

Sustainable Emission Reduction at Existing Landfills in the Netherlands

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Royal Haskoning

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Sustainable Aftercare of Existing Landfills
Masterclass ISWA World Congress, Lisbon 2009



ROYAL HASKONING

Presentation outline

- ✓ Background information
- ✓ Concept of sustainable aftercare existing landfills
- ✓ Conclusions and future perspectives

Categories of landfills (in the Netherlands)

Old landfills (4000)

- closed and abandoned \pm 40-50 years ago
- non separated waste
- no protection measures

Present landfills (70)

- in operation and recently closed
- separated waste
- protection measures (partly) present

New landfills: to be designed for future landfilling

Sustainable aftercare solutions existing landfills

4000 old landfills



Remediation legislation



NA-research at 80 landfills
1999 - 2002



Downstream groundwater



NA-groundwater monitoring
strategy

70 present landfills



Prevention legislation



Research sustainable emis-
sion reduction (2008-2009)

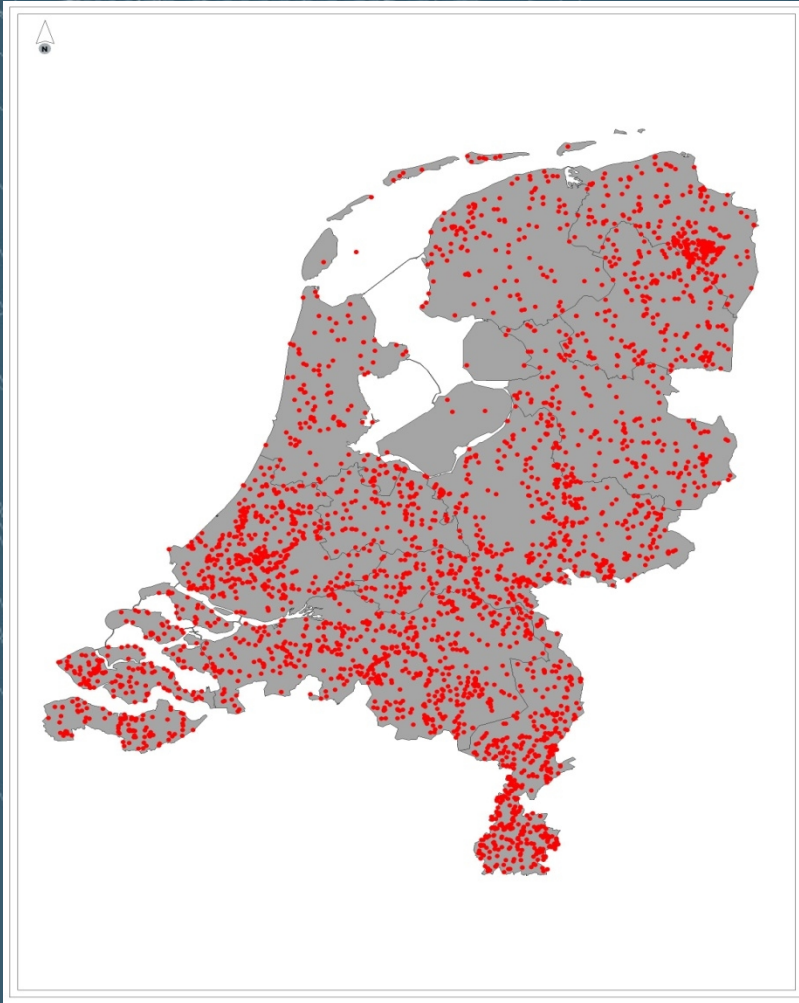


Processes in waste body



Sustainable Aftercare
based on NA (SANA)

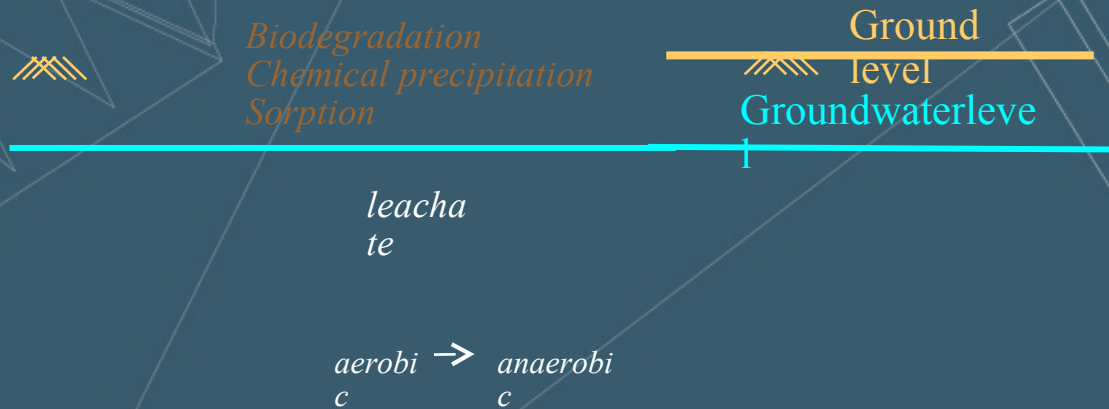
Old and abandoned landfills (4000)



> 75% is clean:
no inadmissible
contamination in
groundwater

What is NA ?

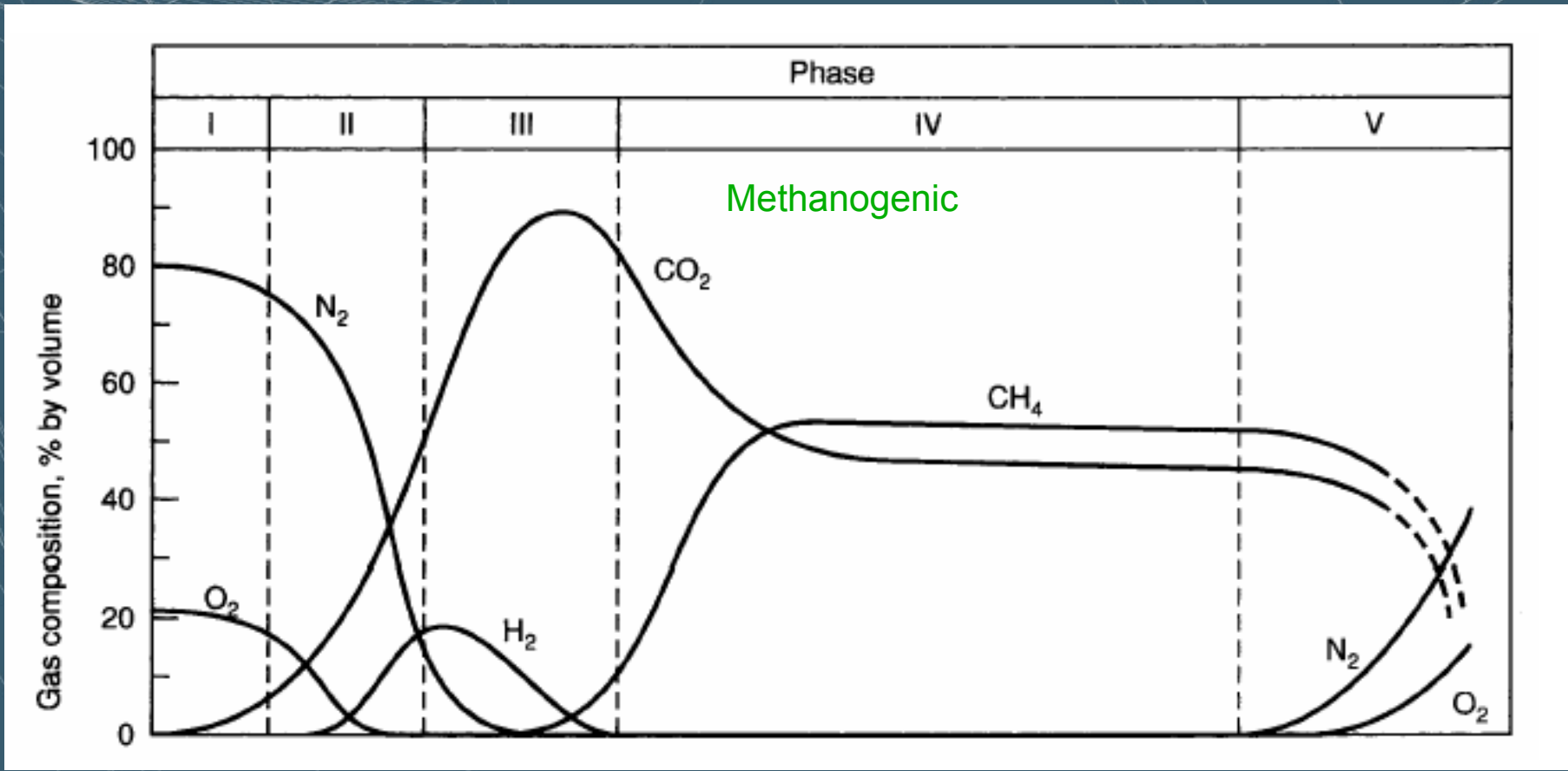
All natural processes in and around the landfill, which are able to neutralize contamination to admissible levels.



- Driving force = degradation of organic matter
- Different sequential redoxconditions in leachate/plume

Life-cycle landfill: degeneration process of waste

(Farquhar & Rovers 1973)



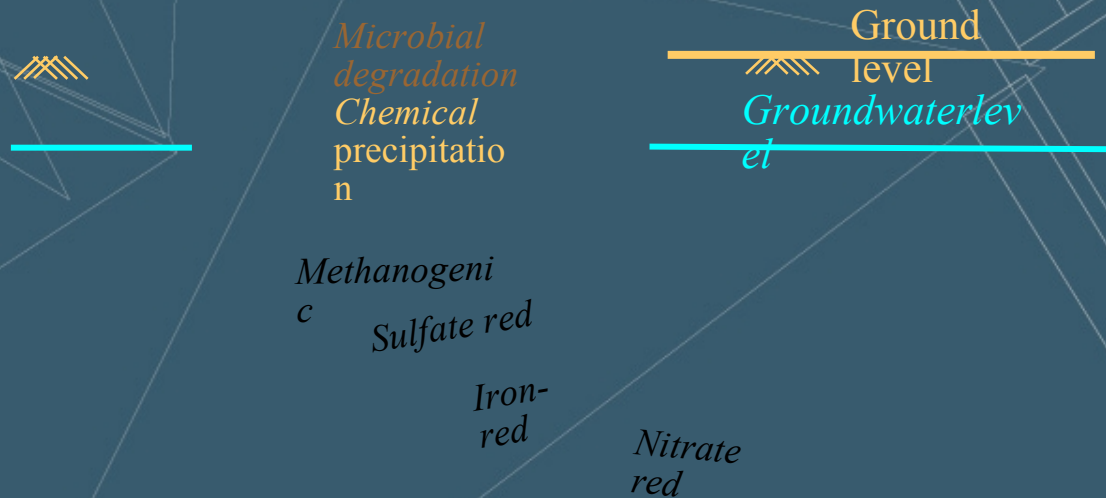
weeks

months

years

decades

NA: favourable methanogenic redoxconditions



Prerequisites:

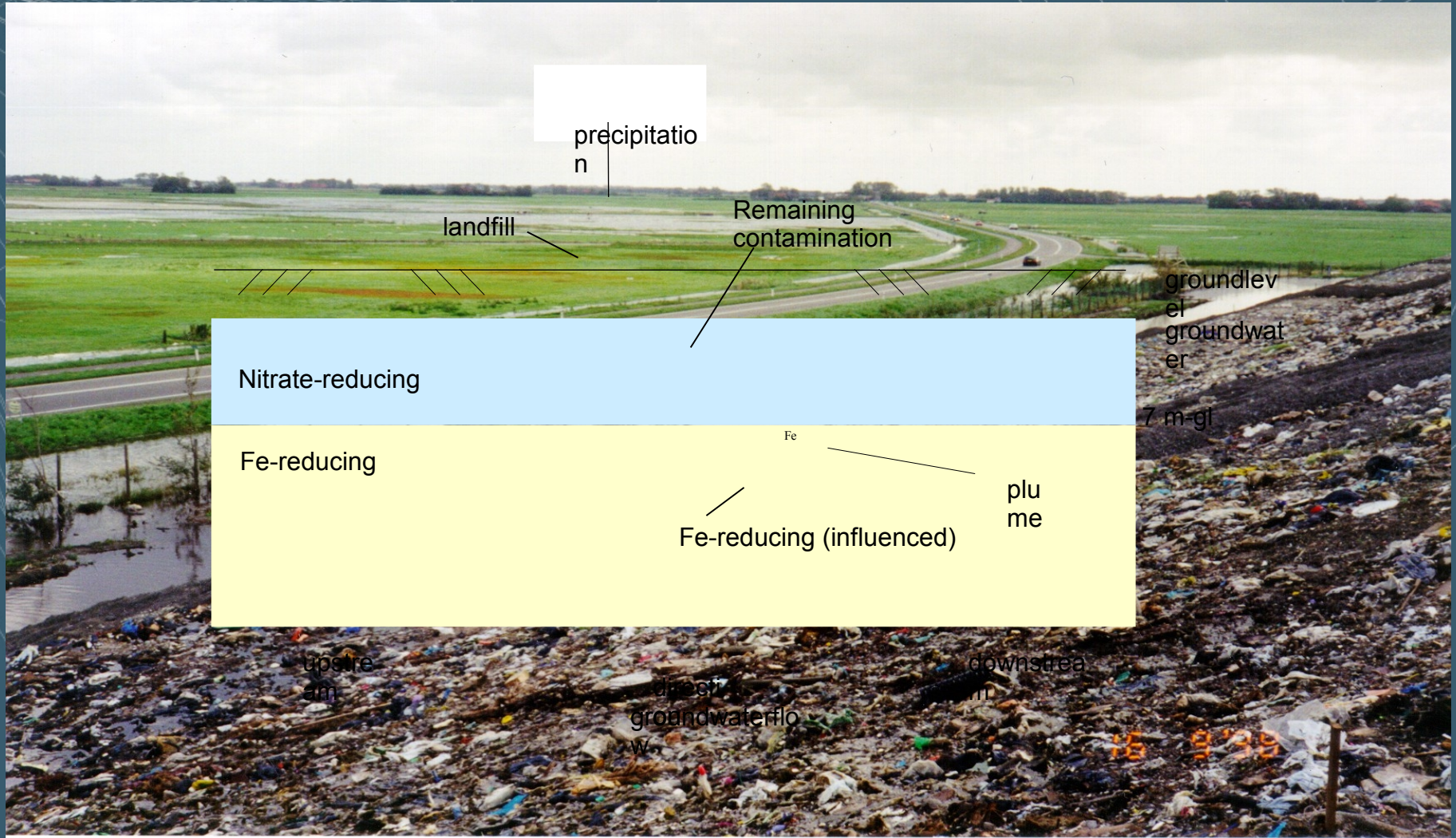
- ✓ presence of organic matter
- ✓ Long term presence of water

Significance of NA at old landfills: core notions

NA is “the self-cleaning ability of nature”

- ✓ Landfill is a dynamic biochemical reactor
- ✓ Admissible emissions of contaminants to groundwater
- ✓ Harmless landfill → discharge from aftercare
- ✓ Improves communication (blackbox→greybox→whitebox)
- ✓ Redevelopment of landfill site at earlier stage

Redoxconditions (pilot landfill Lochem)



NA-groundwatermonitoring: economic advantages

- ✓ Less chemical parameters, less piezometers, lower frequency of monitoring-rounds
- ✓ Less expensive monitoring (during operational stages as well as in aftercare stage)
- ✓ Lower costs of aftercare measures
- ✓ Discharge from aftercare redevelopment landfill site at an earlier stage profits at an earlier stage

NA-groundwatermonitoring: strategic advantages

- ✓ The right data at the right time to take the right strategic decisions with respect to discharge from aftercare
 -
- ✓ Improvement of understanding and explainability of the absence/presence of pollutants
 -
- ✓ Improvement of communication between landfill-owner and competent authorities and to society
 -
- ✓ Increase of quality and reliability in decision making for both landfill-owner and competent authorities

Statements

- Validated risk-assessment methodology for landfills, based upon European expertise **and including Natural Attenuation** is available.
- NA-methodology has been embedded in the traditional investigation methodologies of landfills (in NL).
- Foundation of a European NA-databank (*80 + 162 Dutch landfills, 139 Hungarian landfills, 20 Lithuanian landfills, other European countries*) will contribute to a better understanding of the (absence of) actual and future risks of landfills.

Sustainable aftercare solutions existing landfills

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Research sustainable
emission reduction (2009)



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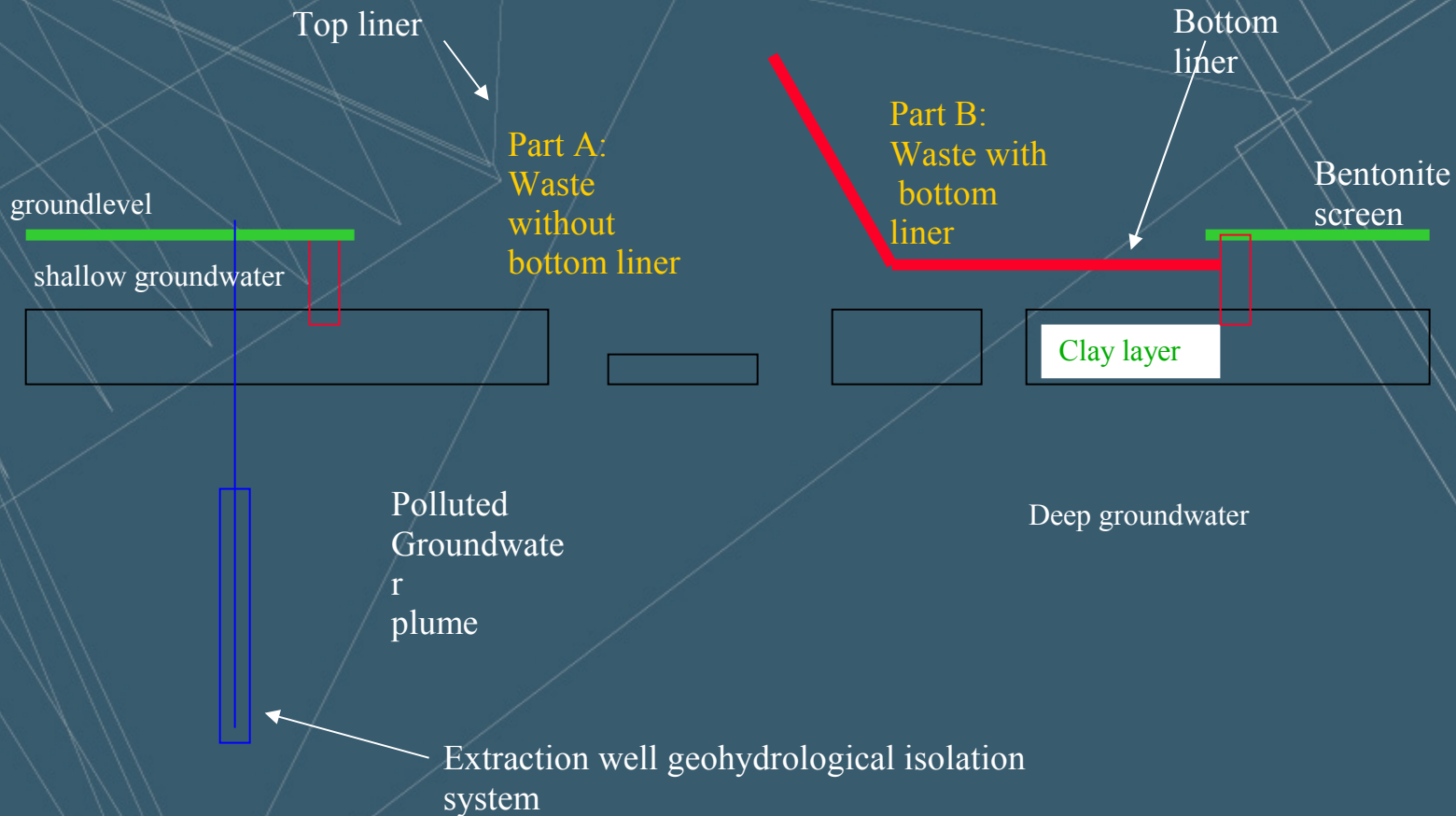


Sustainable Aftercare
based on NA (SANA)

Present landfills in NL

- 70 landfills
- 50% closed
- 50% operational
- 2,5 mln m³/yr of waste.
- remaining landfill capacity: 50 mln m³ for next 20 years

Present landfills: cross section



European legislation

EU-directive 1999/31/EC on the landfilling of waste

Aim is to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste during the whole life-cycle of the landfill.

Dutch legislation on landfills (1993)

Same general objectives as the EU-directive, but.....

Translated in the aim to isolate the landfill as soon as possible from its environment by means of strict directives for the construction of protection and aftercare measures such as bottom liners, top liners, geohydrological containment measures and monitoring of groundwater quality



- no sustainable solution → waste remains polluted
- next generations are burdened with unsolved problem
- everlasting and expensive aftercare

Sustainable aftercare: strategy & approach

SANA-Model

Sustainable Aftercare based on Natural Attenuation

NA- measurements

Natural Attenuation
knowledge and expertise of natural processes in terms of the self-cleaning ability of nature

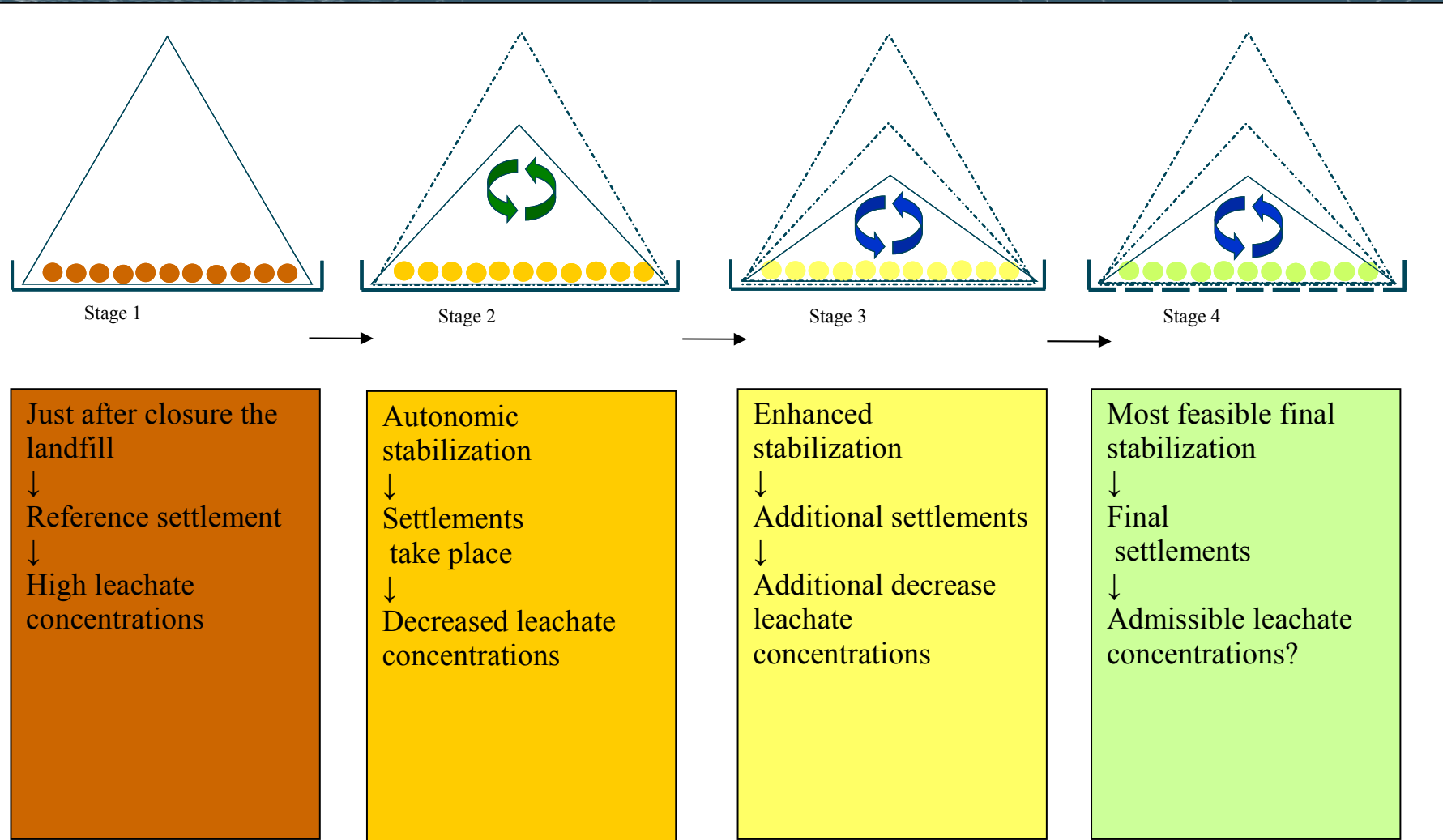
processing
&
interpretation

Existing historical data
biogas production
leachate
groundwater

Explain actual situation
presence/absence
contaminants
increase/decrease
contaminants
blackbox → greybox →

Extrapolation to future
behaviour of emissions
time of admissible emissions
time of discharge from
aftercare

Process of stabilization of organic matter



Just after closure the landfill
 ↓
 Reference settlement
 ↓
 High leachate concentrations

Autonomic stabilization
 ↓
 Settlements take place
 ↓
 Decreased leachate concentrations

Enhanced stabilization
 ↓
 Additional settlements
 ↓
 Additional decrease leachate concentrations

Most feasible final stabilization
 ↓
 Final settlements
 ↓
 Admissible leachate concentrations?

NA-potential micro's versus degradation phases

	Phase 1 Aerobic	Phase 2 Acidification	Phase 3 Anaerobic transition	Phase 4 Methano- genic	Phase 5 Aerobic (borders) Anaerobic (inside)
Heavy metals	Partial leaching and emission		Chemical precipitation		Partial leaching (borders) Precipitation (inside)
	Sorption to solid non degradable organic matter (SOM) and silt particles → immobilization				
		Sorption to DOC → emission			
Aerobic degradable organic micro- parameters	Fast decay		Slow decay	Process of decay uncertain	
	Sorption to solid non degradable organic matter (SOM) → immobilization				
Anaerobic degradable organic micro- parameters			Fast decay	Process of decay uncertain	
	Sorption to solid non degradable organic matter (SOM) → immobilization				

Primary and secondary KPI's

General	Leachate	Gas
Temperature	Redox (Eh)	Measured/calculated gas production
Settlements	Ammonia (NH4)	CH4/CO2 - ratio
Waste composition	Conductivity (Ec)	Gas extraction rate
Moisture content	Acidity (pH)	Oxygen (O2)
Moisture transport	Biochemical oxygen demand (BOD)	Inhibitors
Water balance	Chemical oxygen demand (COD)	
Time capsule	COD-BOD	
	BOD/COD ratio	
	Total organic carbon (TOC)	
	Dissolved organic carbon (DOC)	
	Benchmarking (o.a. LeachXS)	
	Chloride (Cl-)	
	Total Volatile Fatty Acids (VFA)	
	Alkalinity	
	Nutrients (including NA-parameters)	
	Sulphate (SO4) and Sulphite (SO2)	
	Nitrate (NO3) and Nitrite (NO2)	

Final conclusions (Vlagheide landfill)

1. The expected occurrence of **positive NA-potential** has been demonstrated → KPI's points in same positive direction
1. Presence of an **impermeable top liner** as well as the present **geohydrological containment measure** is **counterproductive** to sustainable aftercare.
1. The **infiltration and recirculation** of leachate is **favourable** to sustainable aftercare
1. Development of set of **assessment criteria** (KPI's) and corresponding **threshold values** to enable decisionmaking on **discharge or not from aftercare**

Information & reports

NA-groundwatermonitoring

→ www.landfills.nl
Royal Haskoning

Sustainable Emission Reduction

→ www.sustainablelandfilling.com
Dutch Sustainable Landfill Foundation

Final statement

The SANA-model is an effective approach & strategy to be applied at many of our existing landfills in order to demonstrate and create:



Please contact me for benchmarking our results
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THANK YOU FOR YOUR ATTENTION