Construction and operation of MBP-landfills

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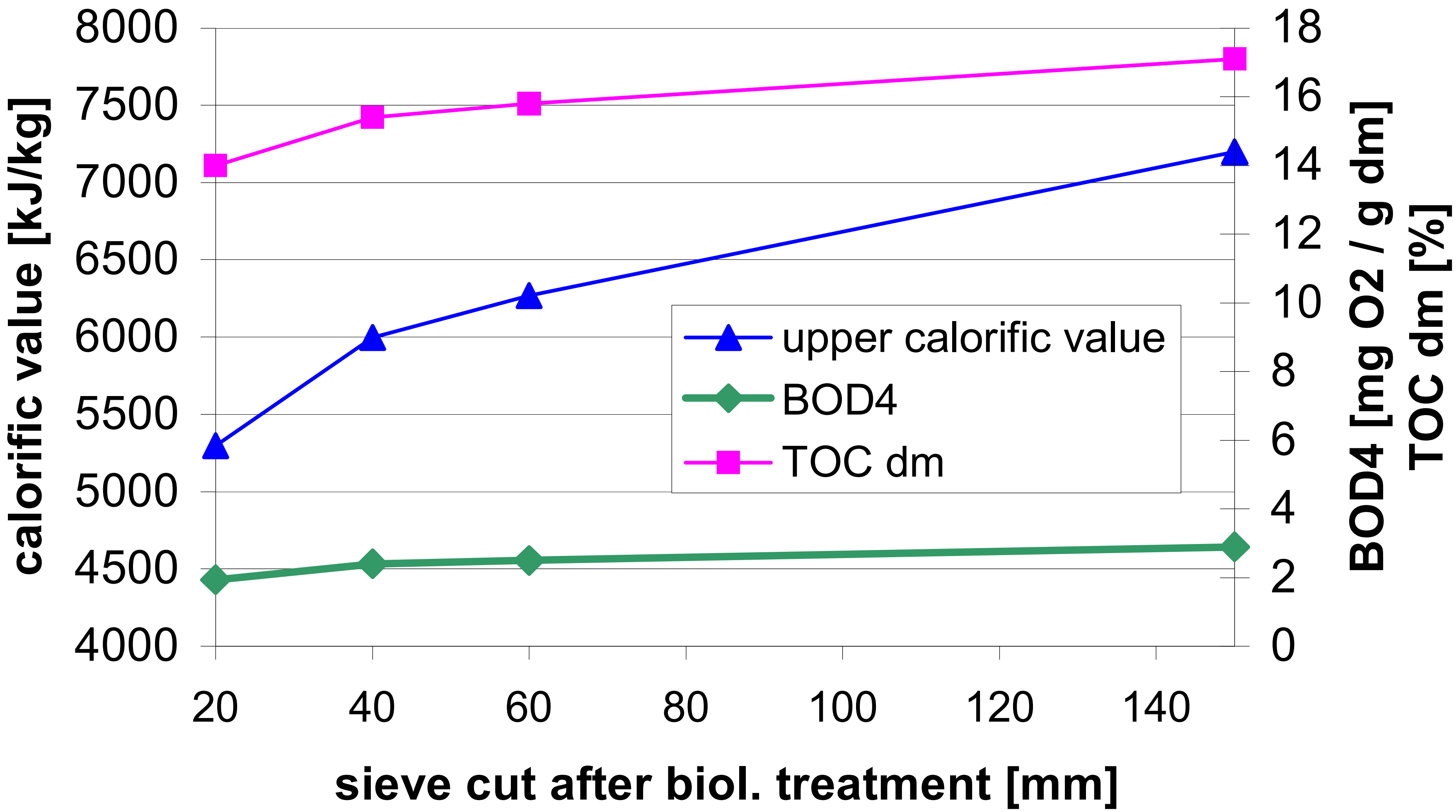
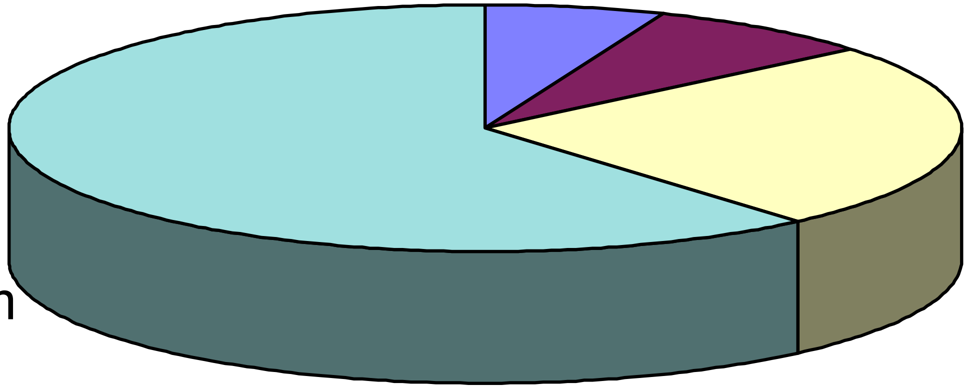
Example of different sieve fractions of aerobic treated residual waste

0 - 20 mm (0.8´´) 0 - 40 mm (1.6´´) 0 - 60 mm (2.4´´)

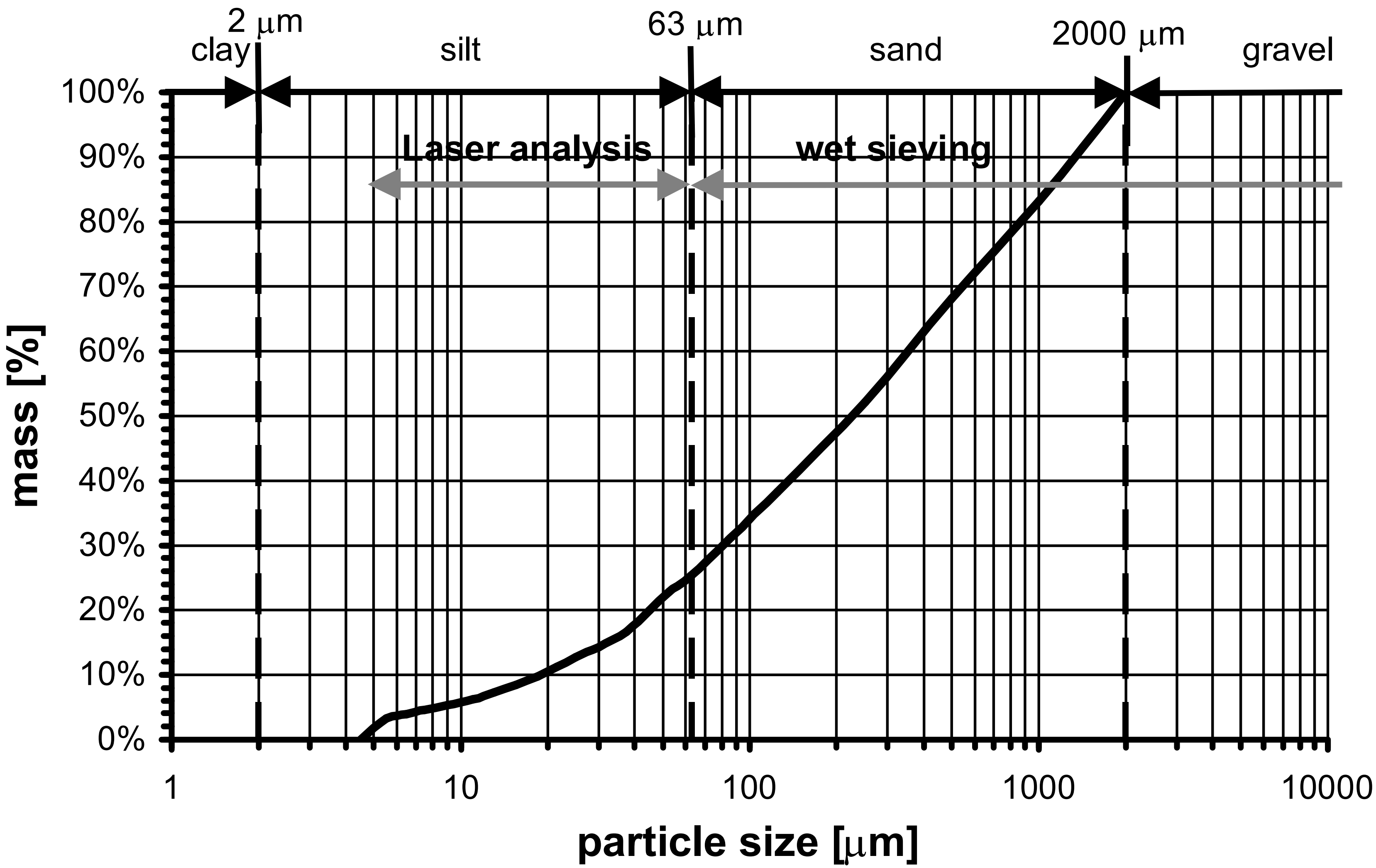
Output properties vs. max. output sieve diameter



Grainsize of composting output (mass% !)



Particle-size distribution in the fine fraction



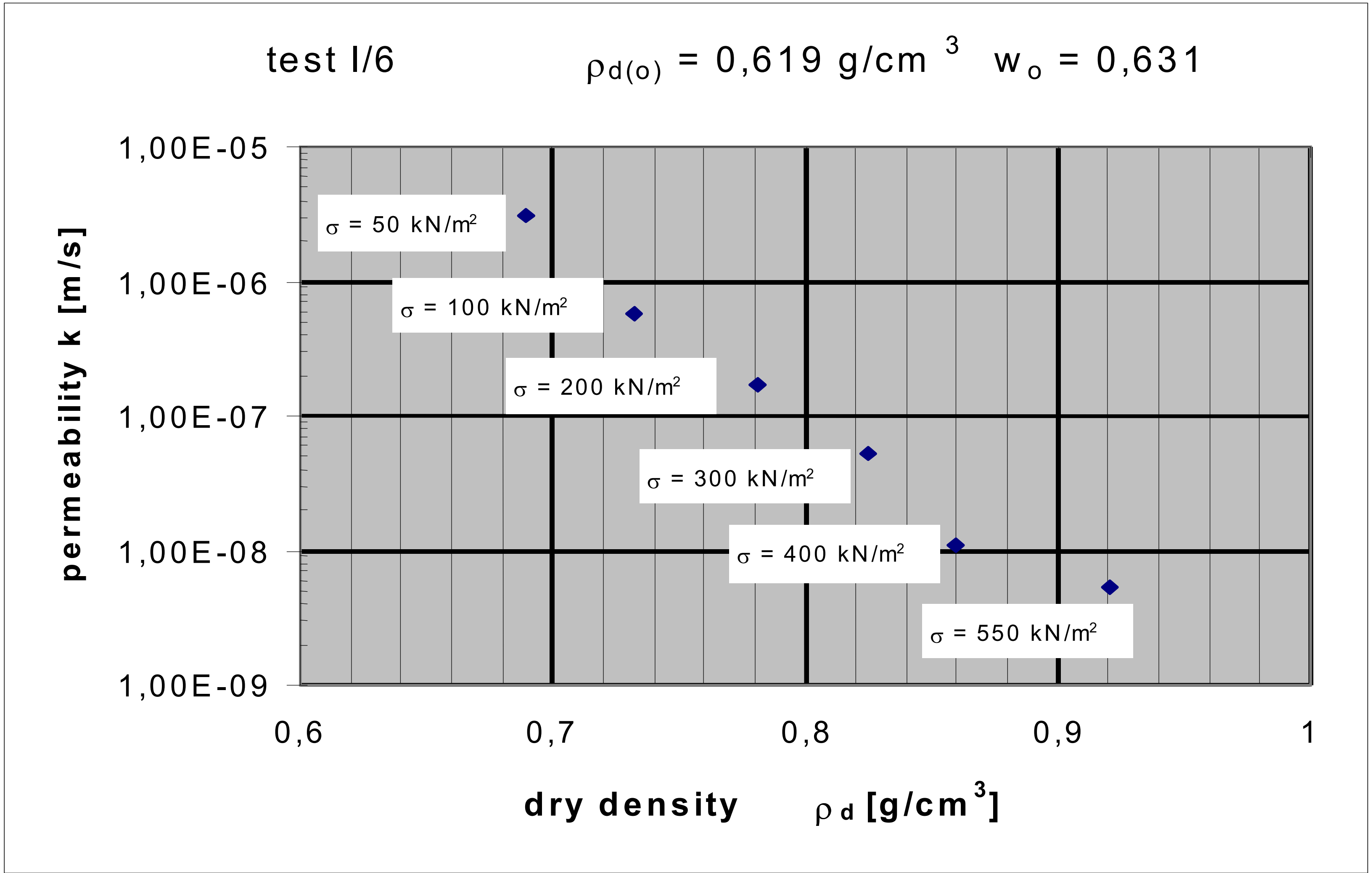
Effects of MBP on physical waste properties

property / influence	mechanical treatment (grain size < 60 mm)	biological treatment	mechanical and biological treatment
water permeability			decrease (10^{-5}-10^{-10}m/s)
angle of shear φ*	apparently no change	increase	increase
cohesion c´*	apparently no change	apparently no change	apparently no change
angle of tensile ξ*	extreme reduction	apparently no change	extreme reduction
oedometric modulus*	increase		increase
calorific value	~20% decrease	~15-40% decrease	~35-60% decrease
subsidence	decrease	decrease	huge decrease
mass reduction	25-50%	~15-20%	40-70%

*based on Ziehmann, 1999

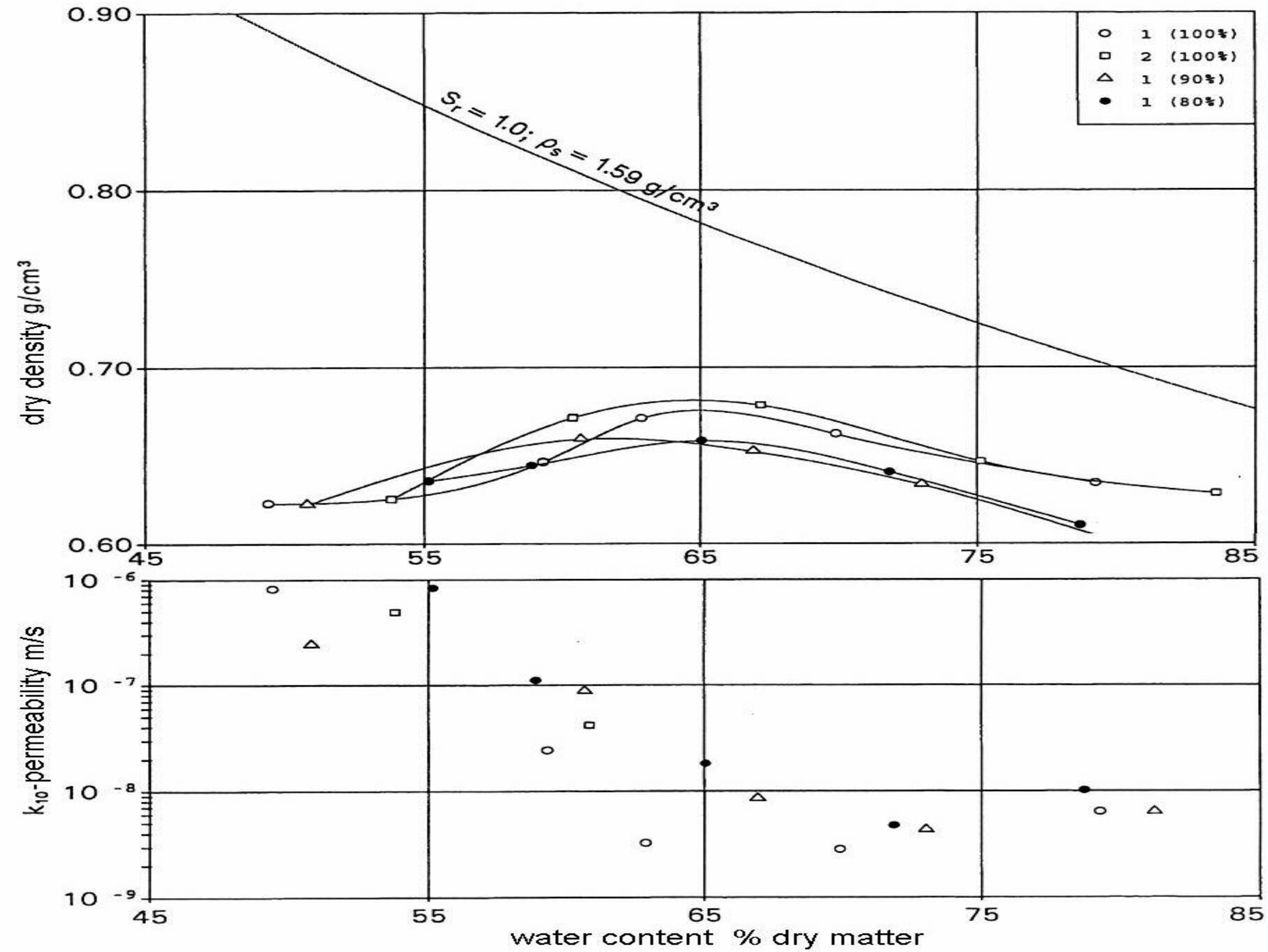
Permeability vs. surcharge σ and dry density ρ_d of an anarobic-aerobic treated mat. 0-30mm

Düllmann 2002



Example: Proctor density and permeability

Düllmann 2002



In-situ permeability measurements 0,55-1,15 m below surface

layer thickness before compaction	30 cm	50 cm	unit
k_f*	1,41E-05	7,90E-06	m/s

Surface runoff from heavy artificial rain on anaerobic-aerobic treated material

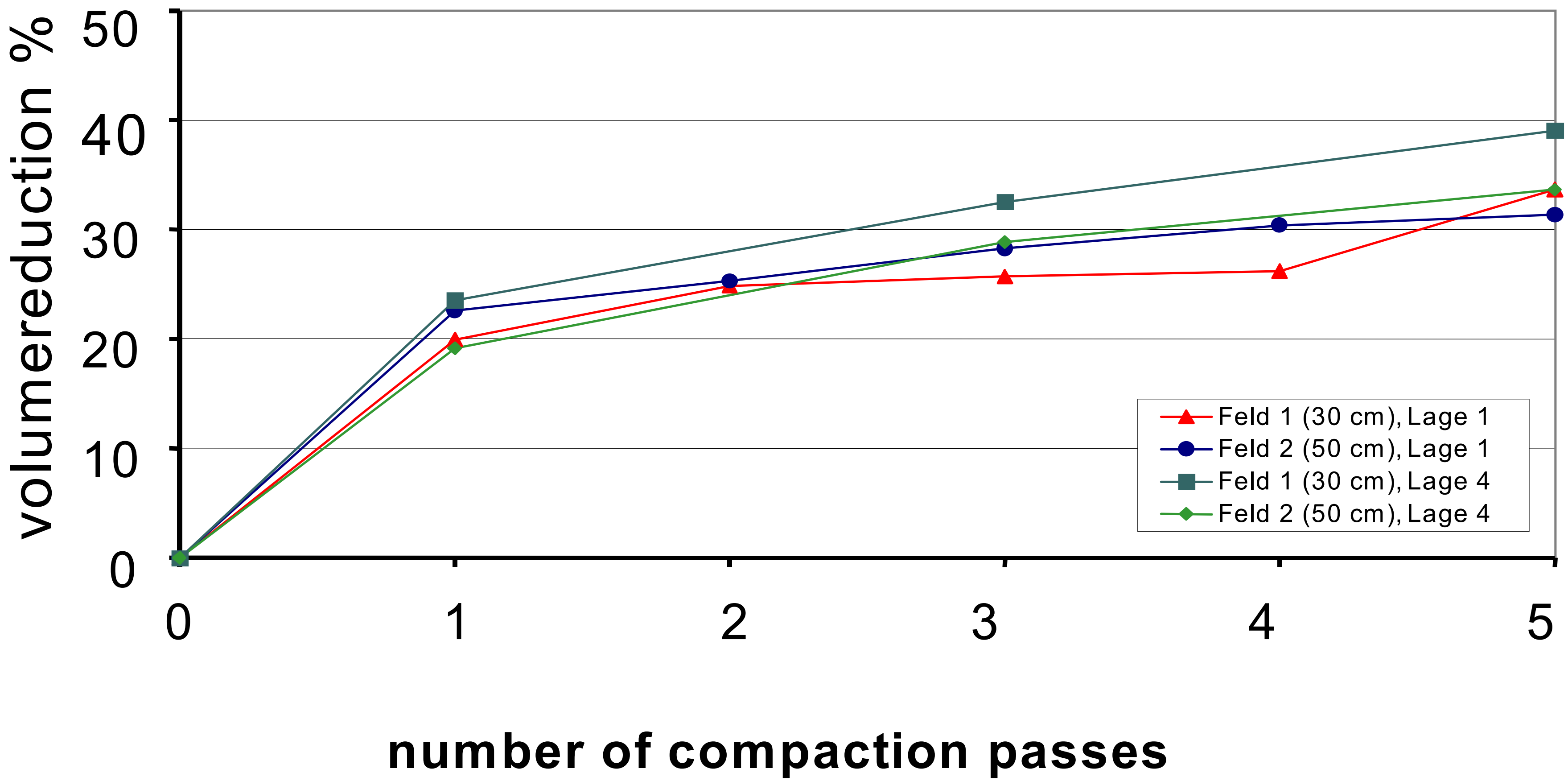
parameter	unit	first test 4 days after construction 30 cm layers		second test 5 weeks after construction 30 cm layers		second test 5 weeks after construction 50 cm layers		boundary value direct discharge
begin runoff af-ter	h:min	11:25		2:30		4:15		
precipitati-on until runoff starts	mm	230		50		85		
		homo-genised	filtered	homo-genised	filtered	homo-genised	filtered	
COD	mg O_2/L	**840**	**790**	**479**	**383**	156	111	**200**
BOD_5	mg O_2/l	**24**	**24**	4,8	7,5	3,8	4,8	**20**
NO_2-N	mg/L		**7,5**		0,28		0,2	**2**
N-whole	mg/L		19,6		6,98		5,1	**70**

Compaction tests Lahe landfill

compactor (BOMAG)	weight	static line surcharge	bandage	adjustion of vi-bration intensity
BW 216 PDH-3	16,65 t	50,23 kg/cm	profiled	manuel
BW 213 DH-3	12,65 t	33,10 kg/cm	plain	Vario-Control

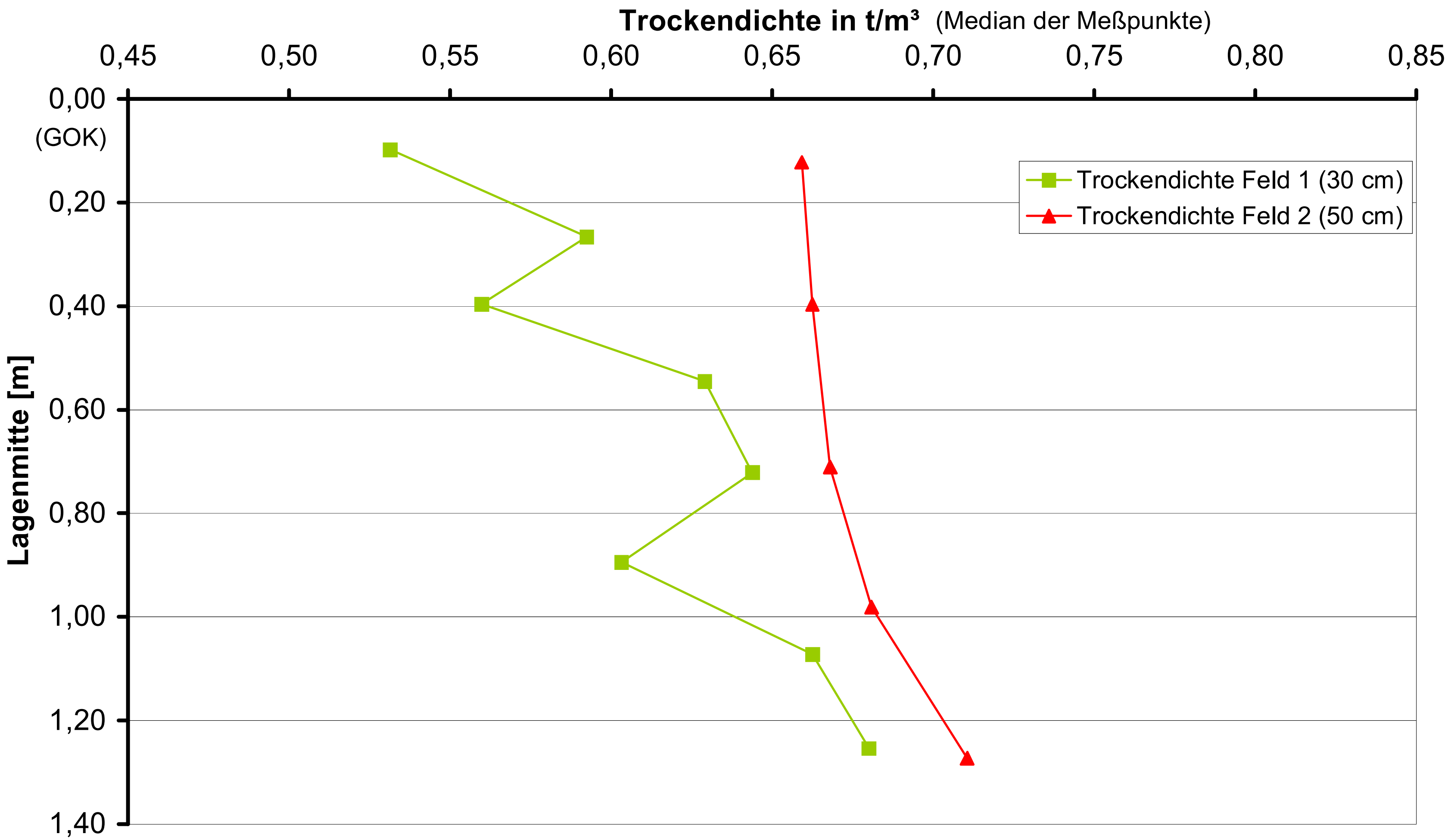
Compaction sucess and number of compaction passes

Kuehle-Weidemeier et al., 2002



Dry densities at 30 und 50 cm layers

Kuehle-Weidemeier et al., 2002

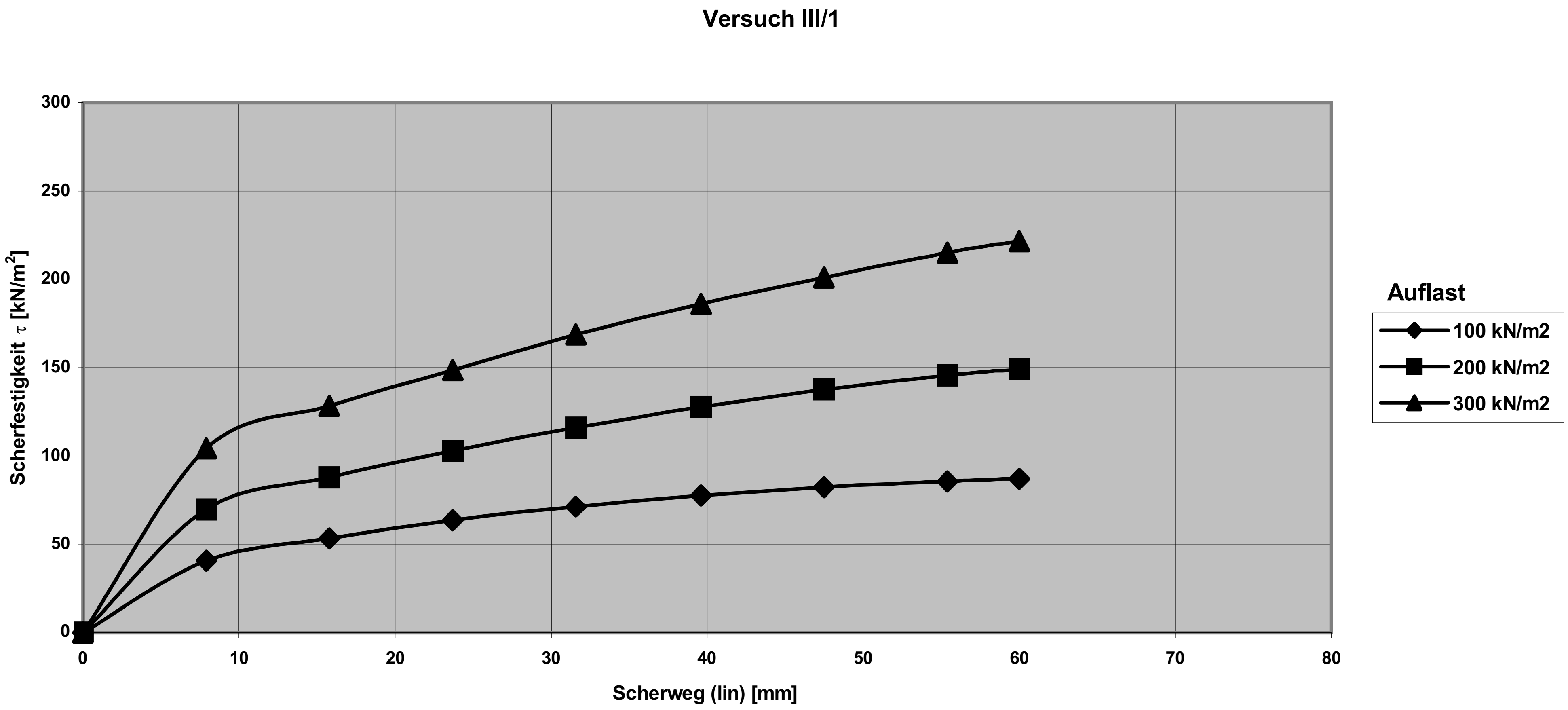


Results of compaction tests Lahe and Bassum

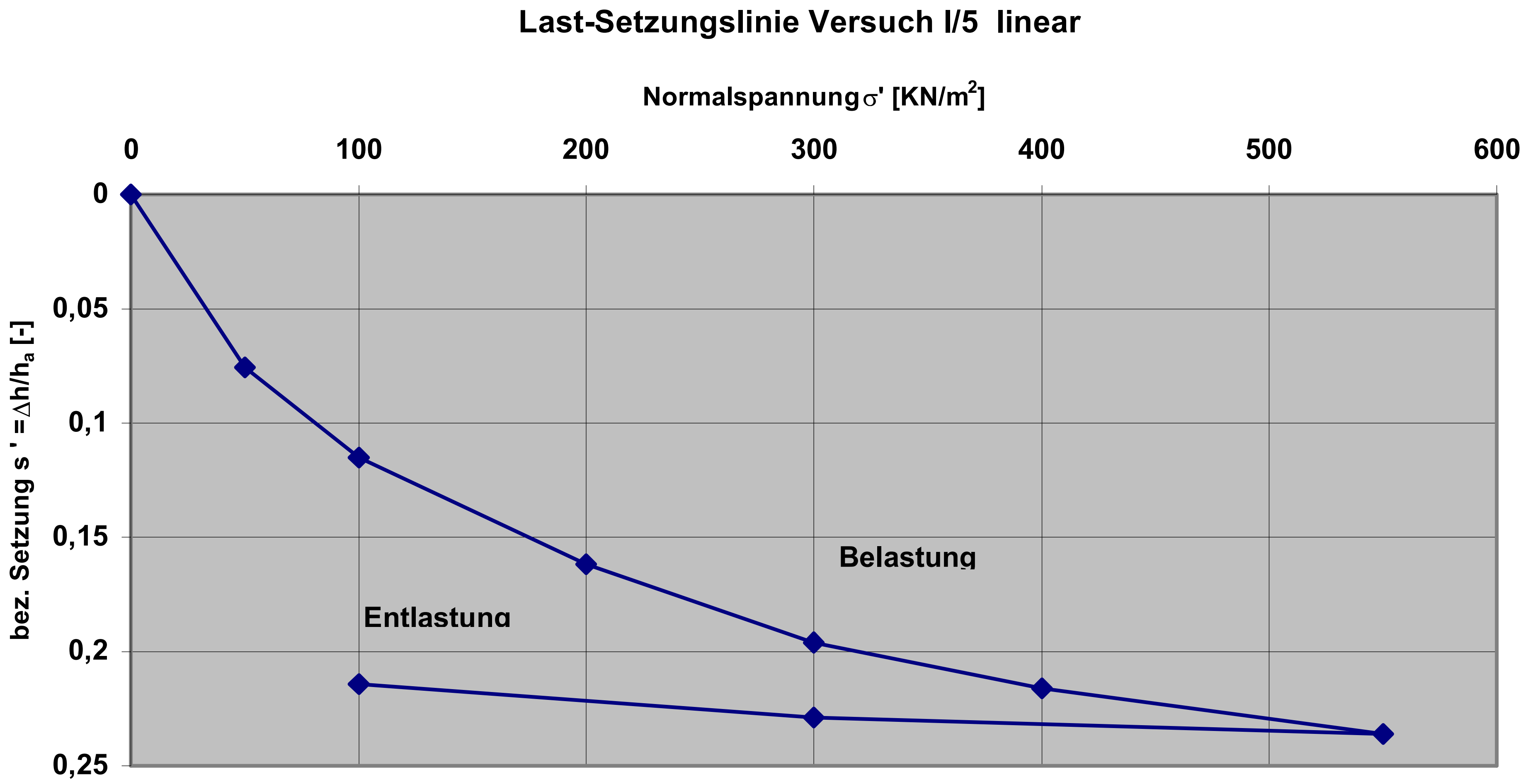
- Placement density at 50 cm layers even higher vs. 30 cm
- A maximum of 3 compaction turns is sufficient, the rest is done by surcharge of the following layers
- Static compaction seems to be slightly better than dynamic (vibration)
- Weight of compactor has low influence on compaction result (Reiff und Marx (1999) had different results)
- Placement density between 1.0 and 1.4 g/cm³
- Practical experience on MBP landfills revealed, that at wet conditions the material gets quickly swampy and impassable

Shear diagram MBP-Output 0-30mm (example)

Düllmann 2002



Load-subsidence-graph (linear) Düllmann 2002

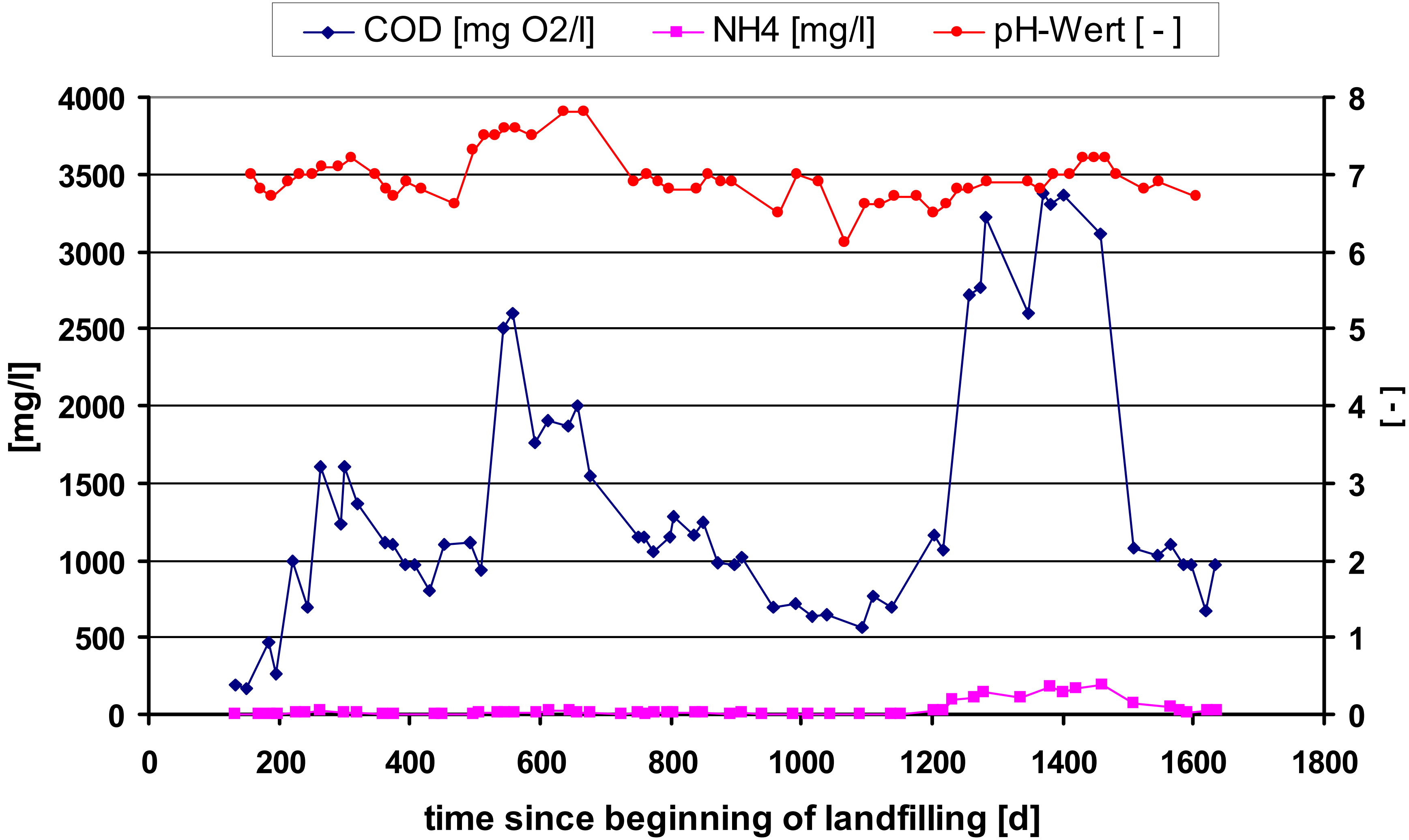


Geomechanical properties

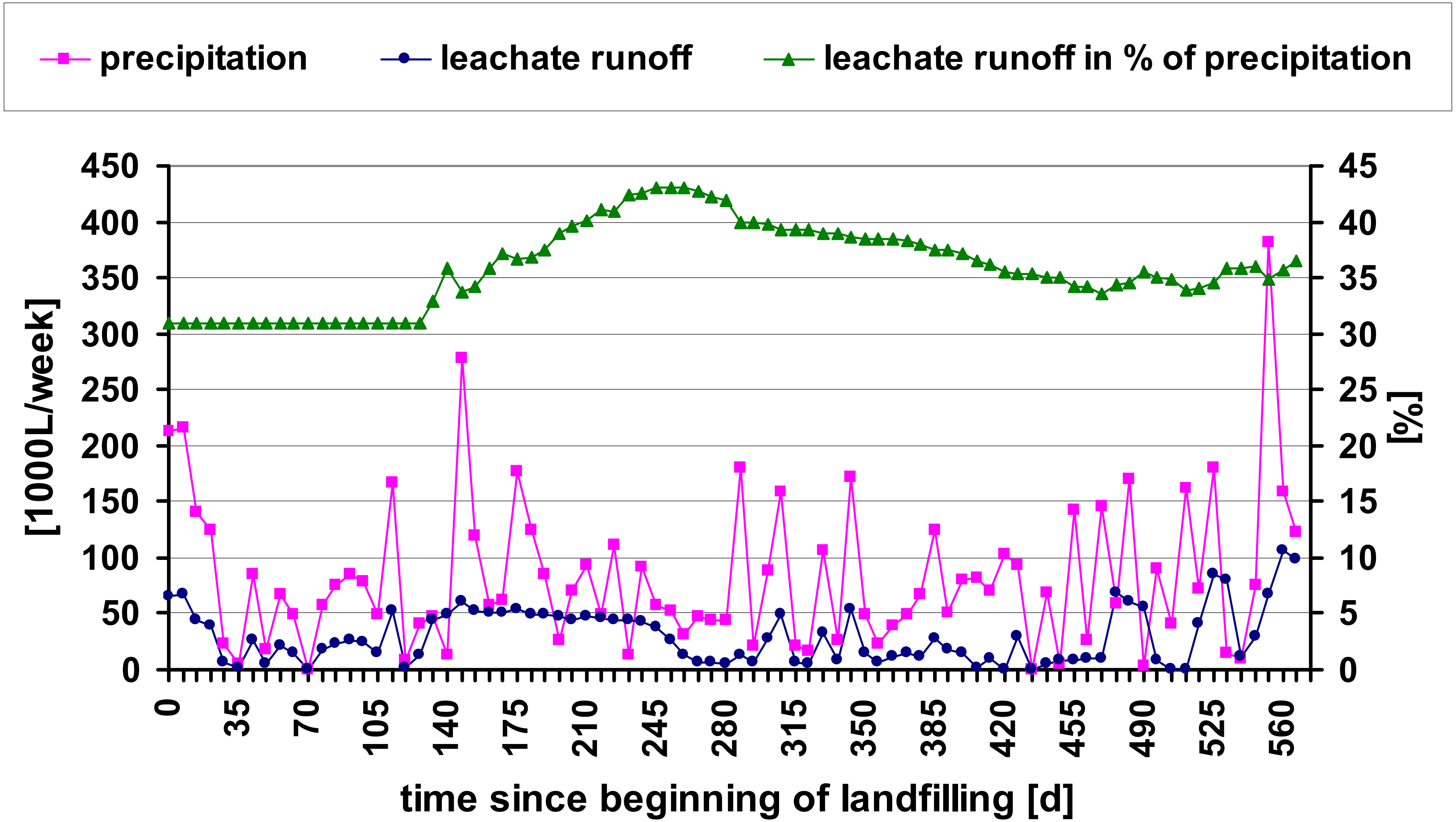
grain size		mm	0-20				0-40				0-60			
origin			V4		V5		V4		V5		V4		V5	
placement moisture		%mo	36		41		37		46		36		41	
		%DM	56		70		58		84		57		70	
placement density	moist	g/cm³	1,40		1,50		1,40		1,50		1,40		1,40	
	dry	g/cm³	0,90		0,90		0,90		0,90		0,90		0,80	
			fail	slide	fail	slide	fail	slide	fail	slide	fail	slide	fail	slide
angle of shear		°	33	33		34	34	34	36	36	35	35	35	27
cohesion c´		kN/m²	38	21		16	43	21	23	11	35	20	49	62
oedometric modulus E_S at a surcharge of	25-50	MN/m²			0,80				0,50				0,60	
	50-100	MN/m²			1,00				1,10				1,30	
	100-200	MN/m²			1,80				1,60				2,00	
	200-400	MN/m²							2,80				2,80	
permeability		Lab	a		a	b	a		a	b	a		a	b
		m/s	7,8*E-8		3,7*E-9	2,3*E-10	6,5*E-6		3,6*E-6	7,0*E-10	6,2*E-6		5,2*E-5	1,8*E-8
placement moisture		%DM	56		70	72	58		64	67	57		70	54
placement density	moist	g/cm³	1,2		1,4	1,4	1,1		1,2	1,4	1,2		1,0	1,3
	dry	g/cm³	0,8		0,8	0,8	0,7		0,7	0,9	0,8		0,6	0,9

Leachate quality

(COD-peaks are caused by external influence and will not appear in usual operation)



Precipitation and leachate runoff



Gasproduction

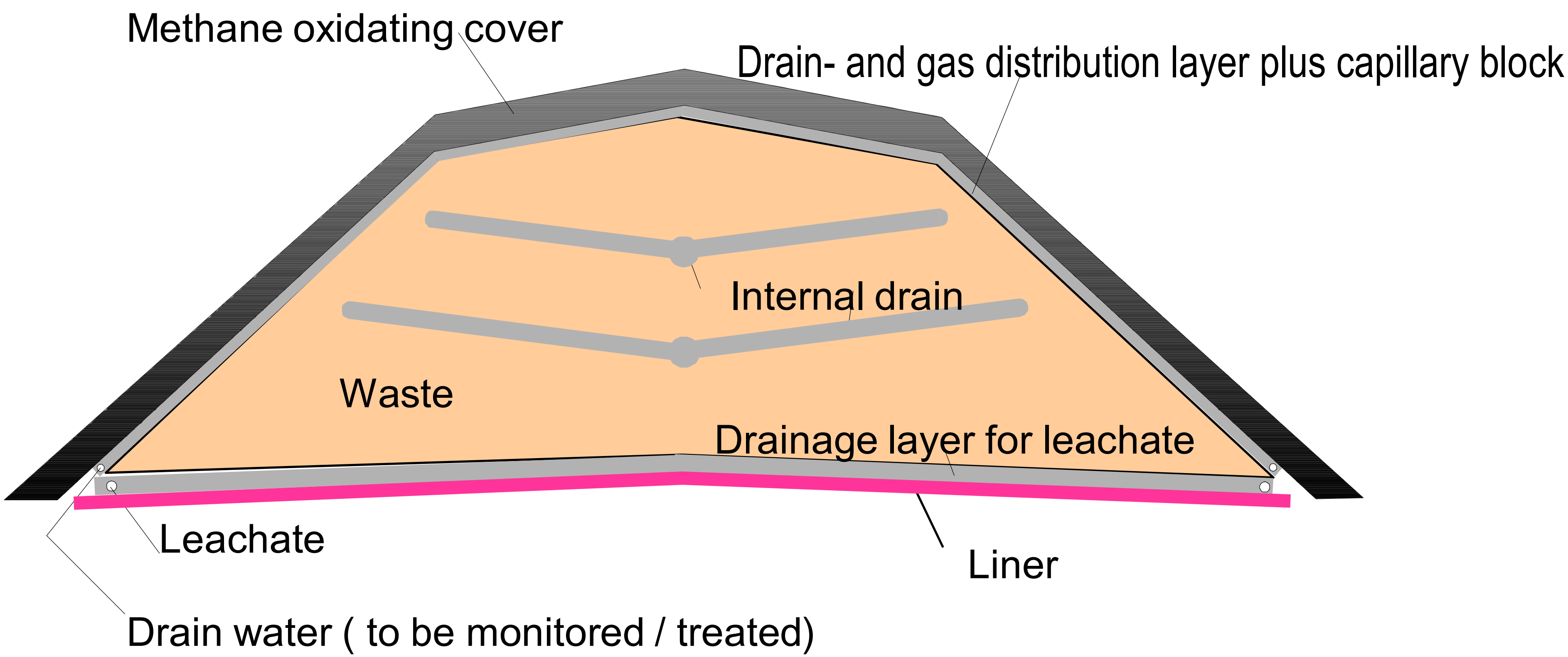
- > 90% less compared with untreated waste
- Gas usage unatractive
- Gas treatment:
  - uncollected by methane oxidation in the landfill cover
  - collected by regenerative thermal oxidation

landfill	CH_4 Vol.%	O_2 Vol.%	CO_2 Vol.%	equals to landfill phase
a	45	0	52	phase III, instable methaneous
i	70	0	22	end phase V, long time
u	60	0	37	ende phase IV, stable methaneous

Further recommendations

- Stability analysis has to consider the individual properties of the local MBP output
- Implacement preferably at dry weather conditions
- Small implacement area;(Dach et al., 1999)
  - < 25.000 Mg/a < 0,5 ha
    < 50.000 Mg/a< 1,0 ha
    < 100.000 Mg/a < 2,0 ha
- Placement moisture should be low to prevent excess porewater pressure
- Possibly an internal drainage is necessary to prevent excess porewater pressure, but internal drains might be inefficient at low permeabilities -> supporting banks (dams) might be necessary!
- Water circulation in untreated waste below MBP waste should be kept going on

Landfill construction



Internal drains might be inefficient at low permeabilities -> supporting banks might be necessary!