Planning and Construction of Landfill Restoration in Germany

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ABSTRACT: To the welfare of the universality, in Germany, each sanitary landfill is after closure to restorated. In the present paper, for the landfill Zerbst (Saxony-Anhalt), lying in the city area, planning principles, legal and specific edge conditions are introduced as well as entered on the cost situation. Different capping systems as well as gas collecting and surface drainage facilities are introduced. Possibilities to assess alternative capping systems over equivalence examinations are shown. More economic solutions can be gained by this way.

1 INTRODUCTION

By the german legislator, claims are requested, to secure closed landfills with precautions in a way that the welfare of the universality is not impaired long-term.

Landfills frequently influence the environment through leaving leachate and gas. These emissions are to be stopped through corresponding capping systems. The legislator gives before, that after conclusion and restoration of a landfill the owner must comply with 30 years long aftercare obligation.

2 BOUNDARY CONDITIONS

At project beginning, the 18 ha big and defunct landfill Zerbst (Saxony-Anhalt, Germany) neither over a basis still over a surface sealing sytem. This had the consequence that precipitation penetrate into the landfill body and the emerging leachate water could therefore contaminate the groundwater unhindered. In addition, landfill gases, that could escape freely because of the lacking surface capping system into the atmosphere, developed through transposition processes in the waste body.

At first, the landfill was explored systematically. Geological information drillings were executed as well as were developed groundwater- and gas-gauges in order to determine the emission behavior. The examinations showed that environmental impairments are available.

An essential point of view for design criteria of restoration was the inventory of the landfill environment. The landfill Zerbst is within the city area, the next-situated residential development is only approximate removed 50 m from the landfill boundary and it considers for itself in immediate proximity to the landfill small grounds and business area. This necessitates a hurls act demand in order to protect the welfare of the universality.

The landfill ultimately was assigned after TASi (1993; german guidelines) into the Deponieklasse DK II. Therefore, suitable constructions are to be seized in order to stop leaving from pollutants over the air path and to reduce the leachate rate through penetrating precipitation in the waste body.

3 CAPPING SYSTEM AFTER TASI AND EQUIVALENCE

In principle the policy of capping systems after TASi are decisive in Germany for the sealing of landfills as represented in figure 1.

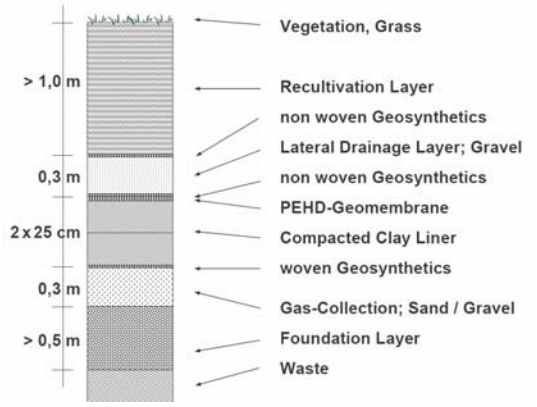

Figure 1. Capping system after TASi (1993)

In principle, the possibility to intend more advantageous capping systems with help of equivalence proof exists. The equivalence is to be especially produced with reference to this of long-term percolation behavior. To this, water balance models with the HELP-Modell are suitable, for example, since here the individual processes of the water supply ground water in the total system under consideration of the complex interactions of grew over, evapotranspiration, etc is considered. Basic idea with the selection of variations is to be optimized costs

The water balance equation of a capping system follows from the conservation of mass for a defined system. It describes the balance of the water inflow into and the water outflow out of the system and the change in water storage in the system in a particular period of time. It can be written in the following water balance equation (s. figure 2 and BERGER, 2002):

$$P = ETa + Q_O + Q_I + Q_D + Q_P + (WS_B - WS_E) \quad (1)$$

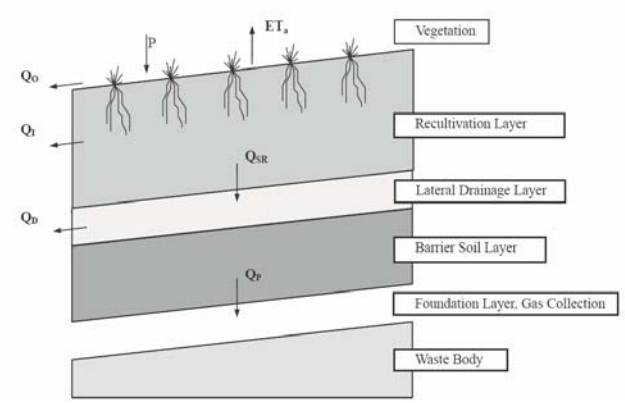

Figure 2. Schematic of a capping system profile (after BERGER, 2002)

The particular values of the water balance equation can be described as follows:

P = Precipitation
ET_a = actual Evapotranspiration
Q_O = Surface Runoff
Q_I = Interflow
Q_{SR} = Percolation through the recultivation layer
Q_D = Percolation through the lateral drainage
QP = Percolation through the capping system
$WS_E - WS_B$= Change in water storage

From the gone ahead considerations, calculations and equivalence proof, following capping systems could be developed for the landfill Zerbst (s. figure 3 and 4):

Asphalt Concrete Liner (building section BA I)
Mineral Liner System (building sections BA II, BA III and BA V)
Geosynthetic Clay Liner System (building section BA IV)

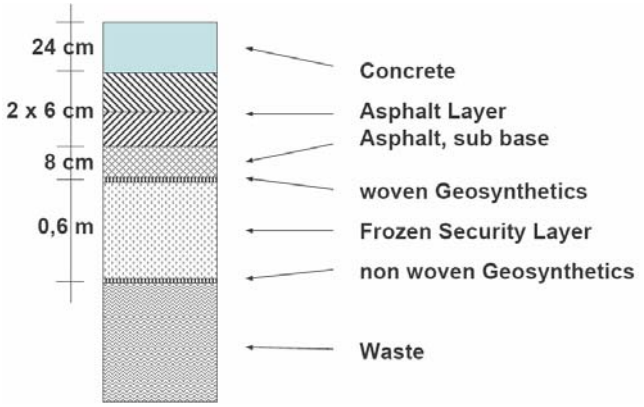

Figure 3a:
Asphalt Concrete Liner

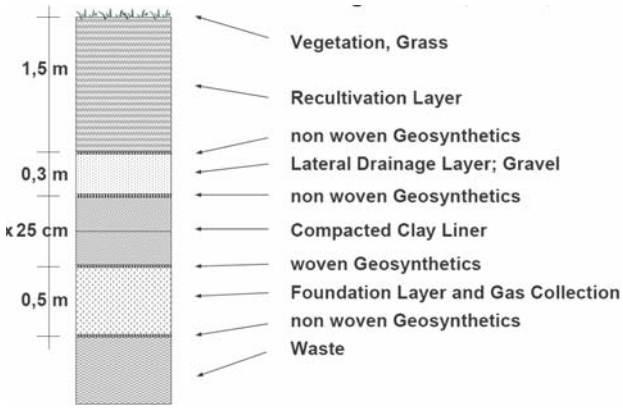

Figure 3b:
Mineral Liner

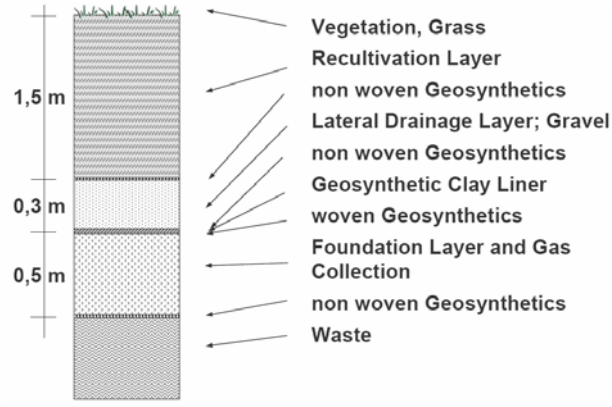

Figure 3c:
Geosynthetic Clay Liner

Figure 3: Different liner systems at landfill Zerbst (see also figure 4)

Figure 4: Position plan of landfill Zerbst, building sections and location in the city

The different capping systems comes like follows to the implementation (s. figure 3 and 4):

- Figure 3.a; Section BA I: Asphalt Concrete Liner = relatively stiff system, extensive consolidation and realization of the garbage, hardly settlements
- Figure 3.b; Sections BA II, II and V: Mineral Liner System = self-healing system, mediocre consolidation and realization of the garbages, different settlements
- Figure 3.c; Section BA IV: Geosynthetic Clay Liner = relatively flexible system, fresh garbage settlements, high settlements are expected

4 SURFACE DRAINAGE

The morphology of the landfill surface was planned in a way that the accruing precipitation reach to open drainage channels and flow away in free slope to seepage treatment (s. figure 4) from there. The seepage treatment lie outside the waste body (downstream the groundwater) and represent the lowest point of the drainage ditch system.

The drainage ditch system lays out in form of trapeze-shaped edge channels. On this occasion, different cross-sections are intended according to calculated drain quantities. The infiltration reservoir is divided into one initial-abstraction retention area and into one infiltration area (s. figure 5). The separation of these two areas takes place with a dam.

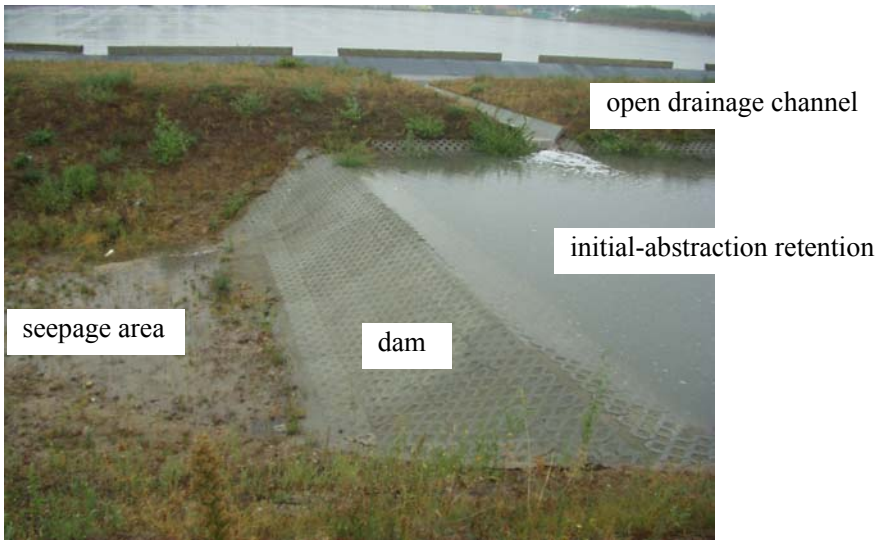

Figure 5: Open drainage channel (in the background), seepage treatment (in the foreground)

5 INFRASTRUCTURE – STREETS AND WAYS

Infrastructure in form of streets and ways are intended in order to carry on the landfill in the course of aftercare to be controlled and to service.

On the part of the fire brigade, there is the demand of an asphalted landfill border street for the truck-traffic. The restoration area are opened up over business ways.

The drainage of the streets and ways takes place into the drainage ditch system (s. figure 6).

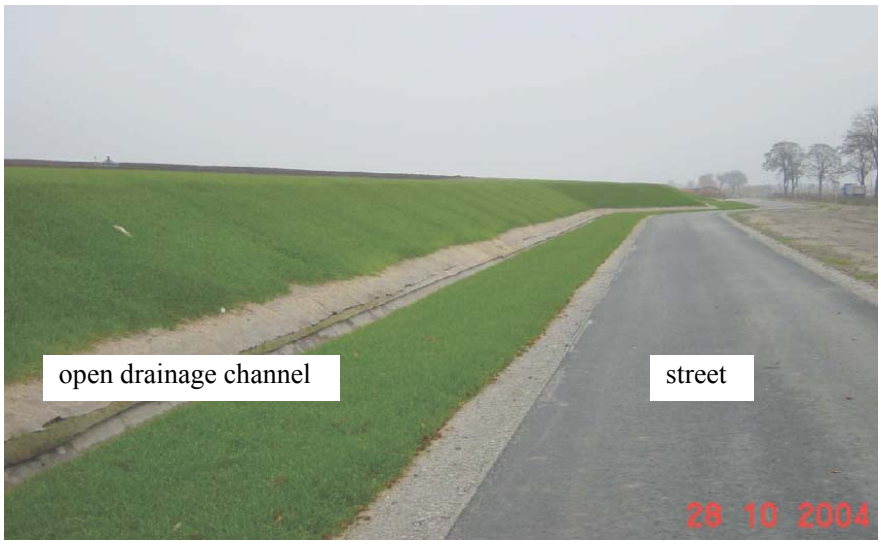

Figure 6: Landfill border street with open drainage channel

6 DEGASIFICATION

The landfill gas collection takes place over an active gas collection system. The total system consists of horizontally transferred gaspipelines and from vertically drilled gas wells. Gas collection stations become at central points of the landfill in order to guarantee an optimal transfer of the landfill gas (s. figure 7, 8 and 9).

An utilization of the landfill gas cannot be given at present, because the methane content is to low.

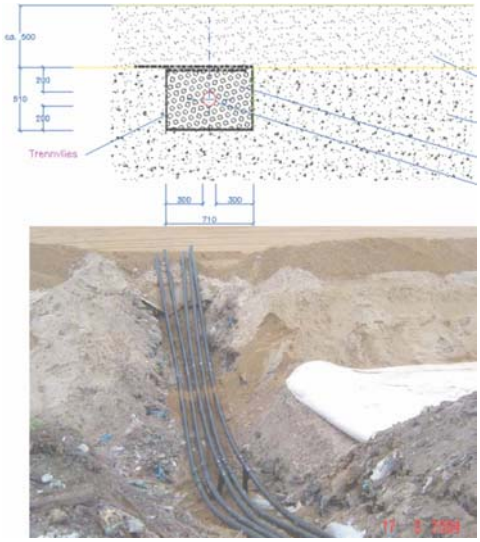

Figure 7: horizontally gas collection system

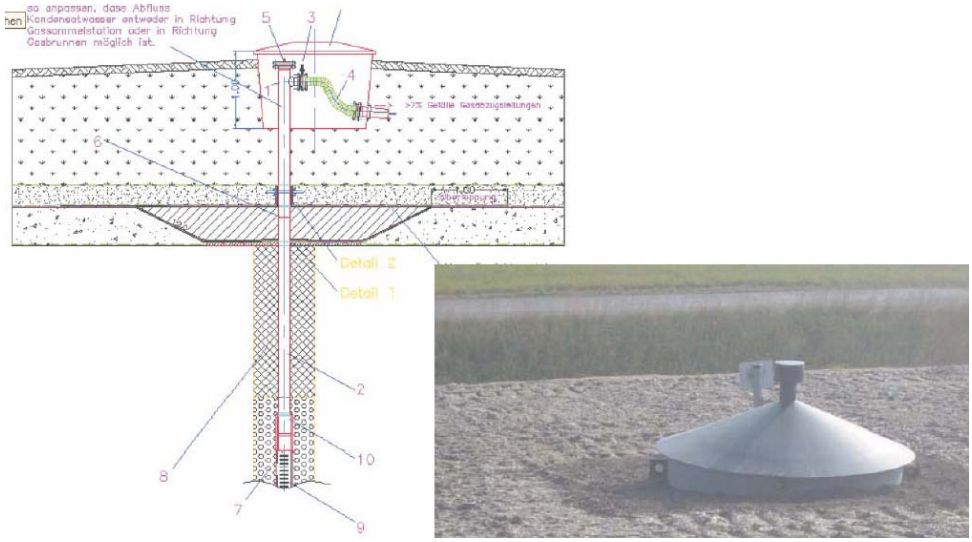

Figure 8: vertically gas collection system (head of gas well)

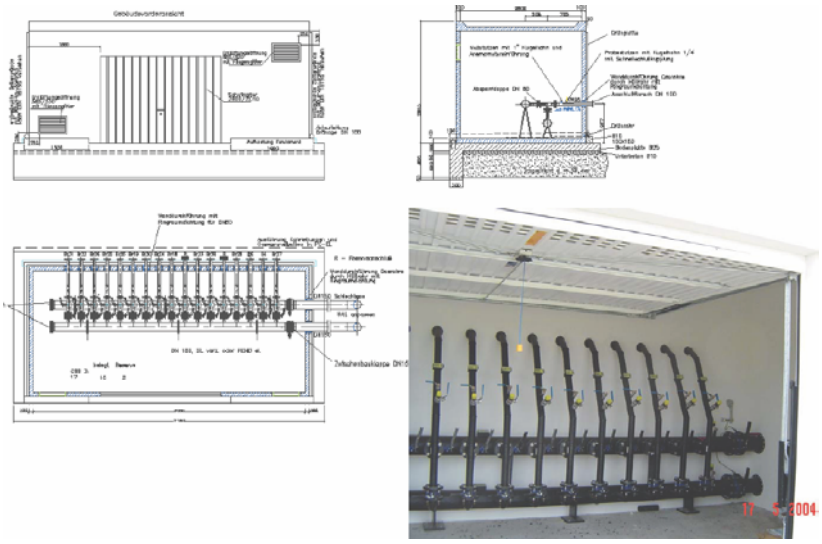

Figure 9: gas collection station

7 COSTS

The cost structure for a restoration on a landfill leaves subdivide itself into four different main cost areas in principle (s. figure 10). It is on this occasion about:

- Costs for the capping system
- Costs for the drainage facilities
- Costs for the degasification facilities
- Costs for the infrastructure

For the landfill Zerbst, the costs amount at present are 14.000.000,00 € (excl. taxes). The distribution of the total costs on the individual cost-groups becomes like follows declared:

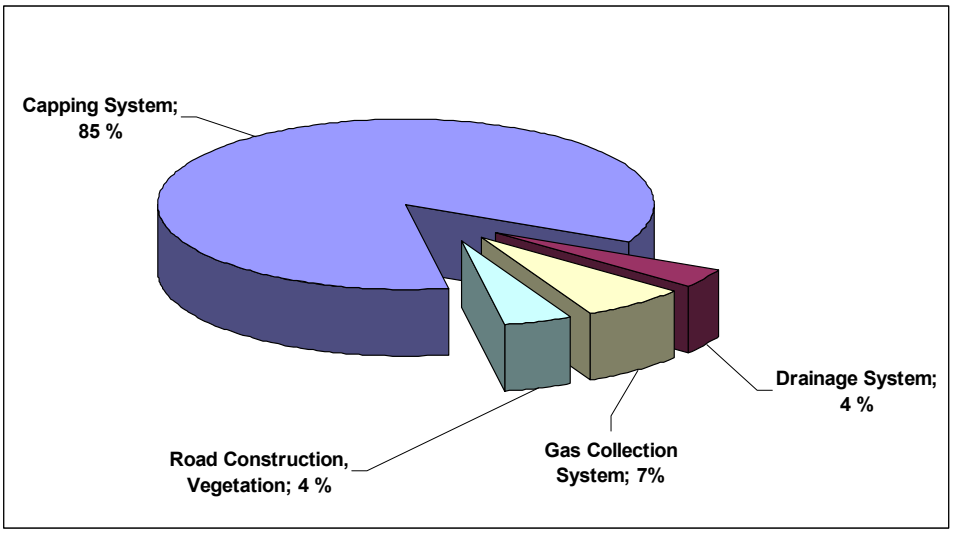

Figure 10: Distribution of costs

The capping system and the gas collection system are the main part of the costs. These parts of costs can also changed essentially more highly according to type and size of the landfill.

The cost relation for the drainage system and infrastructure measures largely constantly remains in contrast to the other facilities.

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