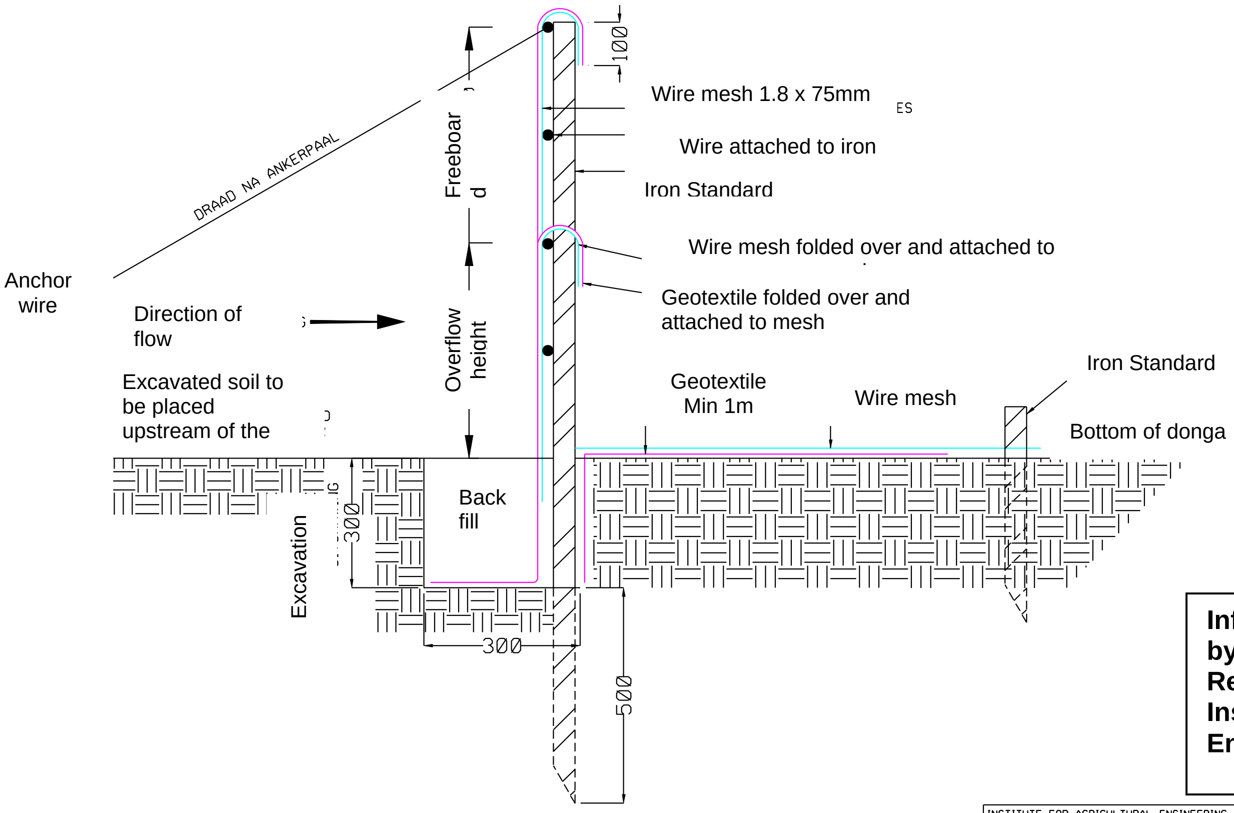
Information supplied by the Agricultural Research Council, Institute of Agricultural Engineering

NOTAS:
1. SIEN ALGEMENE DWARSSNIT VIR KONSTRUKSIE AANWYSINGS.
2. ALLE AFMETINGS IS IN mm TENSY ANDERS AANGEDUI.

INSTITUTE FOR AGRICULTURAL ENGINEERING
AGRICULTURAL RESEARCH COUNCIL
INSTITUUT VIR LANDBOU-INGENIEURSWESE
LANDBOUNAVORSINGSRAAD

STRUKTUUR NR.

## Annexure A




**Information supplied by the Agricultural Research Council, Institute of Agricultural Engineering**

**General Cross section**
Overflow made from geotextile and wire