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The Dutch sustainable landfill management project

Heijo Scharff – Afvalzorg

Journée thématique sur la post-gestion des C.E.T., 23 mai 2017, Liège

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Content

- EU Landfill Directive
- Dutch Landfill Directive
- SLM methodology
- Assessment of effectiveness
- Stabilisation techniques
- History, status and planning
- Financial aspects
- Messages

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EU Landfill Directive 1999

- Article 1 – Overall objective
  - prevent or reduce negative effects on human health and the environment, during the whole life-cycle of the landfill
- Article 10 - Cost of the landfill of waste
  - costs of the closure and aftercare covered for at least 30 years
- Article 13 - Closure and aftercare procedures
  - operator shall be responsible as long as may be required by the competent authority
  - competent authority has to consider the time during which the landfill could present hazards

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Dutch Landfill Directive 1993

- Objective: protection of human health and the environment
- Means: isolation with bottom liner and surface sealing
- Implication: isolation has to be renewed periodically
- Assumption aftercare: continue into eternity
- Far too long for commercial enterprises
- Responsibility transferred to competent authority
- Closure procedure: determination final aftercare fund
- Disadvantages:
  - Burden transferred to future generations
  - Long-term financial uncertainty

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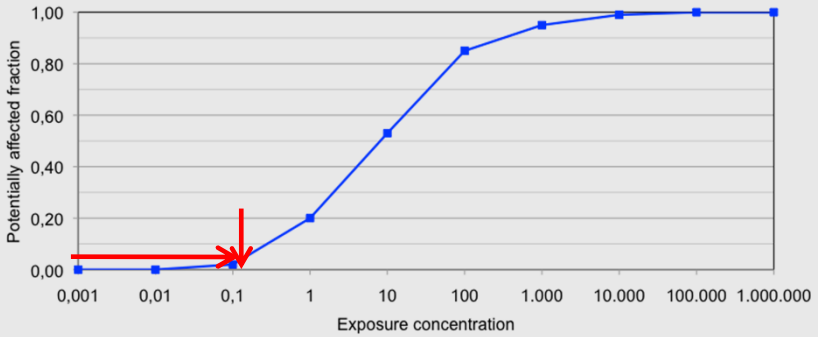
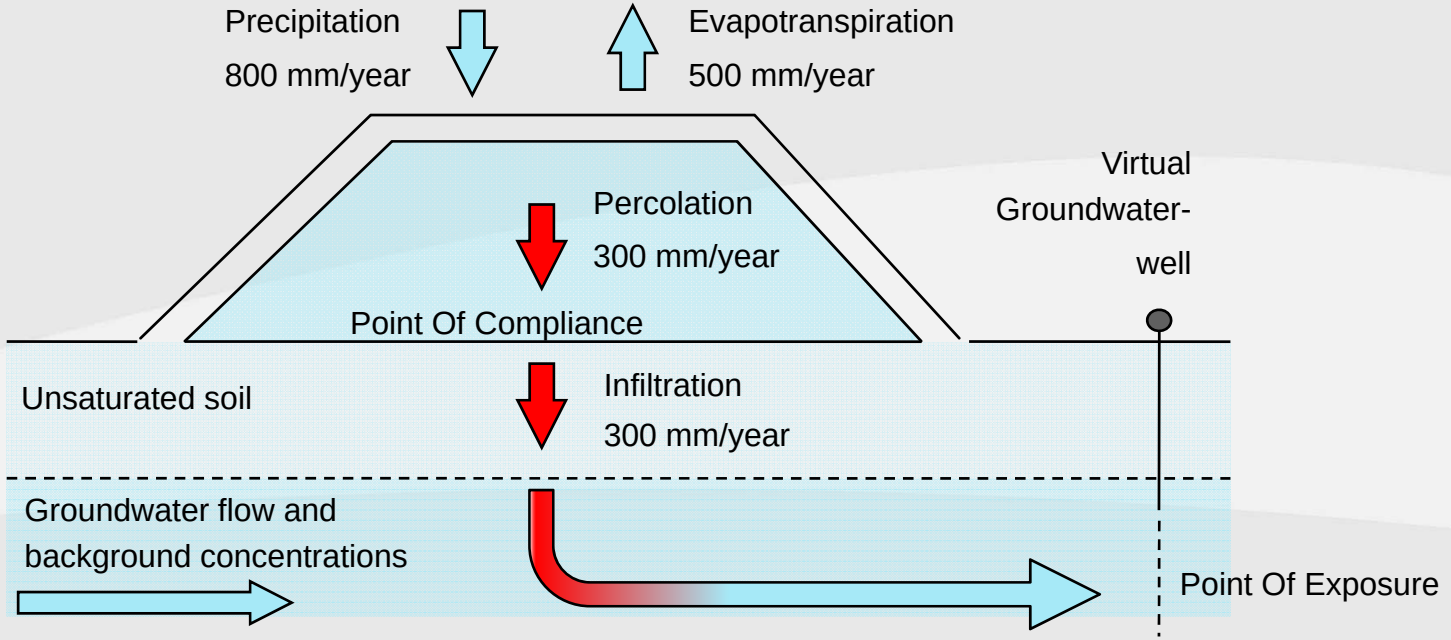
http://www.rivm.nl/en/Documents_and_publications/Scientific/Reports/2014/mei/Development_of_emission_testing_values_to_assess_sustainable_landfill_management_on_pilot_landfills_Phase_2_Proposals_for_testing_values

Methodology

approach





Source: E. Brand, T. De Nijs, J. Claessens, J. Dijkstra, R. Comans, R. Lieste, 2014, Development of emission testing values for pilot landfills for sustainable landfill practices - Phase 2: Proposals for testing values, RIVM Report 607710002/2014, RIVM, Bilthoven, Netherlands

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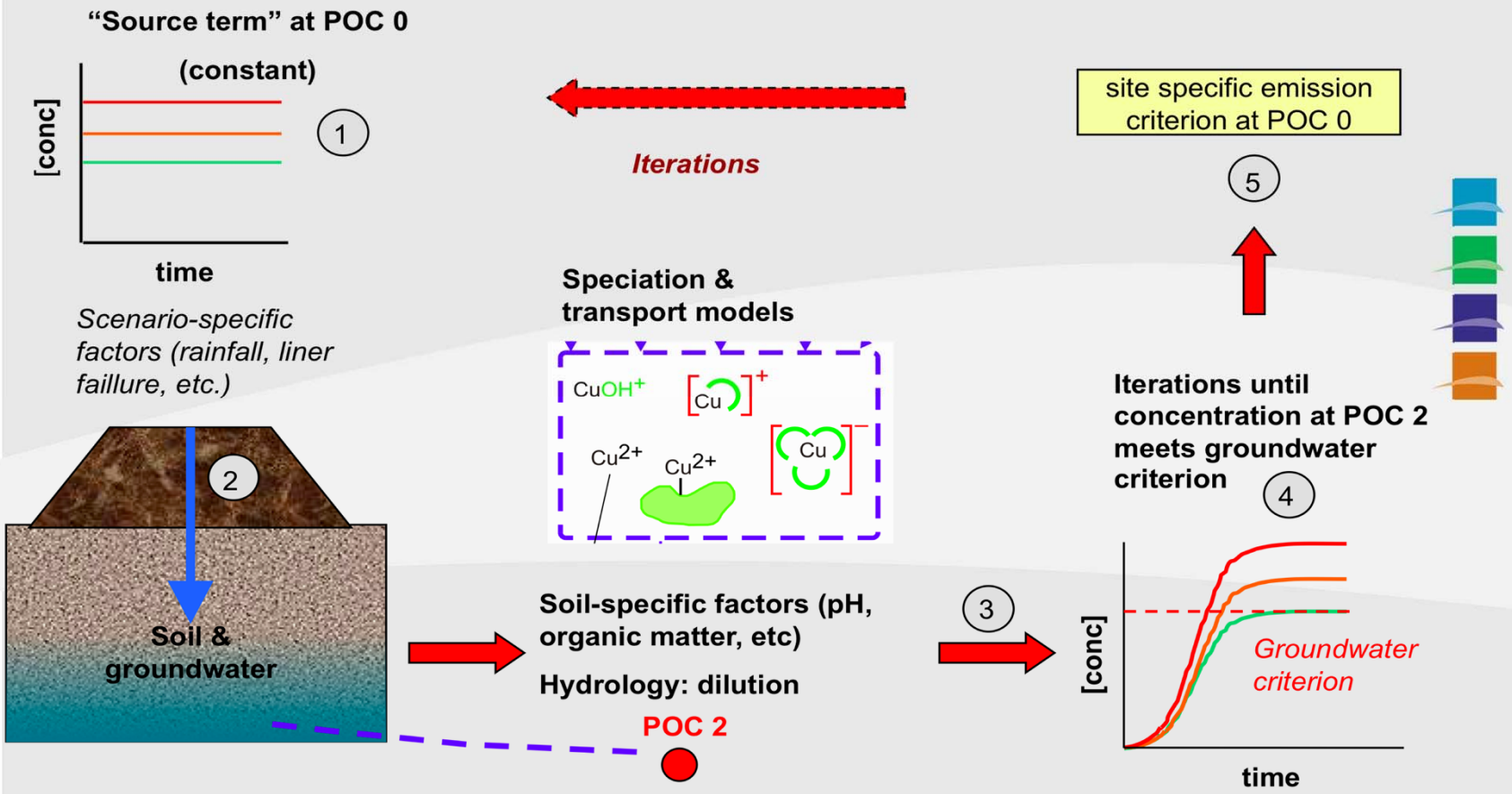
Methodology

calculation



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Methodology

emission target values

Substances	Unit	Braam-bergen	Kragge	Wiering-ermeer
Arsenic	µg/l	190	100	190
Cadmium	µg/l	6.4	3.6	1.3
Chromium	µg/l	210	140	37
Copper	µg/l	50	64	19
Mercury	µg/l	5.8	4.1	1
Lead	µg/l	60,000	130	25,000
Nickel	µg/l	21	47	21
Zinc	µg/l	160	120	39
Cyanides	µg/l	61	6.8	35
Chloride	mg/l	450	160	2,400
Ammonium	mg/l	1.8	1.1	50
Sulphate	mg/l	700	200	1,400
Phosphate	mg/l	n.v.t.	n.v.t.	n.v.t.

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Methodology

emission target values

Substances	Unit	Braam-bergen	Kragge	Wiering-ermeer
Sum mineral oil C10-C40	µg/l	470	270	100
Vinylchloride	µg/l	0.047	0.014	0.01
Dichloromethane	µg/l	0.047	0.014	0.01
1,1 dichloroethane	µg/l	4.7	1.4	1
1,2 dichloroethane	µg/l	1.4	4.1	3
1,1 dichloroethene	µg/l	0.047	0.014	0.01
1,2 dichloroethene (cis,trans)	µg/l	0.047	0.014	0.01
Dichloropropane (1,2)	µg/l	3.8	1.1	0.8
Dichloropropane (1,3)	µg/l	3.8	1.1	0.8
Trichloromethane (chloroform)	µg/l	4.7	1.4	1
1,1,1 trichloroethane	µg/l	0.047	0.014	0.01
1,1,2 trichloroethane	µg/l	0.047	0.014	0.01
Trichloroethene (tri)	µg/l	47	14	10
Tetrachloromethane (tetra)	µg/l	0.047	0.014	0.01
Tetrachloroethene (per)	µg/l	0.047	0.014	0.01

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Methodology

emission target values

Substances	Unit	Braam-bergen	Kragge	Wiering-ermeer
Naftalene	µg/l	0.047	0.014	0.01
Fenantrene	µg/l	0.028	0.016	0.006
Antracene	µg/l	0.0066	0.0038	0.0014
Fluoranthene	µg/l	0.056	0.033	0.006
Chrysene	µg/l	0.056	0.033	0.006
Benzo(a)antracene	µg/l	0.0019	0.0011	0.0002
Benzo(a)pyrene	µg/l	0.0094	0.0054	0.001
Benzo(k)-fluoranthene	µg/l	0.0075	0.0044	0.0008
Indeno(1,2,3cd)-pyrene	µg/l	0.0075	0.0044	0.0008
Benzo(ghi)perylene	µg/l	0.0056	0.0033	0.0006
Sum PAH-10	µg/l	1.9	1.1	0.2
Benzene	µg/l	0.94	0.27	0.2
Xylene	µg/l	0.94	0.27	0.2
Toluene	µg/l	4.7	1.4	1
Ethylbenzene	µg/l	4.7	1.4	1
Phenols	µg/l	0.94	0.27	0.2

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Assessment of effectiveness

	Reduction mechanismens	Estimated reduction	Necessary reduction
Heavy metals			
arsenic	increase Fe(OH)3-complexation	20-50%	0-10%
cadmium	n.c.		none
chromium	decrease DOC-complexation	>60%	0-25%
copper	n.c.		none
nickel	decrease DOC-complexation	>60%	30-50%
lead	decrease DOC-complexation	>25%	none
zink	decrease DOC-complexation	>0%	0-40%
mercury	n.c.		none
Macro parameters			
chloride	flushing	10-80%	0-90%
sulfate	formation during aeration	0%	0-10%
ammonium	anammox, nitrification, denitrification	50-90%	75-98%
Organic micro pollutants			
mineral oil	decrease DOC-complexation, aerobic degradation	>90%	0-70%
VOX	stripping, aerobic degradation	>95%	0-90%
PAH	decrease DOC-complexation, aerobic degradation	>90%	95-99%
BTEX	stripping, aerobic degradation	>95%	60-99%
fenols	aerobic degradation	>> 90%	0-99%

n.c: not considered: current concentrations already comply with target values

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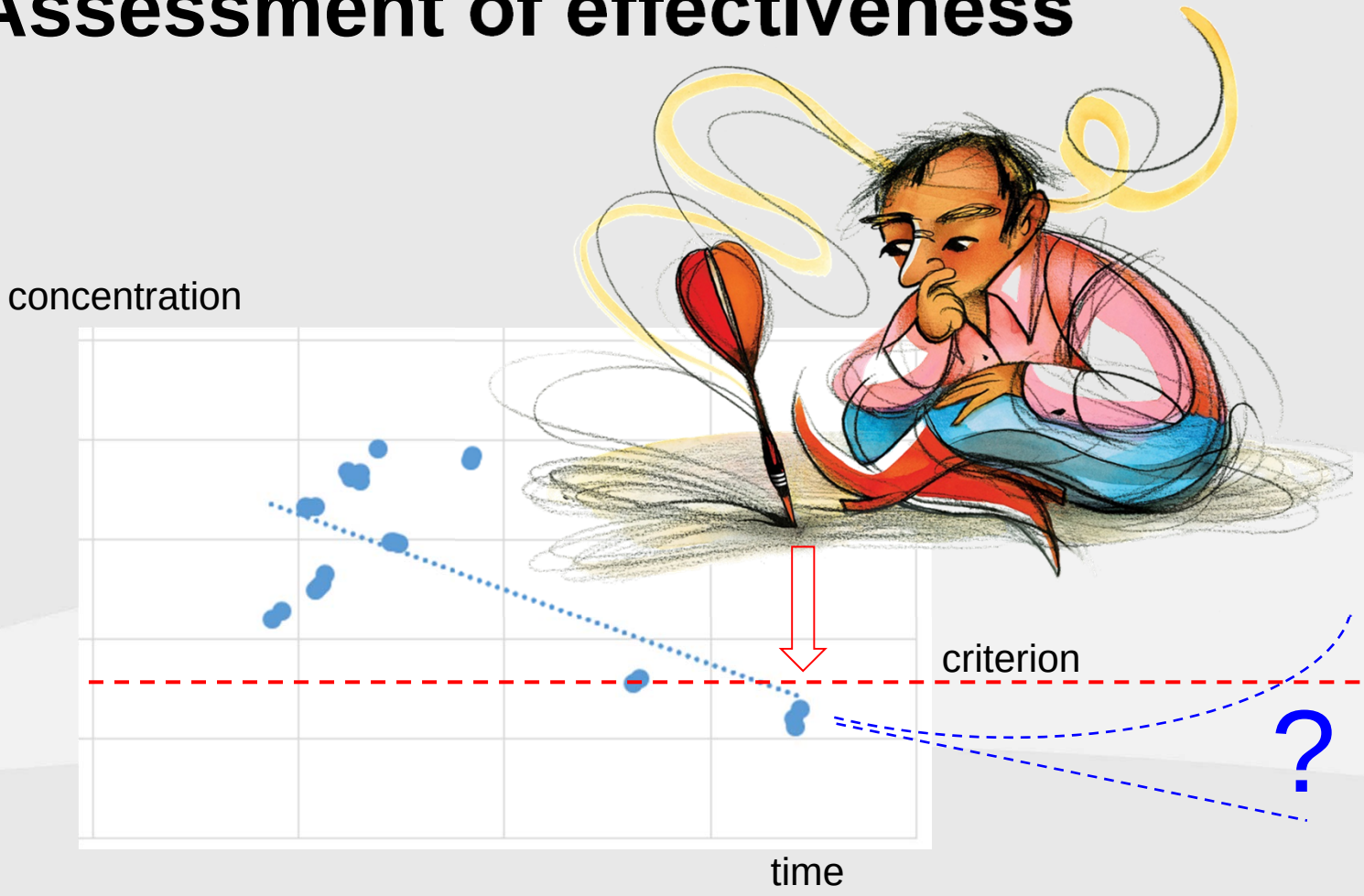
Assessment of effectiveness



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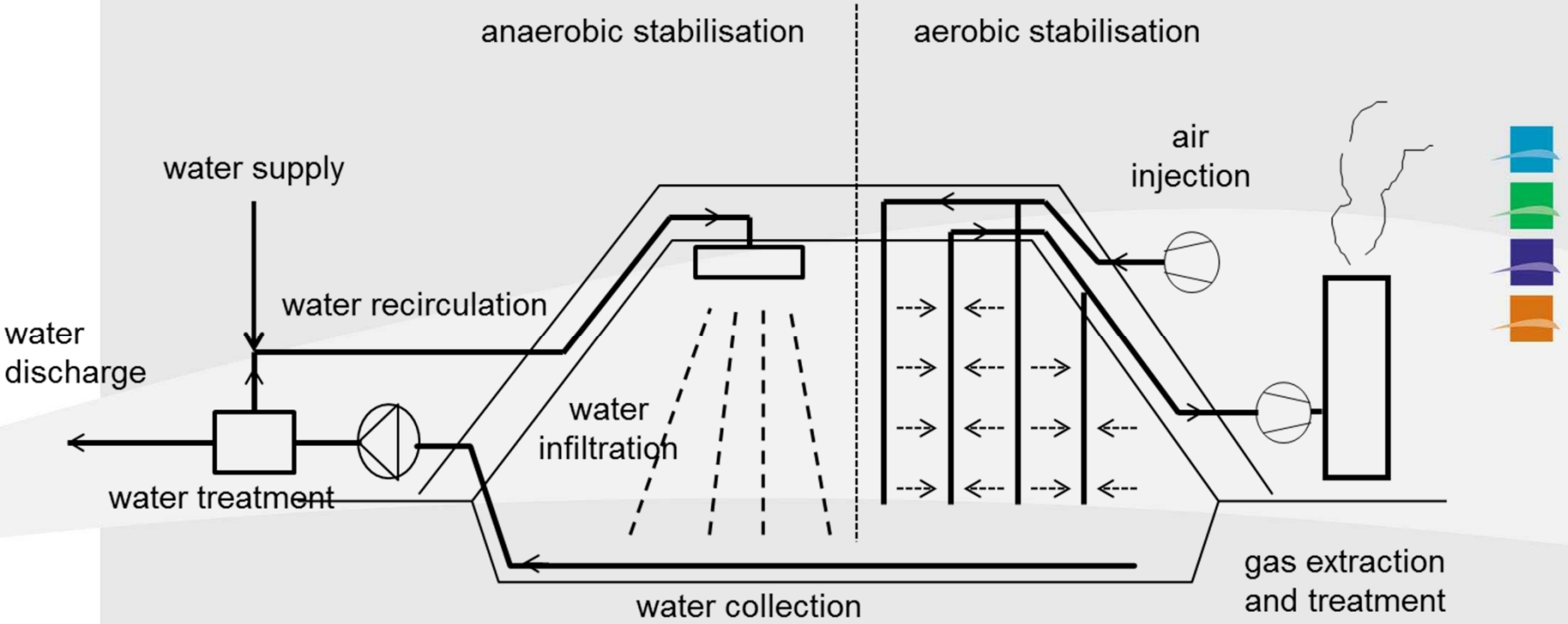
Stabilisation techniques



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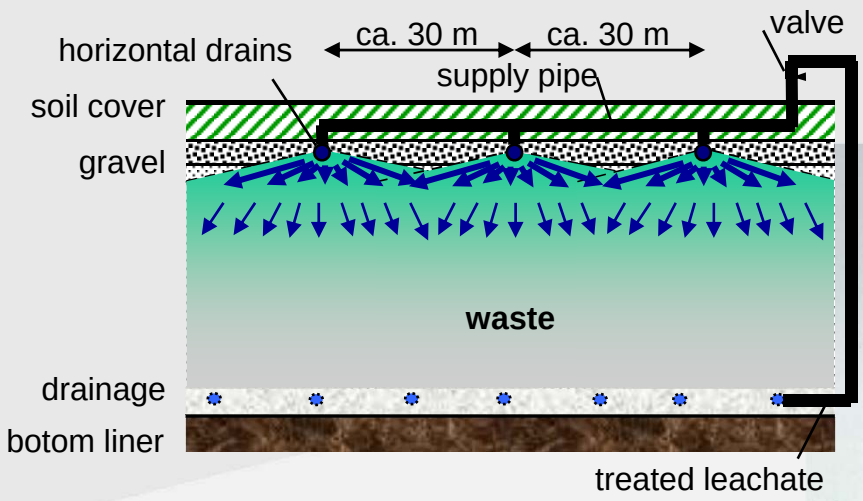
Infiltration

pilot Kragge (Bergen op Zoom)



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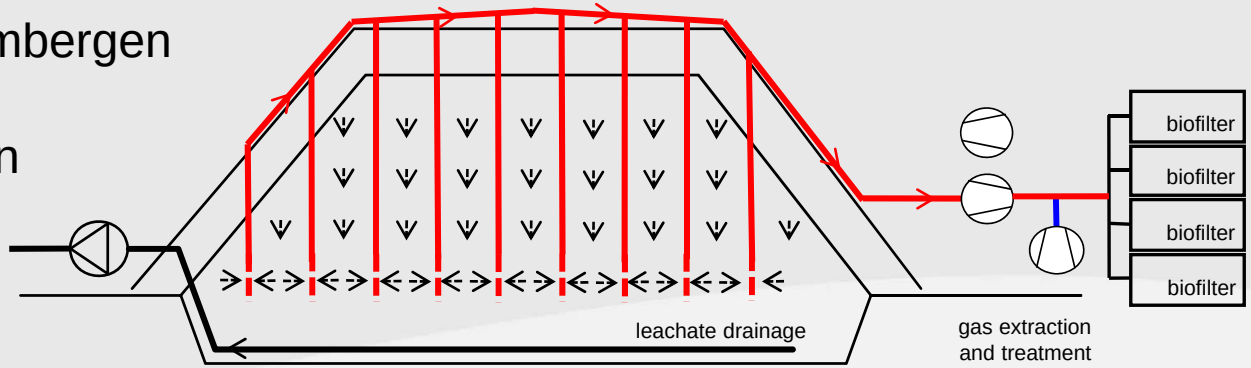
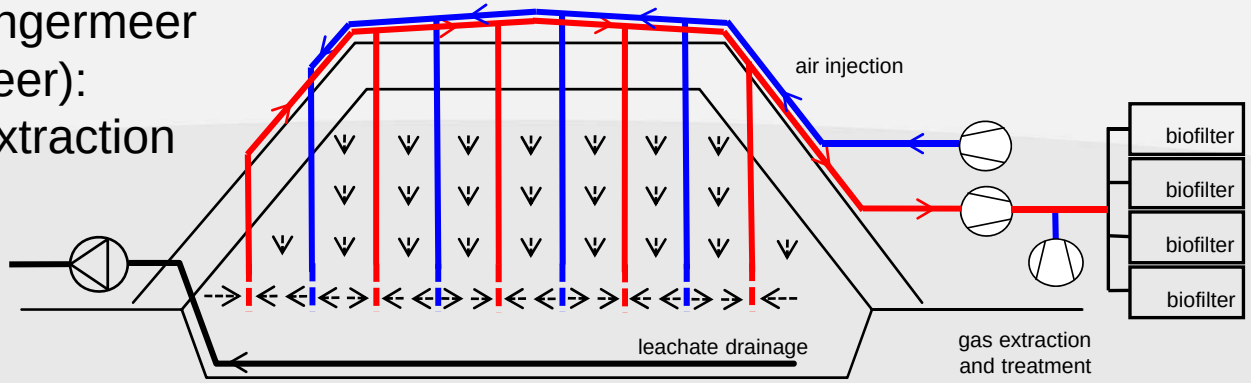
Aeration

two approaches

Pilot Braambergen (Almere): oversuction



Pilot Wieringermeer (Middenmeer): injection-extraction



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Aeration

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History

1994: contest “landfill in the next century”

1997: feasibility sudies: 4 concepts of sustainable landfill

1999: Dutch Sustainable Landfill Foundation

2000-2005: 3 sustainable landfill pilot projects

2007-2009: feasibility studies accelerated stabilisation

2010-2014: iSLM: investigations and discussions

2015: GreenDeal iSLM

Introduction Sustainable Landfill Management

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Status and planning

kick-off 22 May 2017

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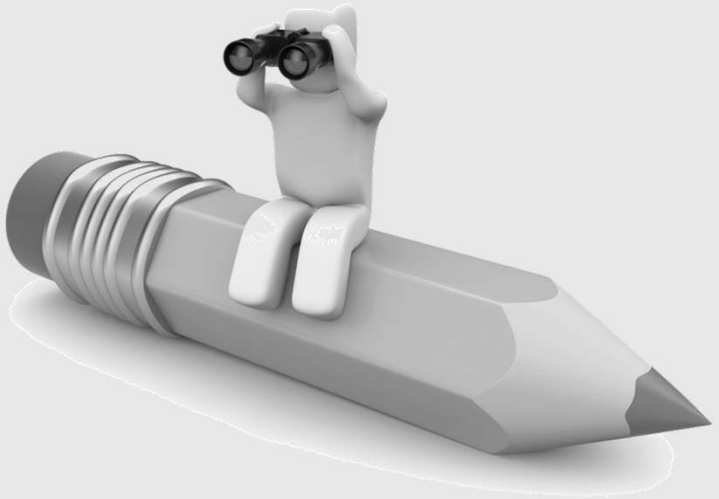
Status and planning



2016: amendment of legislation, final design and permits

2017: construction, start and monitoring

2018 onwards: fundamental research

2021: intermediate evaluation

2026: final evaluation

2028: amendment of landfill regulation

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Status and planning research

- Techniques are proven, but:
- Can target values be reached?
- Especially NH_4^+ and Cl^-?
- What certainty for the future?
- Nitrogen degradation?
- Preferential pathways?

Fundamental research required!

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Financial aspects

- Estimated costs of 3 pilots and monitoring programmes: 12 M€
- Funded by landfill operators through DSLF
  - Membership fee: € 0.0725 per tonne landfilled and year: 12%
  - Postponement surface sealing: € 0.36 per m^2 and year: 36%
  - Own contribution of the two pilot operators: 52%
- Research funding: three different project proposals for applied science and technological innovation already 1.2 M€ granted
- Please note:
  - Total estimated sum of aftercare for 22 operational landfills: 526 M€
  - Estimated cost of surface sealing on 19 landfills: 160 M€
  - Estimated cost reduction of iSLM on 19 landfills: 90 M€

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Messages

- Landfill aftercare will take a few hundred rather than 30 years
- Hundreds of years of aftercare entails financial uncertainty
- It is by definition not in line with sustainable development
- Accelerated stabilisation is necessary to not impose the burden of our landfills on future generations
- Site-specific determination of the risk for HHE is possible
- Proof of compliance with targets requires further research
- Regulators have to be prepared to update landfill directives

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Thank you for your attention

Nauerna landfill, november 2010