BORDA

SOUTH AFRICA

Localised reuse opportunities for DEWATS-derived resources

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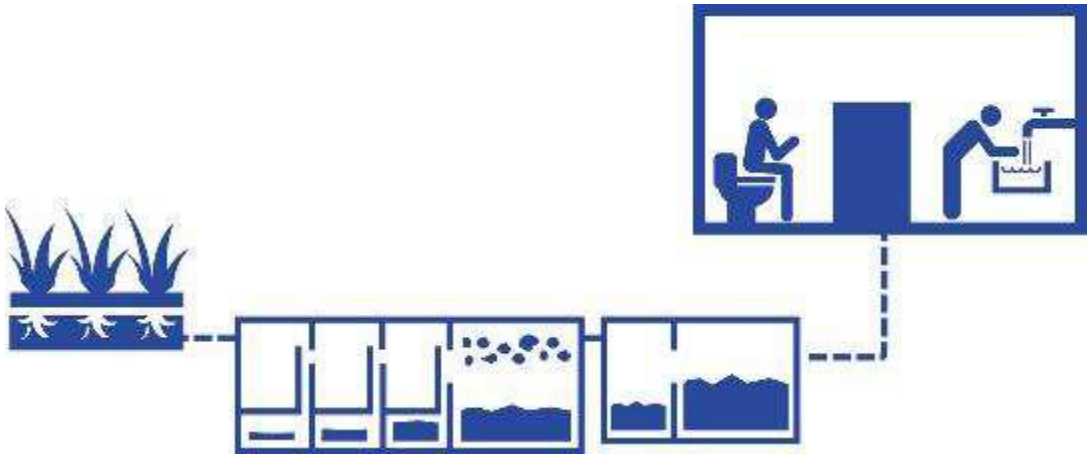
24 July 2019

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Bremen
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Philippines
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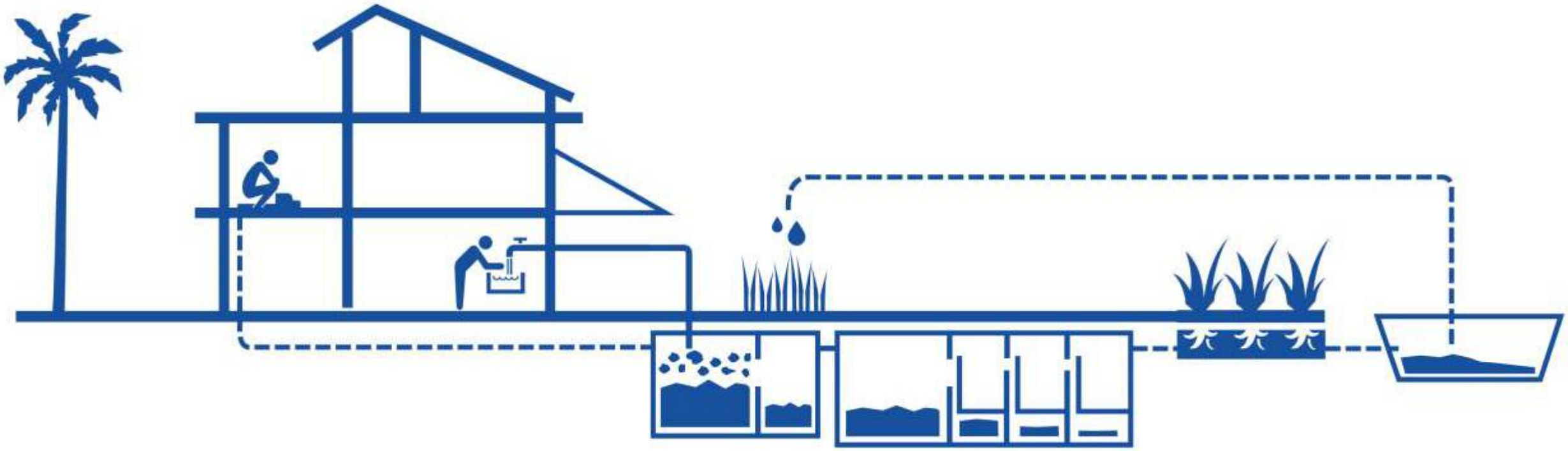
Cuba
Haiti
Mexico
Nicaragua
Ecuador
Tanzania
Zambia
Lesotho
South Africa
Indonesia
Regional Office
Project Partner
6 regions, 25 countries, 350 specialists

DEWATS

DEcentralized WAstewater Treatment Solution



Decentralisation • Simplicity • Reuse

DEWATS is modular

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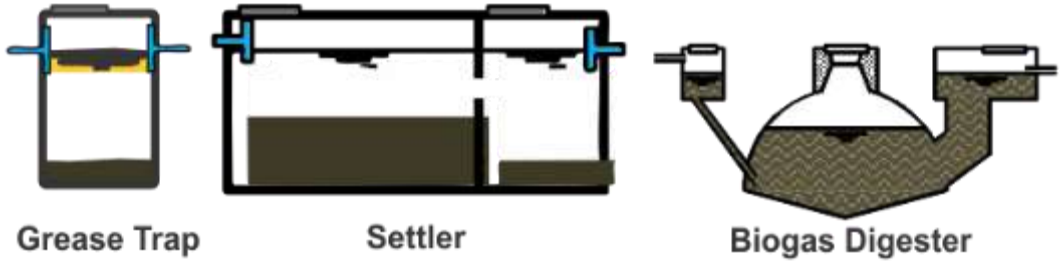
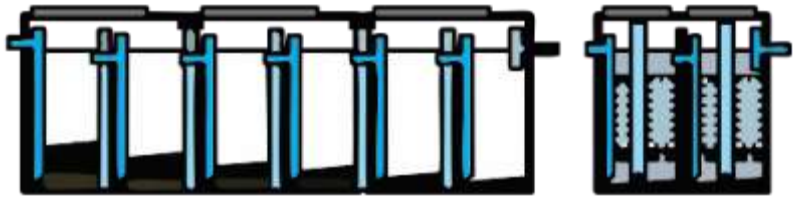
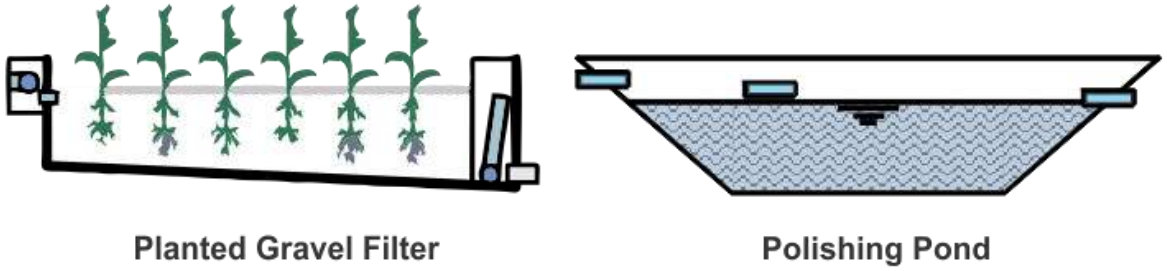
Primary treatment



Secondary treatment

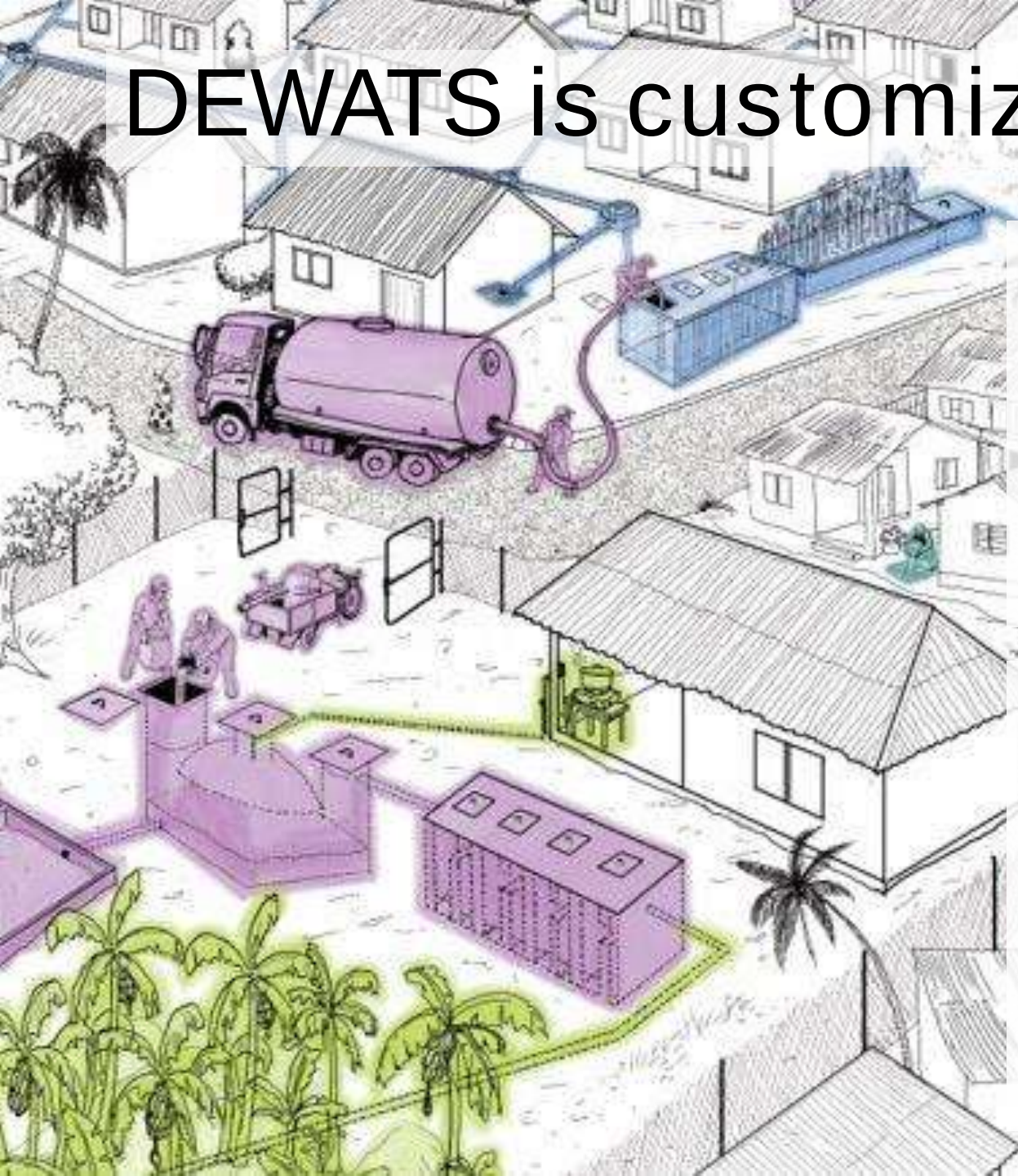


Tertiary treatment



Images adapted from CDD Society, www.cddindia.org/dewats.html

DEWATS is customizable



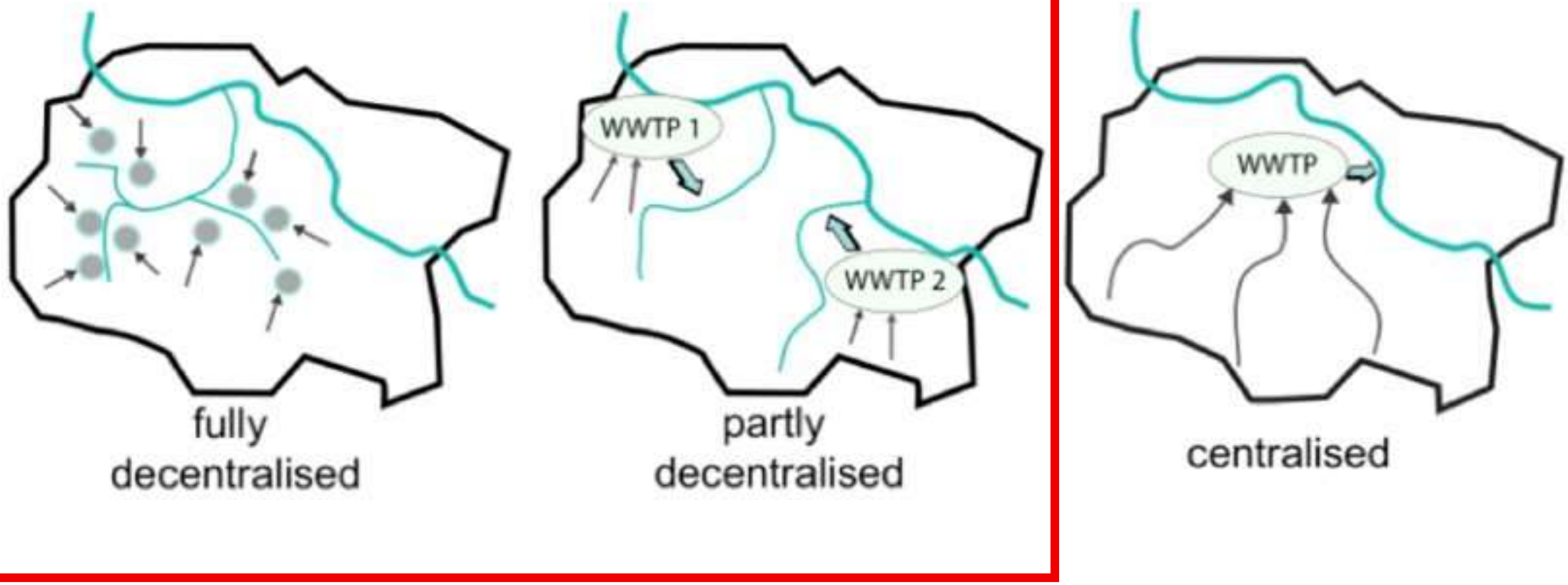
Wastewater characteristics

- Domestic wastewater
- Faecal sludge
- Organic industrial and institutional wastewater
- 1-1500 m^3/day

Applications

- Individual households
- New and existing settlements
- Institutions
- Schools
- Hospitals
- Small and medium-sized enterprises

DEWATS is decentralised



DEWATS benefits

- Local materials, minimal scrap value
- Simple to operate and maintain
- Reduced pipe lengths, pump stations
- No electricity or chemical inputs required → low operating costs
- Can be placed in or near community
- **Beneficial reuse: treated effluent, biogas, urine**

DEWATS fills a sanitation gap

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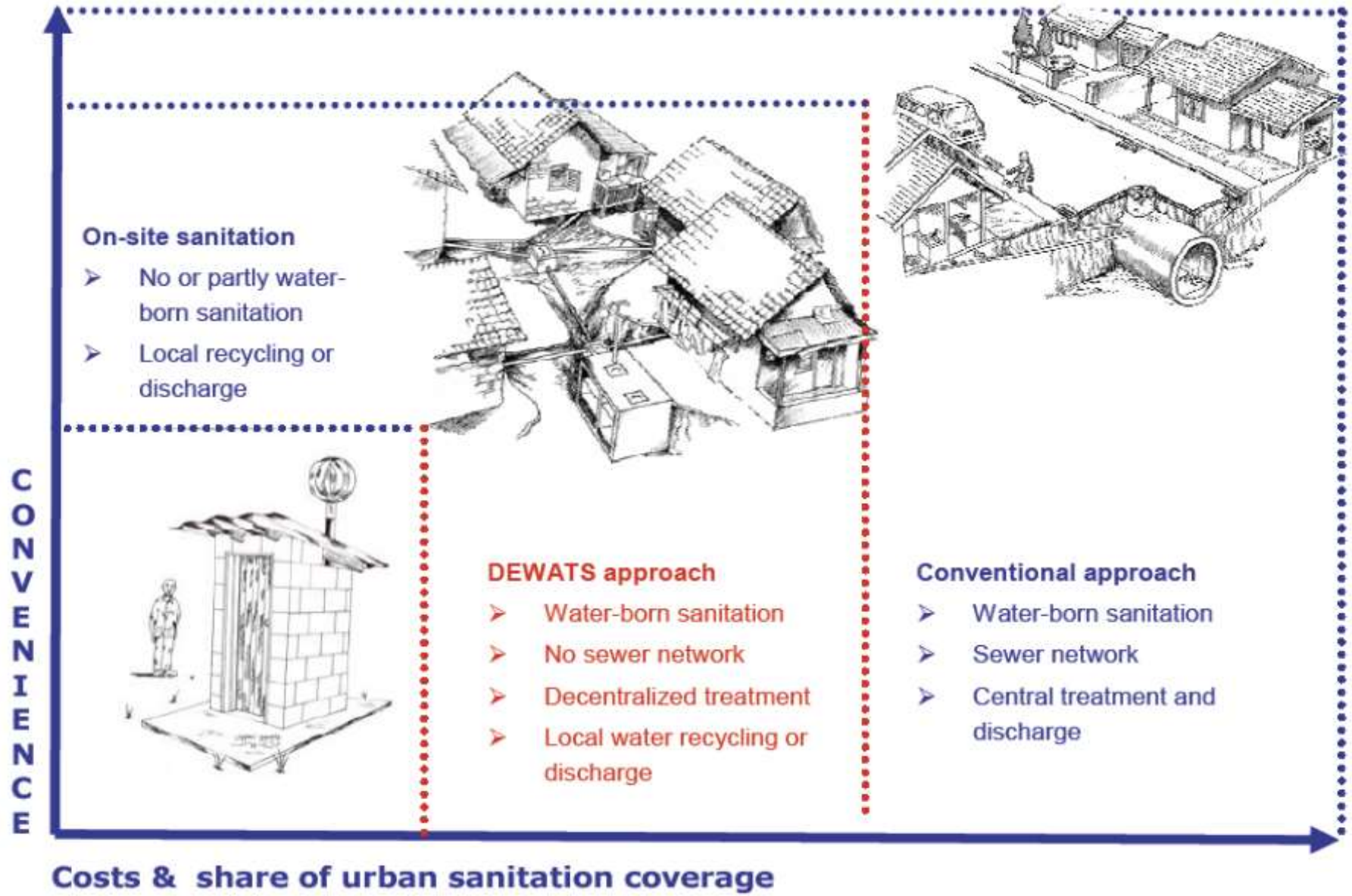


Newlands Mashu demonstration and research DEWATS

ETHEKWINI MUNICIPALITY

PRG pollution research group

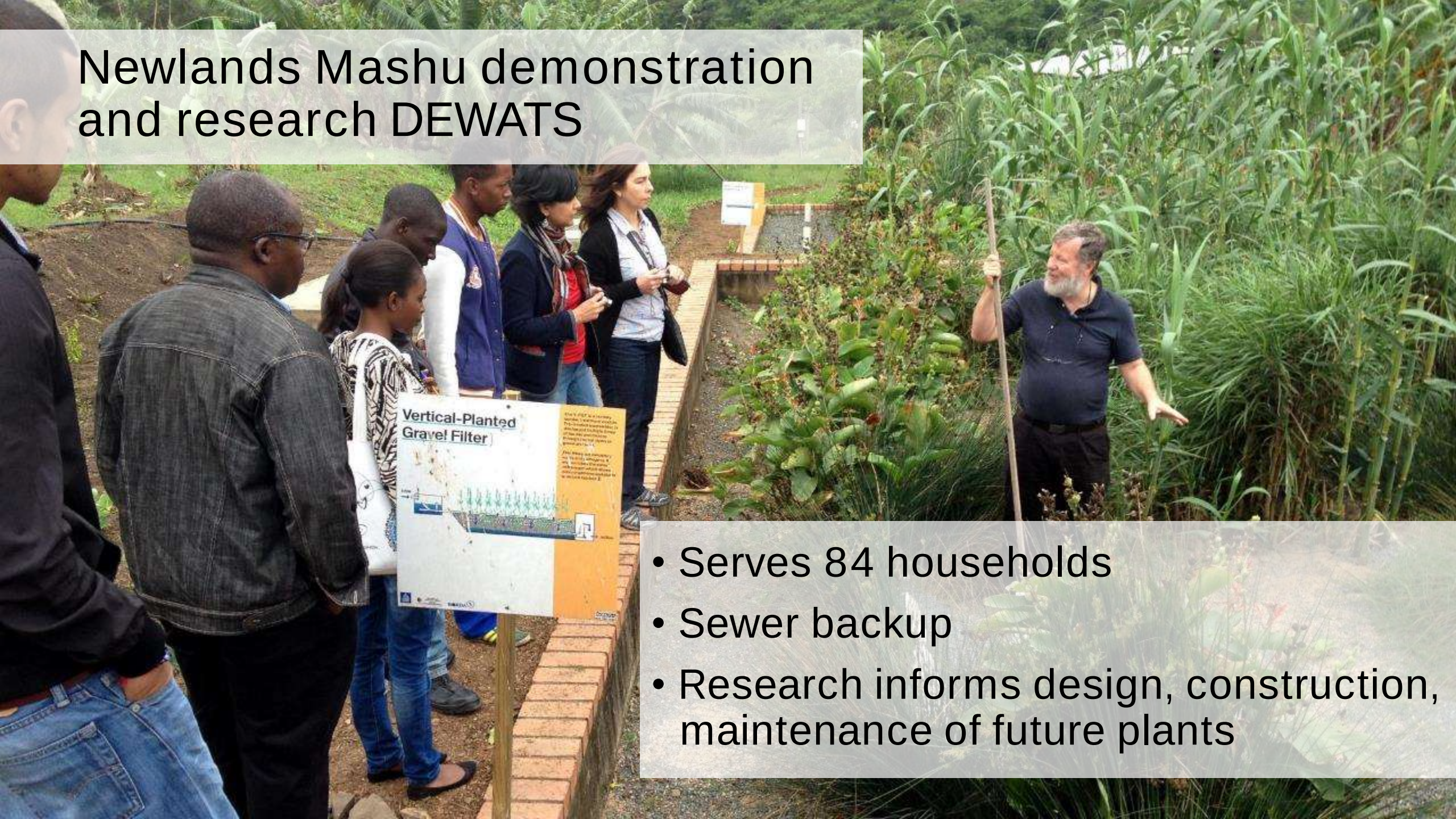
BORDA

UNIVERSITY OF KWAZULU-NATAL

Federal Ministry for Economic Cooperation and Development

Free Hanseatic City of Bremen

Newlands Mashu demonstration and research DEWATS

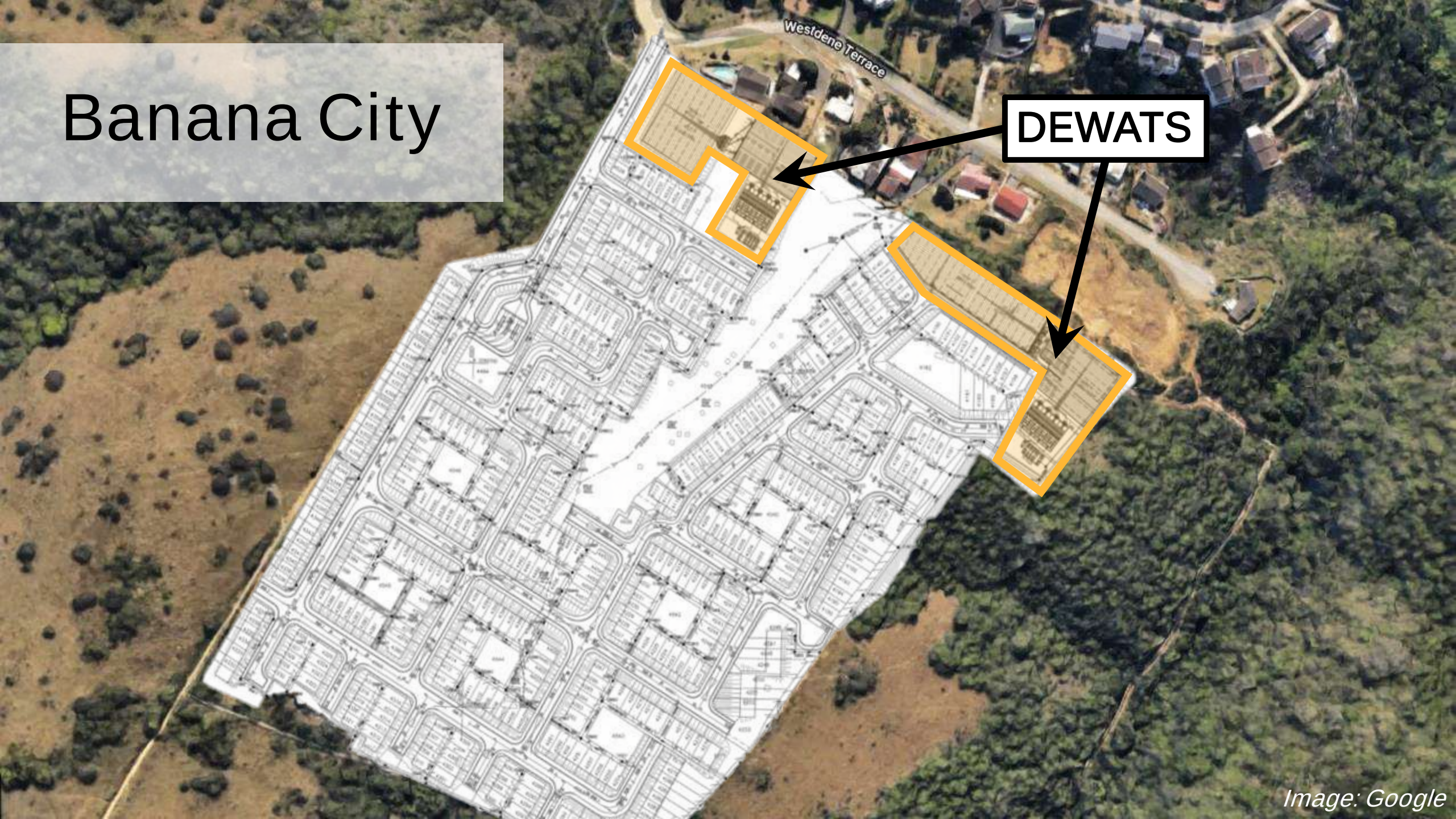


- Serves 84 households
- Sewer backup
- Research informs design, construction, maintenance of future plants

Agricultural research

Banana City

Image: Google


Banana City
Westdene Terrace
DEWATS
Image: Google

eThekwini DEWATS design concept

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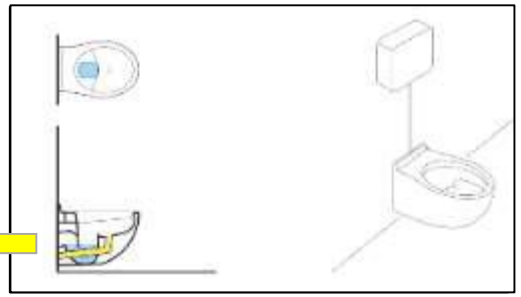
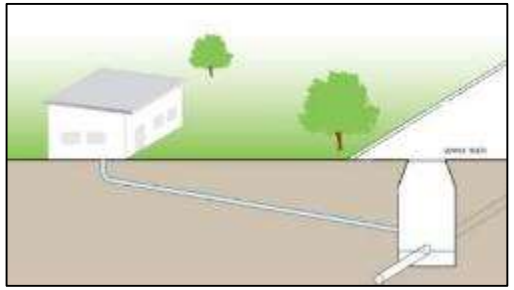
Urine-Diverting Flush Toilets

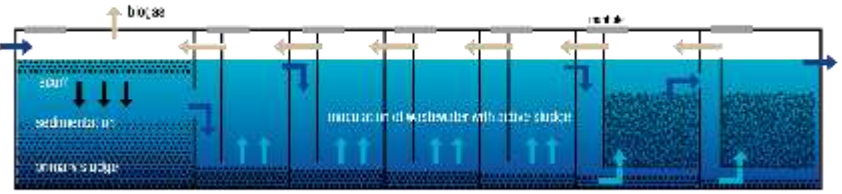


Urine storage + valorisation

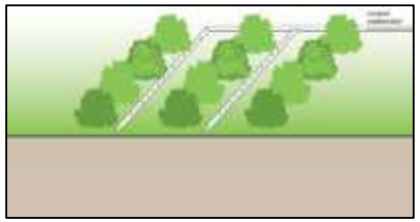
Gravity Sewer



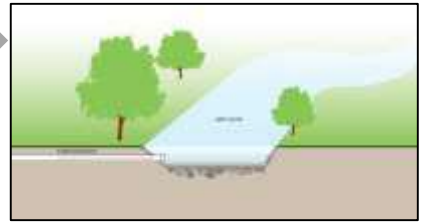
Settler, Anaerobic Baffled Reactor, Anaerobic Filter

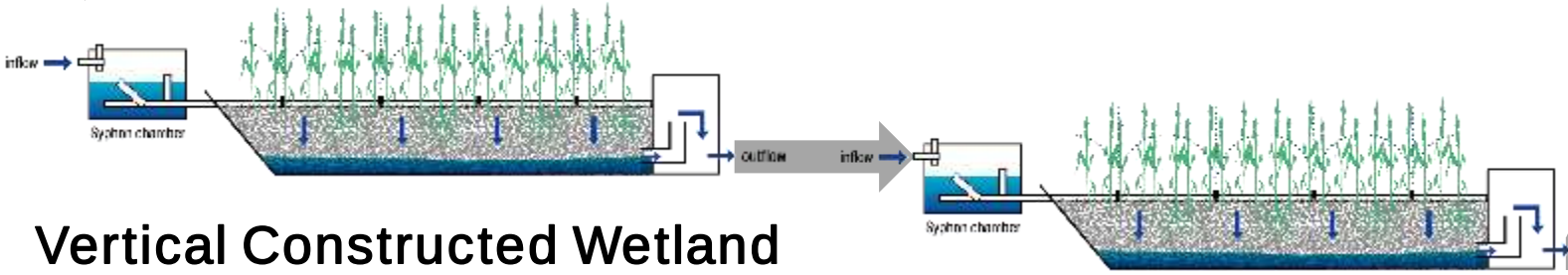


Irrigation



Discharge





Vertical Constructed Wetland

Vertical Constructed Wetland

Eoos urine diverting toilet

- Diverts ~75% of urine from wastewater stream
- Tested by PRG in Durban
- Game-changer for source-separation of urine

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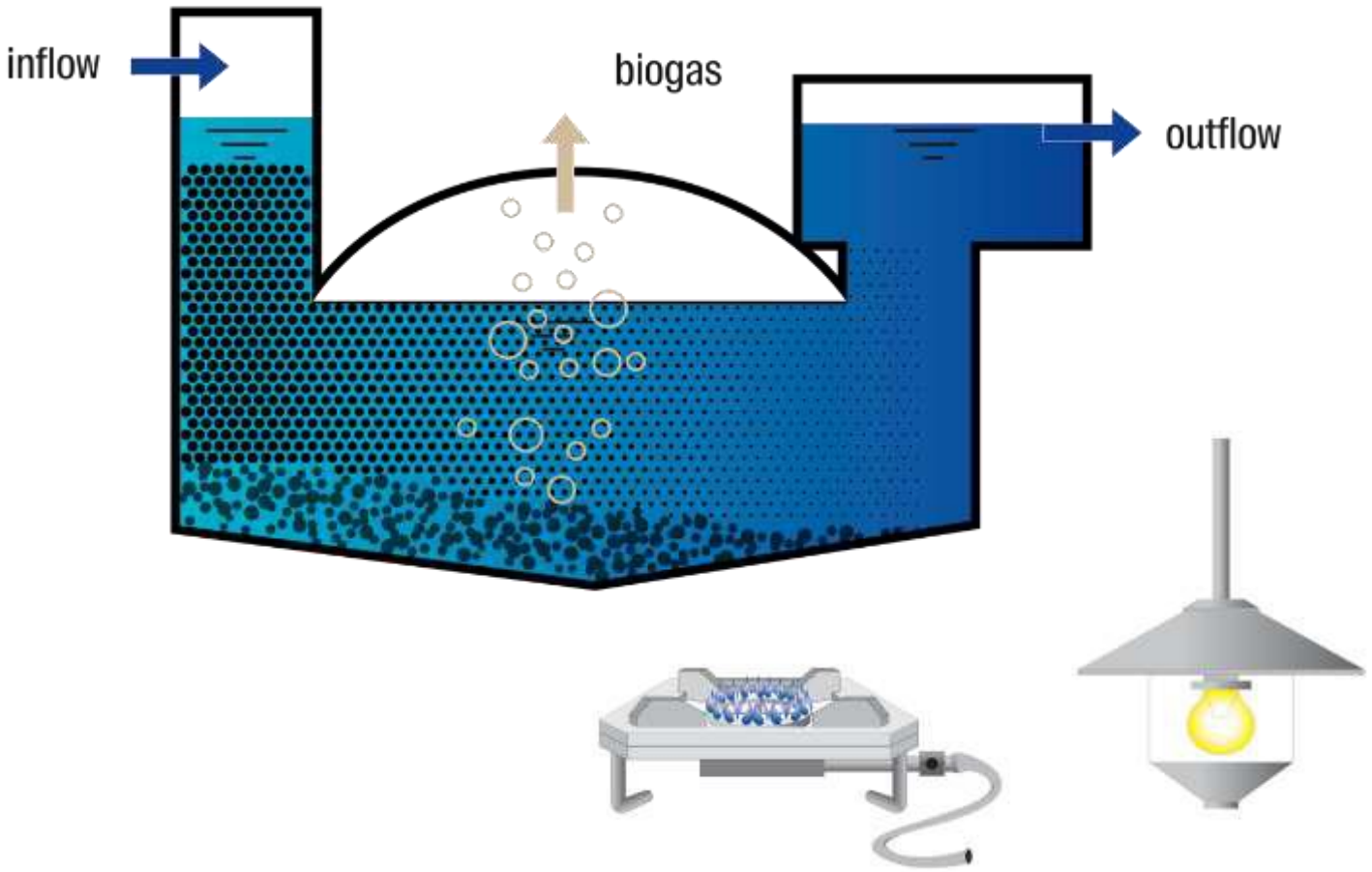
Urine valorization processes

Characteristics	Struvite precipitation	Nitrification/Distillation	Electrolysis
Main product	Struvite (phosphate mineral) $MgNH_4PO_4 \cdot 6H_2O$	Concentrated nutrient solution	Liquid without ammonia, organic substances and pathogens
Primary nutrient recovery	P N Medium, mainly phosphate	N P K + all other nutrients High, nearly all nutrients	None, if not combined with other processes
Primary nutrient loss	N K + other nutrients High, most nutrients in the effluent	Low, little ammonia volatilization	N P K + other nutrients High, ammonia is oxidised to N_2
Sanitisation/ disinfection	Medium, depends on drying	Complete (during distillation)	Medium, due to chlorination
Malodour removal	No	Yes	Yes
Pharmaceuticals (trace organic compounds)	No degradation	Partial degradation (nitrification)	Unknown degradation
Energy demand*	Very low (manual reactor) Low (automated reactor)	Medium ~ 50 $Wh \cdot L_{urine}^{-1}$ nitrification ~ 100 $Wh \cdot L_{urine}^{-1}$ distillation	High ~ 320 $Wh \cdot L_{urine}^{-1}$ (TDIROF electrode) ~ 1600 $Wh \cdot L_{urine}^{-1}$ (BDD electrode)
Volume reduction	High Urine to struvite: concentration factor 250 – 630**	High Liquid volume: concentration factor 20 – 30	No volume reduction
Other outputs	Phosphate depleted urine	Distilled water, excess sludge	Off-gas with chlorinated by-products
Process complexity	Low (manual reactor) Medium (automated reactor)	High	Low
Development level	High	High	Low

* Calculated for a total ammonia concentration of 8 g $N \cdot L^{-1}$. e values for electrolysis are based on the experimental values given in the text. ese values are most probably too high, because they are based on small-scale laboratory experiments, which have not been optimised for low energy demand.
** Assuming phosphate concentrations between 200 and 500 mg $P \cdot L^{-1}$ in stored urine.

Table: VUNA Handbook on Urine Treatment, Eawag 2016

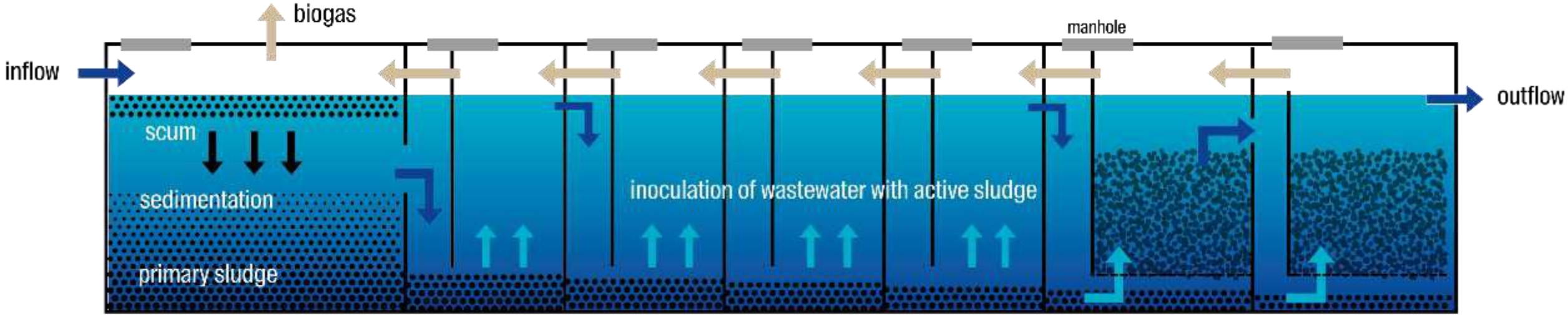
Biogas digester



- Degrades organic material to produce biogas
- 200L biogas per 1 kg of COD removed
- Reduces greenhouse gas emissions
- Additional maintenance, failure potential
- Can provide biogas to 10% of households
- Will people use it?

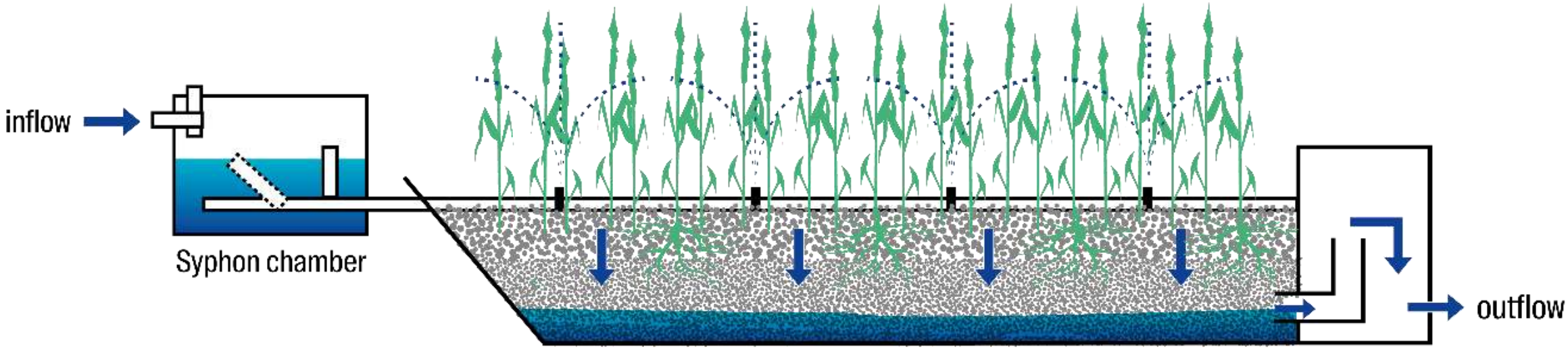
Images: BORDA, Tilley et al 2014

Anaerobic baffled reactor/ anaerobic filter



- Up to 90% reduction in biodegradable COD
- 1-2 log reduction in pathogens
- Gravity flow
- Effluent is high in nutrients, pathogens

Vertical-flow constructed wetland



- Aerobic treatment process to remove nutrients, pathogens
- More efficient than horizontal constructed wetlands (smaller footprint)

Polishing pond

- Pathogen deactivation through oxygenation and sunlight (UV)
- Open water surface can pose a health and safety risk
- High evaporation losses


Dispose
or
reuse?

RSA discharge & agricultural limits

Parameter	General Discharge Limit	Agricultural Limit (<500 m^3/day)
TSS (mg/L)	25	–
COD (mg/L)	75	400
NH4-N (mg/L)	6	–
NO3-N (mg/L)	15	–
PO4-P (mg/L)	10	–
Faecal coliforms (CFU/100 mL)	1 000	100 000

Selected parameters from *Revision of General Authorisation in terms of Section 39 of the National Water Act , 1998 (Act no. 36 of 1998)*

Recommended norms for effluent uses (India)

	Parameter	Toilet flushing	Fire protection	Vehicle Exterior washing	Non-contact impoundments	Landscaping, Horticulture & Agriculture			
						Horticulture, Golf course	crops		
							Non edible crops	Crops which are eaten	
								raw	cooked
1	Turbidity (NTU)	<2	<2	<2	<2	< 2	AA	< 2	AA
2	SS	nil	nil	nil	nil	nil	30	nil	30
3	TDS	2100							
4	pH	6.5 to 8.3							
5	Temperature °C	Ambient							
6	Oil & Grease	10	nil	nil	nil	10	10	nil	Nil
7	Minimum Residual Chlorine	1	1	1	0.5	1	nil	nil	nil
8	Total Kjeldahl Nitrogen as N	10	10	10	10	10	10	10	10
9	BOD	10	10	10	10	10	20	10	20
10	COD	AA	AA	AA	AA	AA	30	AA	30
11	Dissolved Phosphorous as P	1	1	1	1	2	5	2	5
12	Nitrate Nitrogen as N	10	10	10	5	10	10	10	10
13	Faecal Coliform in 100 ml	Nil	Nil	Nil	Nil	Nil	230	Nil	230
14	Helminthic Eggs / litre	AA	AA	AA	AA	AA	<1	<1	<1
15	Colour	Colourless	Colourless	Colourless	Colourless	Colourless	AA	Colourless	Colourless
16	Odour	Aseptic which means not septic and no foul odour							

All units in mg/l unless specified; AA-as arising when other parameters are satisfied;
A tolerance of plus 5% is allowable when yearly average values are considered.

- Norms vary based on use
- Adapt to South Africa?
- Developing DEWATS-specific reuse guidelines for South Africa

DEWATS effluent reuse for agriculture in eThekwini?

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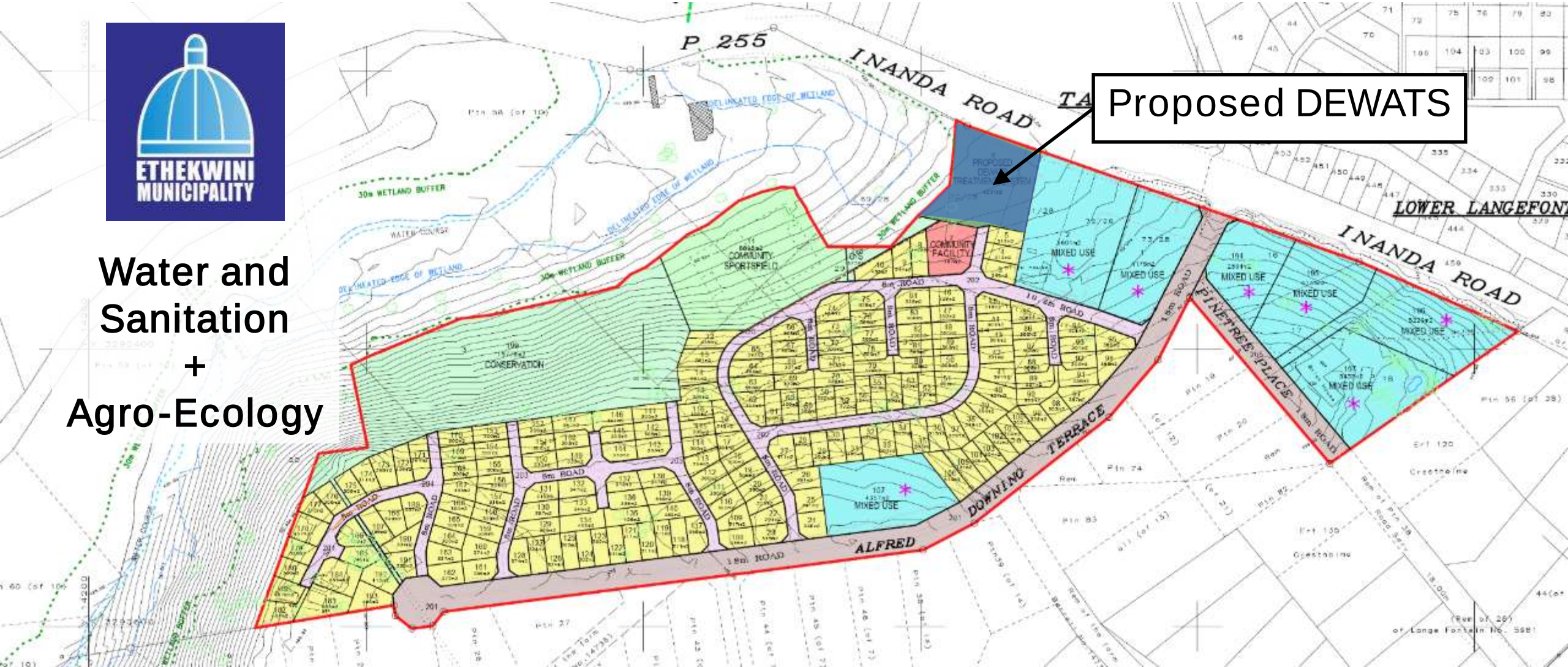
Water and Sanitation + Agro-Ecology



Thank you

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