environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

TECHNICAL ADVISORY PRACTICE NOTE: CAPPING CLOSURE OF WASTE MANAGEMENT FACILITIES AND POLLUTION POINT SOURCES

1. PREAMBLE

There is a fundamental difference between capping closure of waste management facilities and containment barrier systems at such facilities, despite the objectives of pollution control and environmental protection in an equitable and sustainable manner being common. This difference is that baseliners are generally not accessible in the event of their failure or substandard performance, whereas closure caps are reasonably accessible for repairs or improvements.

The capping system of a waste disposal facility serves the following purposes:

(i) It separates the waste body from the atmospheric environment. The cap is the only layer protecting and isolating the waste from the long-term effects of wind and water erosion, burrowing animals, etc.

(ii) It limits and controls the quantities of precipitation that enter the waste. It may also allow water to leave the landfill by evapo-transpiration and vent landfill gas in a safe manner.

When comparing the capping design with the corresponding basal liner system design, it must be realised that the cap works in conjunction with the basal barrier by limiting the long-term generation of leachate.

As is the case for a basal barrier system, a landfill capping or final cover system is also made up of a series of elements. The capping system is designed to maximise run-off of precipitation, while minimising infiltration and preventing ponding of water on the landfill.

2. LEGISLATION

The legislation applicable to closure caps is primarily the National Environmental Management Act, Act 107 of 1998, (NEMA) which informs Organs of State on principles of decision making with respect to activities that affect the environment; the National Water Act, Act 36 of 1998, (NWA) which controls activities with respect to water resources management; the National Environmental Management Waste Act, Act 59 of 2008, (NEMWA); the National Environment Management: Air Quality Act, Act 39 of 2004 (NEMAQA) and its amendments along with their regulations, amongst other legislation.

This is not a complete list of legislation and does not purport to be a definitive guide. Other legislation such as the Engineering Professions Act, Act 46 of 2000, (EPA) and its Rules are considered to be implicit. Similarly, for State owned entities and Organs of State, the prescripts of the Public Finance Management Act, Act 1 of 1999, (PFMA) and relevant Treasury Regulations are to be adhered to.

3. PRINCIPLES

The NEMA defines the principles to be taken into consideration by officials when considering actions which may significantly affect the environment. These principles are summarized as follows:

- **Consistency:** the principles apply throughout the RSA and to all Organs of State. (2.1)
- **Equitably:** environmental management must put people at the forefront of concern and serve their needs equitably. (2.2)
- **Sustainability:** development must be socially, culturally and environmentally acceptable (2.3)
- **Impact avoidance:** impacts on biodiversity, pollution, landscape, resource depletion, people's rights, and waste generation must be avoided, and where unavoidable be minimised and mitigated recognising a risk averse and cautious approach. (2.4a)
- **Integration:** all aspects are interlinked and to be recognised in pursuance of the best practical environmental option. (2.4b)
- **Environmental Justice:** any adverse impact shall not disadvantage other persons, especially the previously disadvantaged and vulnerable (2.4c)
- **Equitable Access:** all persons shall have fair access to resources, even if special measures are to be taken to facilitate previously disadvantaged persons. (2.4d)
- **Responsibility:** responsibility must be maintained throughout the activity life cycle. (2.4e)

- **Participation:** processes must be inclusive and provide for capacity building where necessary. (2.4 f)
- **Inclusive decision making:** decisions must recognise person's interests, needs, values and all knowledge of I&APs (2.4g)
- **Environmental Education:** Community well-being and empowerment must be encouraged through knowledge sharing (2.4h)
- **Complete consideration:** decisions must reflect consideration, assessment and integration of disadvantages and advantages (2.4i)
- **Right of refusal:** workers may refuse to do dangerous work, and should be informed of dangers (2.4j)
- **Transparency:** access to information must be in accordance with the law (2.4k)
- **Harmonious policies:** there must be intergovernmental coordination and harmonisation on policies and actions (2.4l)
- **Conflict resolution:** actual or potential conflicts between organs of state should be resolved procedurally (2.4m)
- **Global interests:** global and international responsibilities are to be discharged in the national interest (2.4n)
- **Public trust:** environment beneficial use must serve public interest, and be protected for common heritage (2.4o)
- **Polluter pays:** costs of remediation and of preventing, controlling or minimising further pollution and health impacts... must be paid by those responsible for harm (2.4p)
- **Recognition of women and youth:** the vital role of women and youth must be recognised and promoted (2.4q)
- **Ecosystems require special attention:** specific attention shall be given to stressed, vulnerable, highly dynamic and sensitive ecosystems (2.4r)

Further to this, the considerations should include the principles of the NWA having primary principles of equity and sustainability, and aspects to be taken into consideration as reflected in inter alia NWA section 27. It is noted that the NEMWA requires concurrence between the lead authority, Department of Environmental Affairs (DEA) at national or provincial government, and the Department of Water and Sanitation (DWS) on licences.

4. SITE SPECIFIC APPLICATION

When considering the required final cover or capping closure design for a Waste Management Facility (WMF), the following broad aspects are to be addressed as a minimum:

4.1. NATURE OF THE WASTE BODY OR POLLUTANT TO BE CAPPED (THE SOURCE)

The Type of waste (as assessed by NEMWA R635), its age and rate of degradation, reactivity/stoichiometry, compressibility, and change in materials properties with time is to be understood and recorded. This will inform the design on the significance of pollutant anticipated as well as the duration in time that the waste body would be a source of pollution. Such aspects contribute to defining the required capping performance and period of competent function required i.e. whether a dry tomb or infiltration approach is desired, and if to serve for decades or centuries.

4.2. PAST, PRESENT, AND FUTURE IMPACTS ON WATER RESOURCES (THE PATHWAY)

The waste disposal facility (WDF) monitoring system of boreholes should inform the capping closure design as to whether the site is producing pollution or has the potential for pollutant dispersion.

Furthermore, the details of the historic/existing WDF base barrier system (comprising leachate collection drains and liners) should be considered with respect to present and future performance, both in respect of the liner component and the drainage component performance for the remainder of the polluting period of the waste mass.

Thus, irrespective of whether the WDF is a historic unlined facility, a limited infiltration clay liner based on pollution dilution and dispersion with attenuation as mitigation measure (Minimum Requirements 2nd Edition of 1998 philosophy), a competent containment barrier system (NEMWA Regulations 2013, R636), a failed barrier system, or a barrier system that is anticipated to fail, the pathway risk or probability of failure is to be assessed quantitatively (and expressed in litres per hectare per day).

4.3. THE CAP AS A FUNCTION OF BASELINER PERFORMANCE

The closure cap system is to be designed recognising both the pollutant source and pathway with respect to rate and period of pollution potential as described above.

Where a gas management system is required at a site, it must be correctly designed, operated, maintained and monitored to ensure that any landfill or similar gas emanating from the facility is properly managed. The venting of landfill gas generated which is a function of the waste body behaviour may be undertaken passively or actively. In all cases, the rate of venting shall be controlled so as to avoid inducing smouldering or combustion of the waste, with due consideration to the influence of the gas management procedure on the containment system as a whole.

The progressive rehabilitation of landfills by means of capping and the subsequent establishment of vegetation is a requirement. (It is recognised that in some circumstances that the waste may influence the capping design to the extent that a non-infiltration cap without vegetative cover, but rather a penetration resistant material, is required, such as for some waste containing asbestos.) Capping should be implemented on all areas where no further waste deposition will take place, and vegetation should commence as soon as possible.

Screening berms are the first areas where vegetation is to be established. This ensures that waste disposal operations take place behind vegetated berms. These are extended upwards in advance of the disposal operation to ensure continued screening. This is referred to as the 'rising green wall' approach.

All final levels and slopes must be in accordance with the landfill design and the End-use Plan. Slopes should not be steeper than 1 in 2,5, as this will promote erosion and/or instability. Irrespective of slope, erosion resistance and (both veneer and global) stability must be demonstrated. The design is based on site specific materials for which design parameters are determined by laboratory testing or similar. It is acknowledged that some sites may have unique constraints of space and available materials which could lead to capping system designs incorporating stability measures of berms or reinforcing materials, or combinations of such systems.

Immediately on completion of an area, the final cover must be applied. The thickness of the final cover must be consistent and in accordance with the design.

The final cover must comprise material capable of supporting the vegetation called for in the End-use Plan. In order to prevent erosion and improve aesthetics, re-vegetation should commence as soon as possible after applying the final cover.

All covered surfaces on the landfill must be so graded as to promote run-off to prevent ponding (taking settlement into consideration). Re-vegetation must commence as soon as is practically possible after the final cover has been placed, in order to rehabilitate on an on-going basis.

In the event of a basal barrier system being a secure and fully functional containment facility for the particular waste polluting period, then a limited infiltration cap may be appropriate. The rate of infiltration should be limited to 0,5m per annum steady state seepage rate (as per the MR2 of 1998) unless the stoichiometry of the waste body and barrier system performance determines otherwise.

In the WDFs where base system performance is substandard or not demonstrated to fulfil post closure service life, non-infiltration capping closure is pursued with recognition that areas steeper than 1v:4h should optimise design based on runoff, whereas flatter areas should design for eliminating infiltration. Stormwater runoff may require concentration and down slope management through hardened channels or pipes so as to avoid damage such as erosion or instability or under cutting of the toe before being returned to the environment.

4.4. STRUCTURAL STABILITY

Structural stability for plateau and side slope areas will be influenced by the nature of the waste material itself and how it changes with time, the properties of construction materials to be used and their interaction, both during construction and in the long term. In doing so the global and veneer stability is to be assessed, recognising deformation (global and local) and strain compatibility between materials, (which should be confirmed by actual laboratory test results), as well as seismic loading. Capping designs should recognise the 3- dimensional convex shape stability may be over estimated by 2-dimensional analysis.

Final cover or capping areas with slopes flatter than 1v:4h are considered to be potential primary infiltration areas, whereas steeper slopes are considered to be low-infiltration areas. The plateau type of potential infiltration area should generally be sloped at an angle less than 10 degrees for stability, but not less than two

percent including post consolidation period settlement, to allow for runoff and avoidance of ponding or excessive water retention. The construction materials making up the various layers of the capping design and the interface shear strength properties are to be determined by conventional test methods. Where geosynthetic materials are included, interface shear strengths should be determined under saturated conditions. The performance of adjacent drainage systems and characteristics of the construction materials are to inform the type of test to be undertaken for parameter quantification under consolidated undrained or drained conditions or as appropriate. (The internal shear strength of topsoil is given as typically of the order of 10 degrees, which is similar to the interface shear strength between geomembranes and clayey soils. Reference is made to the USCS guidelines and GRI Report #30 on "Direct Shear Database of Geosynthetic to Geosynthetic and Geosynthetic to Soil Interfaces" with their cautionary notes.)

Areas steeper than 1v:4h require particular attention to more than veneer stability, which includes storm water discharge management and erosion resistance.

Global stability should be demonstrated recognising the influence of the phreatic line within the waste and performance of drainage layers, taking waste degradation with time into account. It is, however, very likely that the critical zone for shearing may be the underlying natural soil, or a geosynthetic surface, particularly in the event of contamination in which the contaminant or permeant changes the strength characteristics of soils and layered material interfaces.

4.5. PERFORMANCE OF INFILTRATION AND NON-INFILTRATION CAPS

The performance of the capping system is informed by the materials and construction quality of layers in its make-up.

(a) **FOUNDATION PREPARATION LAYER**

This layer above the waste body is a shaped and compacted layer of waste or if useful an imported material layer, to serve as a foundation without discontinuities and point loads on the overlying layers, and should be of the order of 150mm in thickness.

(b) **GAS VENTING/ CAPILLARY BREAK**

This layer should be of the order or equivalent performance of 150mm in thickness and of single sized gravel between 25mm and 50mm in size. This layer must be connected to a gas venting system. Alternative materials may be used provided they have equivalent performance for the required service life and conditions.

(c) **LEACHATE DRAINAGE LAYER**

This can be achieved by the same layer as used for gas venting but is required to eliminate the development of excessive pore water pressures due to leachate migrating laterally or vertically beneath the relatively thin veneer cap.

(d) **THE LINER COMPONENT**

The liner component shall control infiltration rate to less than 13 700 l/ha/d (0,5m/annum steady state infiltration) for infiltration caps, and to below 15 l/ha/d for non-infiltration caps. (These parameters are derived from the MR2 of 1998 soil only capping performance specification and typical performance values achieved for well-constructed geomembrane lined systems as at 2017. (In all cases, the implications of the design parameter is to be validated.)

(e) **ABOVE LINER DRAINAGE**

Drainage is absolutely critical to the performance and stability of veneer systems and should be designed with filter compatibility for adequate drainage capacity recognising deterioration in transmissivity with time due to root ingress, compressive creep collapse, deformation induced displacement, and precipitate (e.g. ferric oxide) and similar. Particular attention to geosynthetic system joints and overlaps may be required so as to maintain continuity of performance. The size and spacing of collector drainage pipes is to be defined based on-site conditions, topography and above drain material specifications.

The drain specifications should thus typically be a 150mm thick layer of free draining filter sand, or alternatives comprising of various natural and/or geosynthetic materials of equivalent performance provided atmospheric pressure within the drain is maintained.

(f) **ABOVE DRAINAGE NORMAL LOAD AND GROWTH MEDIUM**

The above liner normal stress, achieved by soil or similar material, is required for several purposes including to provide direct contact between geomembrane and compacted clay or Geosynthetic Clay Liner (GCL) components of a composite liner where relevant, to provide resistance to panel shrinkage when a GCL is used beneath a geomembrane (and should be equivalent to at least 300mm thickness of soil), to provide adequate load to overcome desiccation cracking when a GCL liner is used (and should be at least equivalent to 600mm of soil), and/or to provide protection to the geosythetic materials from environmental damage such as from wind uplift, UV exposure, vandalism, animal induced mechanical damage (hooves or burrowing) or similar.

The capping system shall restrict percolation through the liner component to less than 0,5m per annum for

controlled infiltration caps, and to less than 15l per ha per day for non- infiltration caps unless the site-specific conditions dictate otherwise (such site-specific conditions may be due to proximity of humans, special water control areas, or particular toxic or mobile pollutants etc.).

5. COST EFFECTIVENESS

For State owned entities and Organs of State, the prescripts of the Public Finance Management Act, Act 1 of 1999, (PFMA) and associated Treasury Regulations apply. Hence specifications shall be performance based, and product brand names or over specification shall be avoided. The responsible person shall ensure that the design and specifications avoid anti-competitive practices of alignment or similar, and that the most cost-effective materials and capping system use is employed.

Caution: The guidance in respect of capping closure is only part of the pollution control system, and does not address groundwater management through cut-off walls or interceptor drains and similar, surface water drainage of the site surrounding the WDF, nor the consequences of capping on baseliner performance amongst others. Similarly it is noted that performance can be achieved by a variety of natural and/or natural geosynthetic materials, hence this advisory note on capping design for technical reports to the authorities is not all encompassing.

Prepared by the DWS for DEA and Provincial authorities in 2016, with acceptance by the Institute of Waste Management SA in 2018.