

Waste free wastewater treatment wetlands in France

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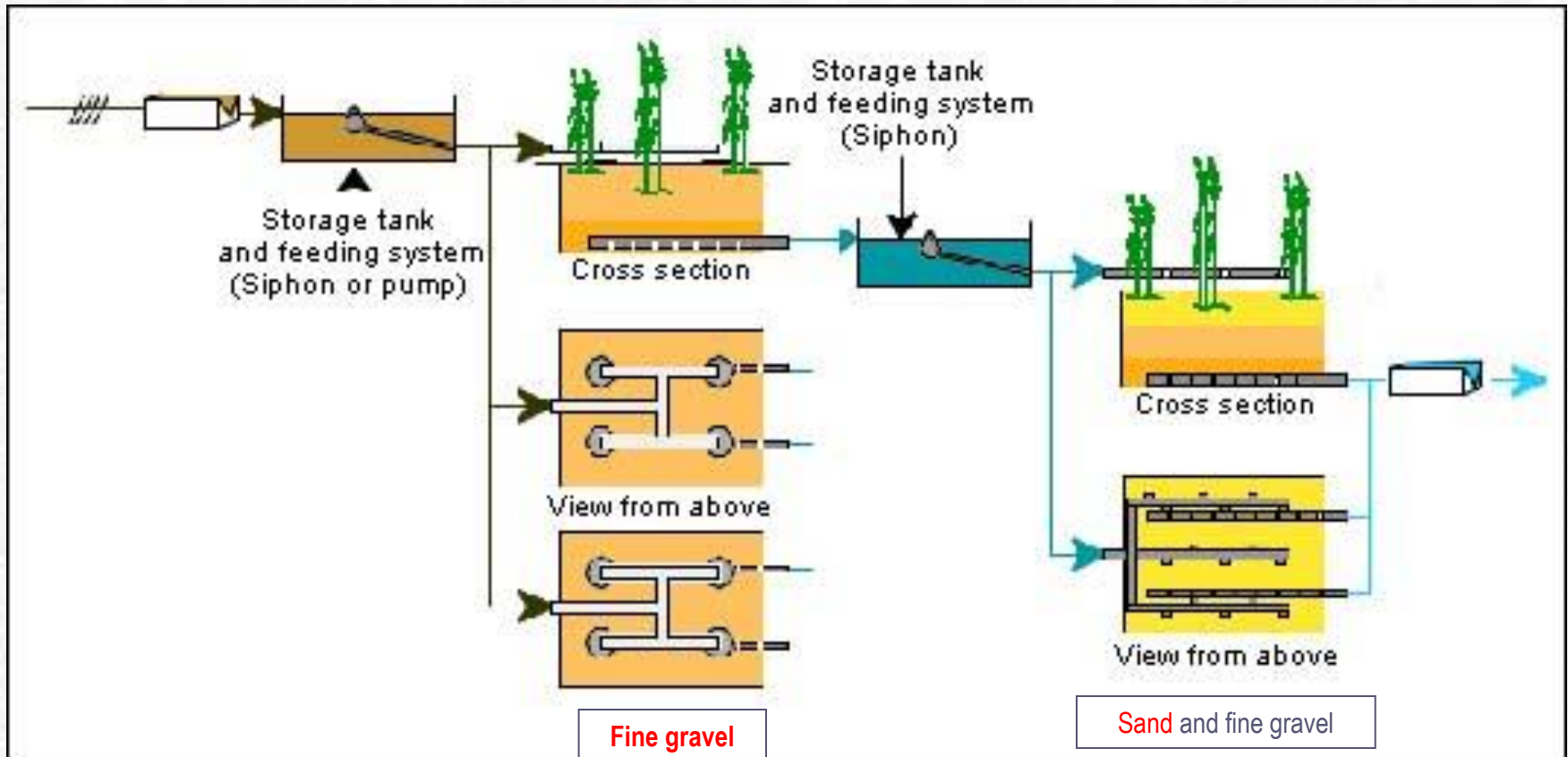


Short Biography

- **Dirk ESSER**, agricultural engineer from Germany
- Came to France in 1988 to do post-graduate studies and research work with Cemagref, now IRSTEA (public research institute)
- Created **SINT** in **1991** to develop a new wetland system under license from Cemagref > “**Phragmifilter®**” (excl. license until 2003), also known as “French System”, which are **vertical flow filters, planted with common reeds (Phragmites), treating raw, unsettled sewage, thus producing NO WASTE**
- Associated partner of SINBIO (www.sinbio.fr) and SYNTEA (www.synteanature.com), co-founder and treasurer of GWT



Lay-out of a typical Phragmifilter®



1st stage: 3 * 0.4 m² per person

1.2 m²/p.e. (100 g COD .m⁻².d⁻¹ on the total filter surface, max 0,7 m. d⁻¹ on the filter in operation)

- Three parallel filters
- feeding/resting : 3-4d/7d

2nd stage: 2 * 0.4 m² per person

0,8 m²/p.e.

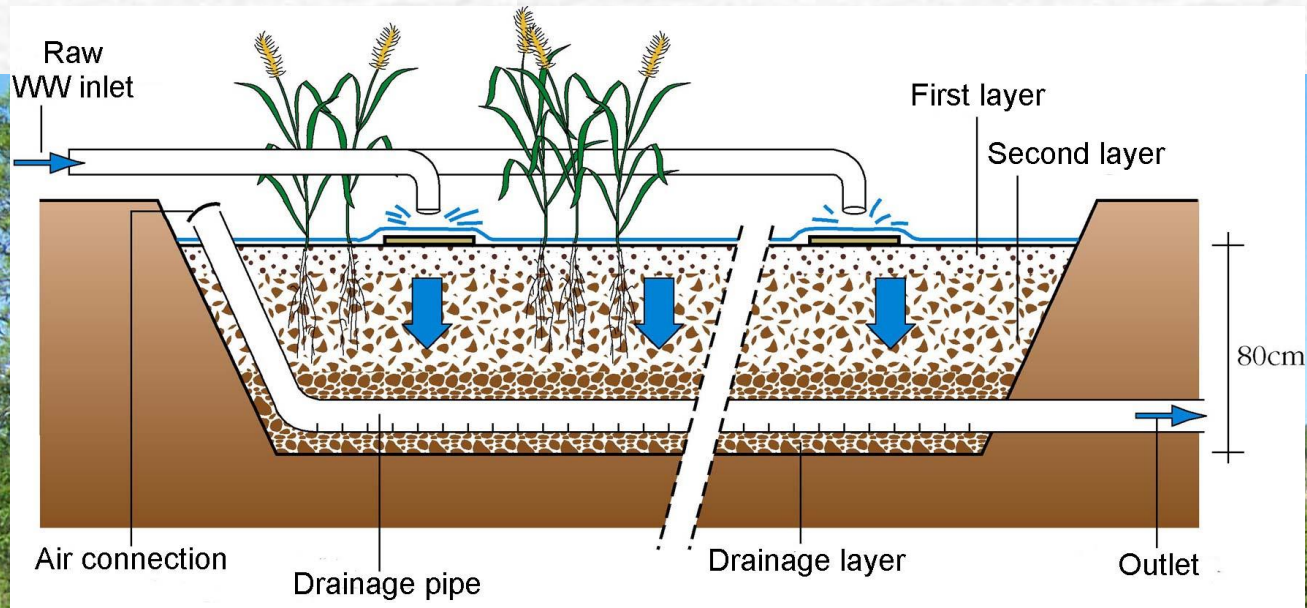
- Two parallel filters
- feeding/resting: 7d/7d



A typical Phragmifilter, working by gravity, before planting of reeds

Waste free wastewater treatment wetlands in France

The first stage of a Phragmifilter®



- Non saturated, freely drained filter media (good oxygen transfer for aerobic degradation)
- First stage fed with raw unsettled sewage
- Build up of sludge layer 1 – 2.5 cm / year

Feeding of the first stage of a Phragmifilter®

Needs a good distribution of the water and the waste water solids on the entire surface of the filter

Can be achieved by gravity, if sufficient slope, NO ENERGY needed

With the
patented self-
priming
siphon





Desludging after 8
to 15 years



Sludge quality



The sludge retained on the first bed looks and smells like a compost

Analyse		Résultat sur le brut		Méthode d'Analyse
* pH (eau à 20°C)		6.4		NF EN 12 176
* Dry matter		36.2	%	NF EN 12880

Analyse		Résultat	/sec	/ brut	Méthode d'Analyse
* Organic matter	per Perte au Feu	256	92.8	o/oo	NF EN 12879 (matières volatiles)
* Carbone Organique (C)		148	53.8	o/oo	Combustion Sèche NF ISO 10694
* Azote Total (N)		22.5	8.1	o/oo	Azote Kjeldahl méthode interne MA7-77
Rapport C/N		6.6	6.6		Calcul : C organique / N total
Azote Ammoniacal (N-NH4)		< 0.05	< 0.05	o/oo	Extraction KCI M & Dosage color. Berthelot
* Phosphore Total (P2O5)		22.6	8.17	o/oo	NF EN 13346, Dosage ICP AES NF EN ISO 11885
* Potassium Total (K2O)		2.68	0.97	o/oo	NF EN 13346, Dosage ICP AES NF EN ISO 11885
* Calcium Total (CaO)		53.1	19.2	o/oo	NF EN 13346, Dosage ICP AES NF EN ISO 11885
* Magnésium Total (MgO)		5.48	1.98	o/oo	NF EN 13346, Dosage ICP AES NF EN ISO 11885

Montromant (200 p.e.), 500 m² of filter, near Lyons, built in 1994, one desludging



Montromant		August 2013		24 h composite samples						
	Flow	COD	BOD ₅	SS	TKN	N-NH ₄	TN	TP	% of nominal load	
	m ³ /day	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
Inflow	15,4	1280	400	770	103		103	13,9	82,13%	
Outflow		80	6	24	4,8	1,4	120	8		

Les Breviaires (150 p.e.), near Paris, built in 1995, 375 m² of filter, no desludging



Les Breviaires				December 2011				Spot sample			
	COD	BOD ₅	SS	TKN	N-NH ₄	TN	TP				
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
Inflow	3390	1950	1800	149	78	149	24				
Outflow	60	< 3	14	< 3	1,2	39	5,9				

Roussillon, 1250 p.e., 1550 m² of filter, south of France
(mediterranean climate) built 1998, one desludging

[illegible]

Performance of Roussillon Reed bed filter treatment plant:

		Inflow			Outflow			Discharge Limits	Removal %
	Number of analyses	Average	Min.	MAX.	Average	Min.	MAX.		
COD (mg O ₂ /L)	10	921	573	1677	40	20	71	125	95.7
BOD ₅ (mgO ₂ /L)	10	504	262	1102	6	1	19	25	98.7
TSS (mg/L)	10	402	198	1072	7	0	17	35	98.3
TKN (mgN/L)	7	74	25	119	5	2	11		92.7

Some more recent references...

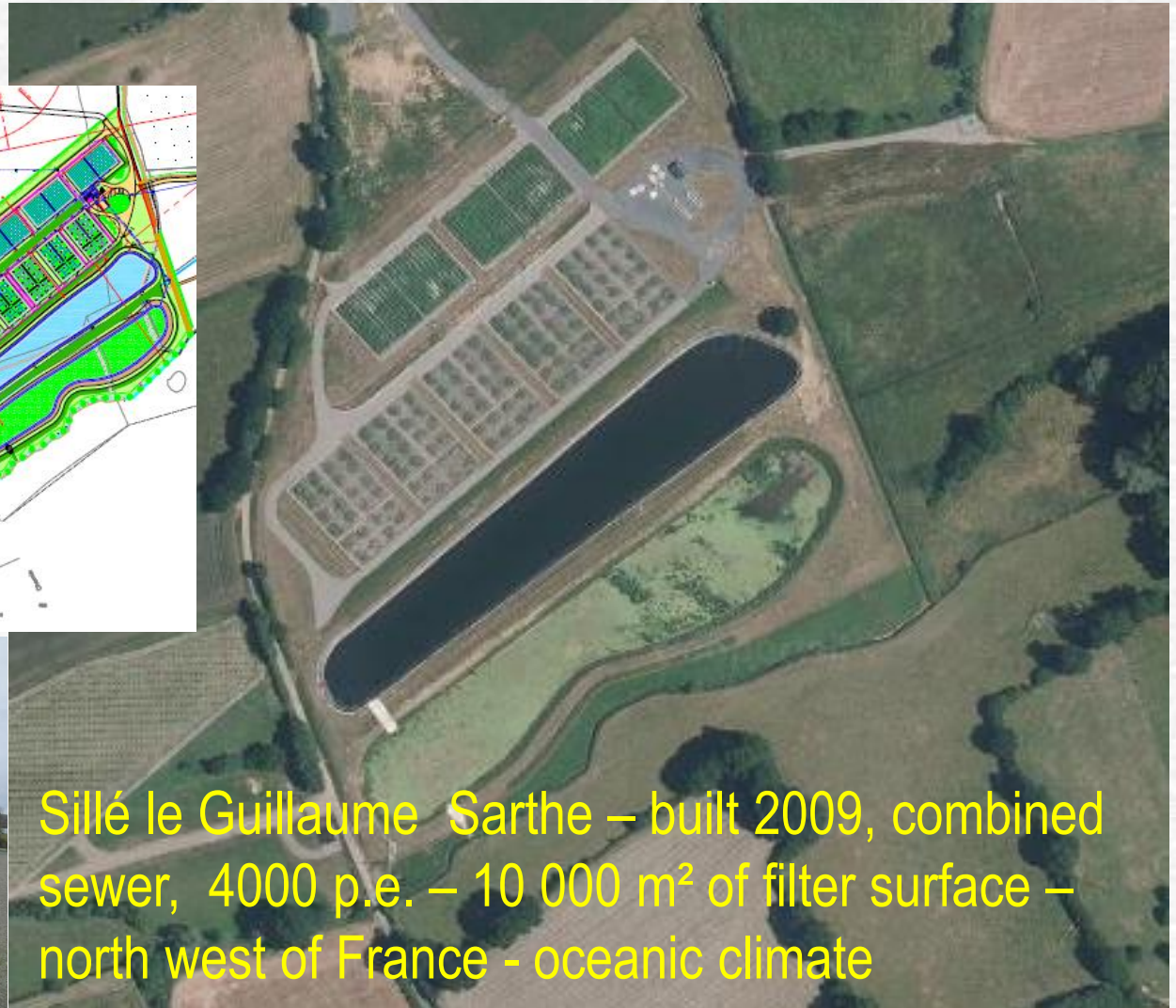
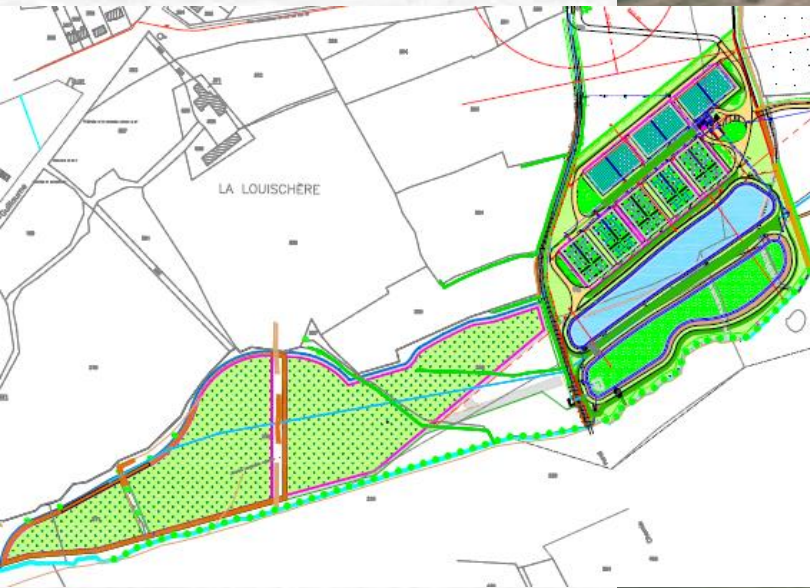


Nègrepelisse
(Tarn et Garonne)
seperative sewer,
4000 p.e., b. 2008
8000 m² of filter
surface – SW of
France -



Nègrepelisse			April 2011	24 hour composite					
	Flow	COD	BOD ₅	SS	TKN	N-NH4	TN	TP	% of nominal load
	m3/day	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Inflow	476	886	348	362	51,6	50,3	51,6	10,8	87,86%
Outflow		63	4	10	3,1	1	23,2	6,7	

Some more recent references...

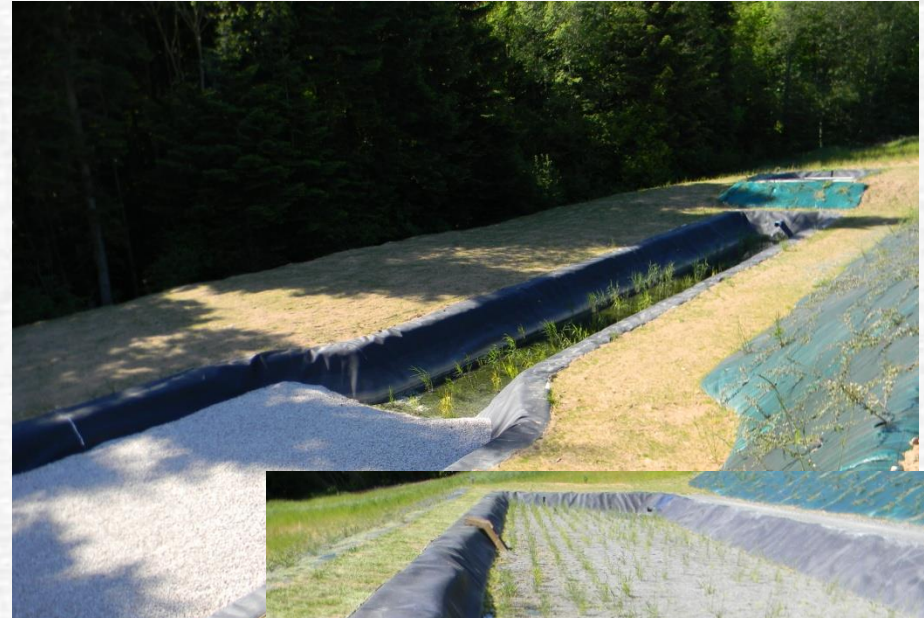


Sillé le Guillaume Sarthe – built 2009, combined sewer, 4000 p.e. – 10 000 m² of filter surface – north west of France - oceanic climate



Sillé Guillaume		November 2009		24 hour composite		
		COD	BOD ₅	SS	TKN	
		mg/L	mg/L	mg/L	mg/L	
	Inflow	250	210	320	44	
	Outflow	< 30	< 3	2	< 2	

Some more recent references...



Les Halles - Rhône, near Lyons – 2013, 800 p.e. – about 2000 m² of filter surface : denitrification and P-removal with zero energy



epur nature

	Les Halles		July 2014	24 hour composite					
	Flow	COD	BOD ₅	SS	TKN	N-NH ₄	TN	TP	% of nominal load
	m ³ /day	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Inflow	60	663	260	420	89,4	54	89,4	8,6	41,44%
Outflow	48,3	< 30	< 3	3	< 3	0,6	19	1	

Phragmifilters® in the French overseas departments and territories

French Guyana



Mayotte

New Caledonia



Efficiency and outflow concentrations for the two stages

(from *Epur Nature* database)

Phragmifilter®



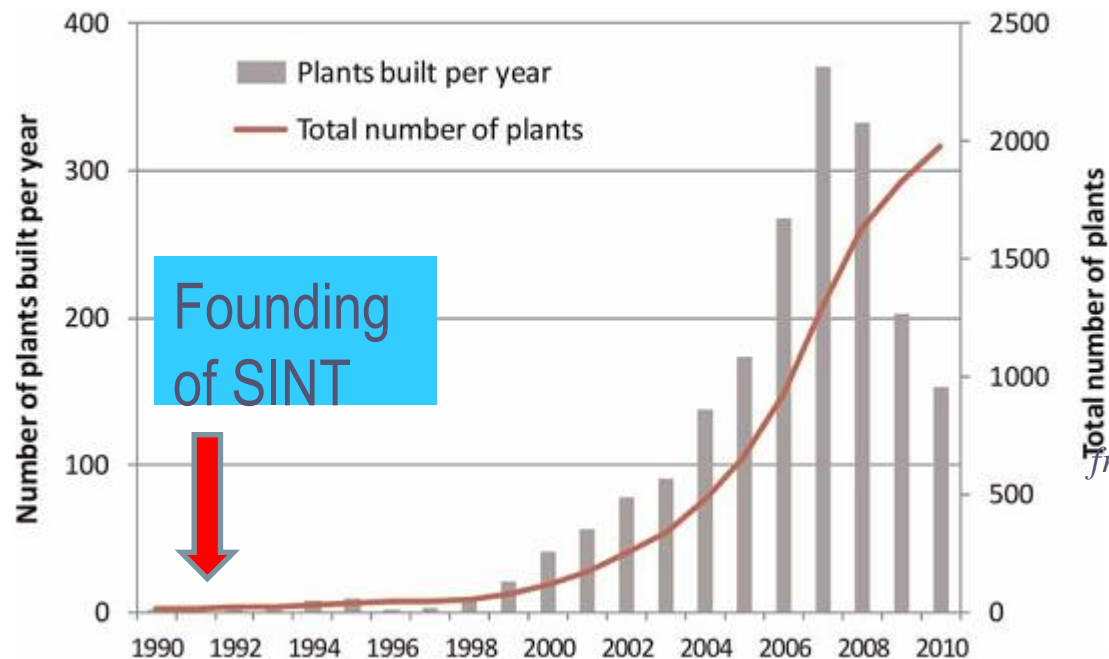
					10	20	30	40	
COD						80	90	95	
BOD5			Mean	Median	SD	percentile	percentile	percentile	Nb
SS	COD	mg/L	50,27	41,00	28,89	62,60	73,00	91,40	74
TKN	BOD5	mg/L	7,91	5,00	9,09	10,40	15,70	19,70	74
TP	SS	mg/L	8,37	7,00	6,45	11,00	15,96	17,70	74
	TKN	mg/L	6,86	3,00	11,52	6,86	11,27	21,51	20
	TP	mg/L	5,70	5,70	3,05	6,94	10,25	10,82	20

		Mean	Median	SD	10 percentile	20 percentile	30 percentile	40 percentile	Nb
COD	%	78,77	81,31	13,48	64,48	72,00	73,66	77,29	62
BOD5	%	88,88	88,87	18,48	78,58	88,55	91,84	88,88	61
SS	%			Mean	SD	80 percentile	90 percentile	95 percentile	Nb
TKN	%	COD	mg/L	126,53	76,89	167	224,8	312,95	62
TP	%	SS	mg/L	31,61	20,15	50	62	64	62
		TKN	mg/L	19,69	14,55	25,2	38,6	46,3	11

Efficiency and outflow concentrations for the first stage

Development of **waste free wastewater treatment wetlands** in France

Around 3200 treatment wetlands in France, serving communities from 40 to 4000 people (500 designed by SINT between 1992 and 2007)



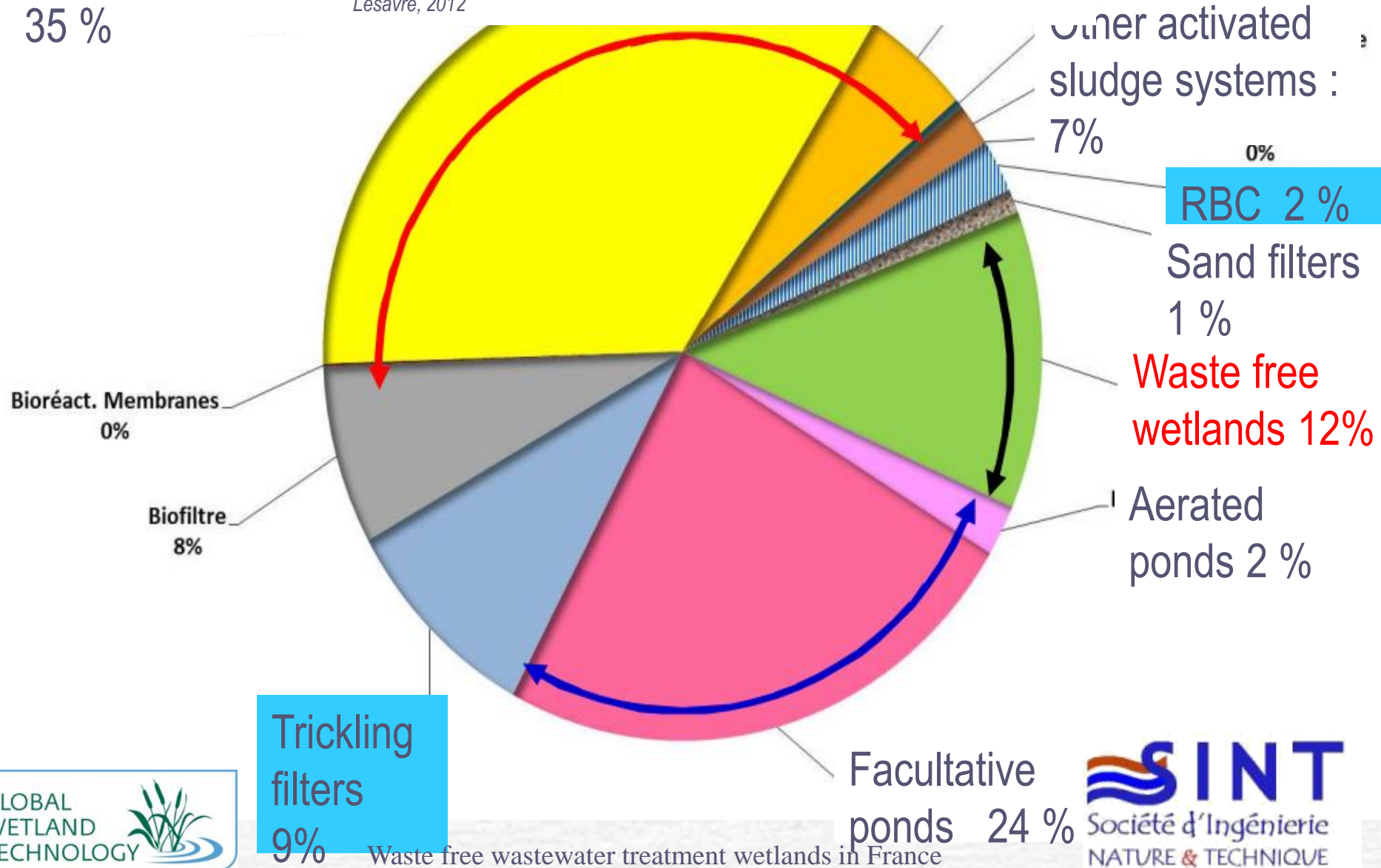
from Molle et al. (2005)

Municipal WWTP in France (19300

Activated sludge – plants in 2012) according to water
extended aeration **agency data base**

Lesavre, 2012

35 %



Other applications : treating wastewater from a mountain refuge in the Italian Alps







Extra light weight patented self priming siphon, brought to the site by helicopter



And treating wastewater in 2000 m altitude for a tourist site in the French Alps



Other applications : treating wastewater from a motorway service area



26/9/2014

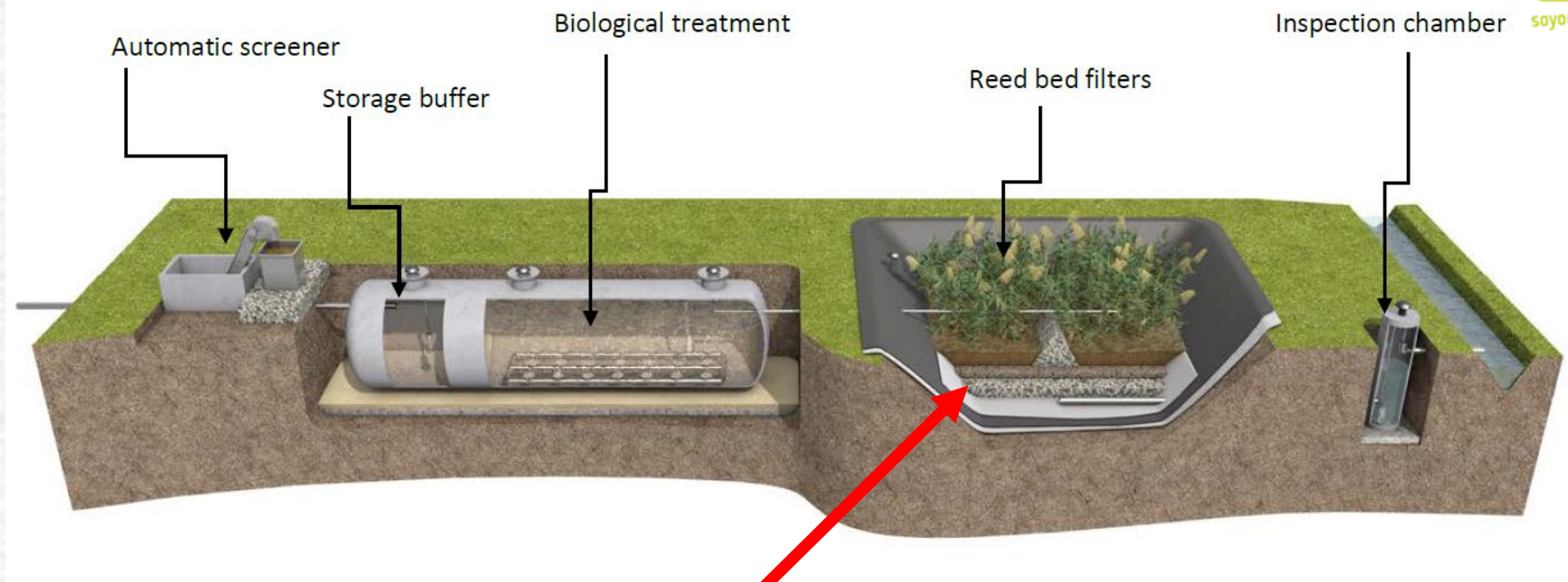
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Phragmifilters are well adapted to highly variable wastewater loads of motorway facilities and tourist sites



26/9/2014 18:30

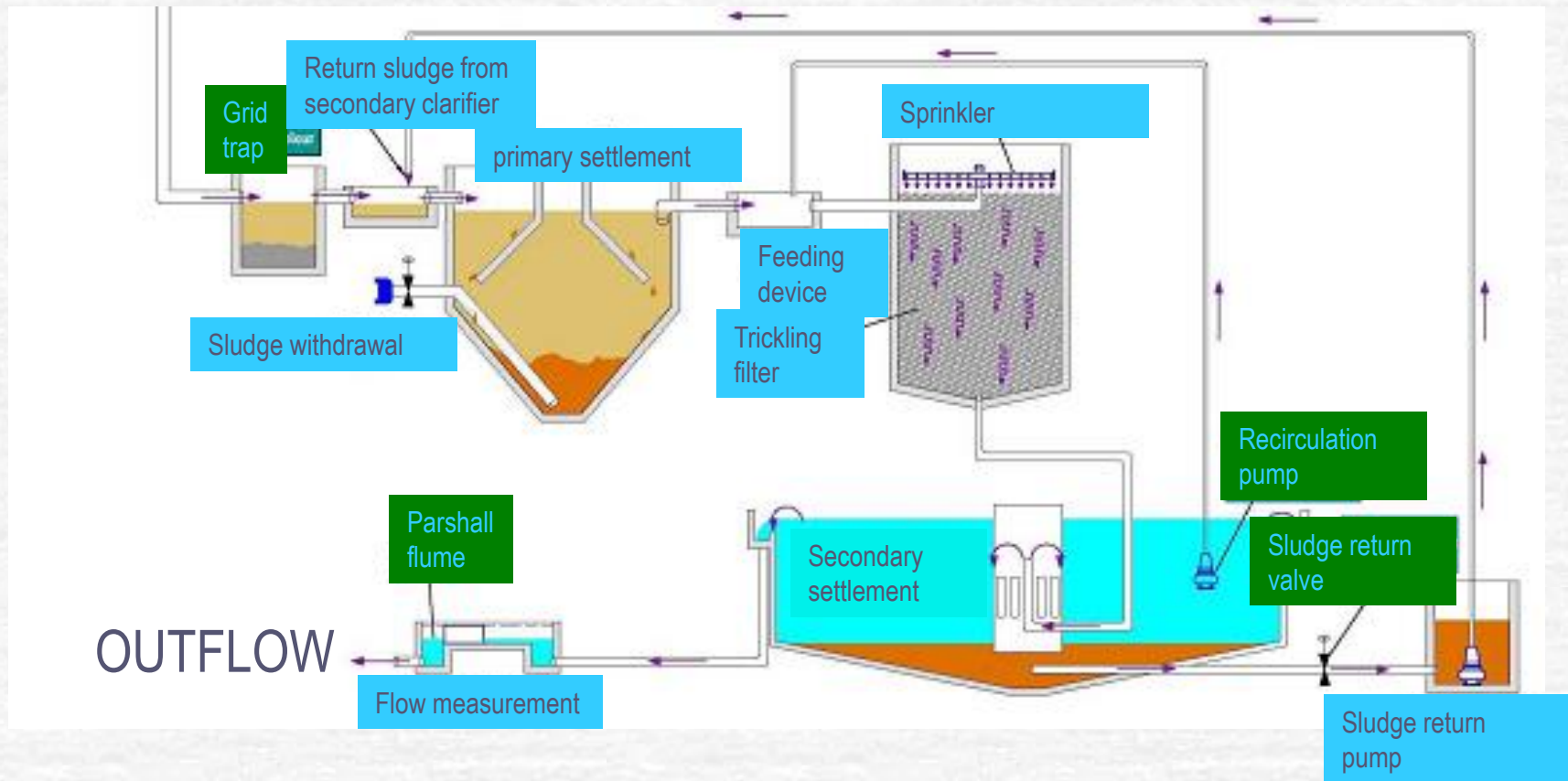
Treating high strength wastewater from agrofood industries with activated sludge plus wetlands



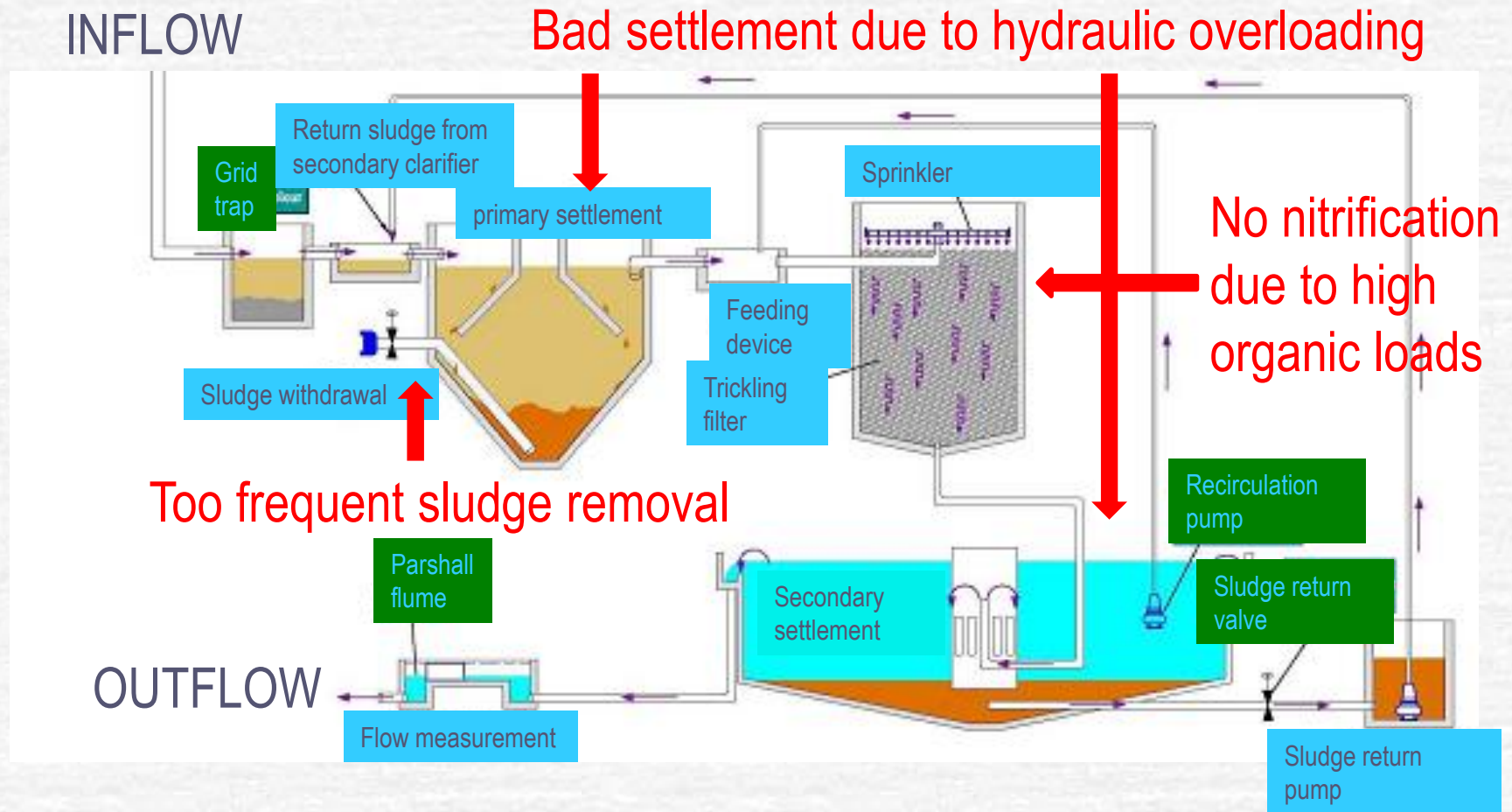
Reed bed filters for polishing, clarification and sludge treatment

Upgrading of trickling filters with Phragmifilters®

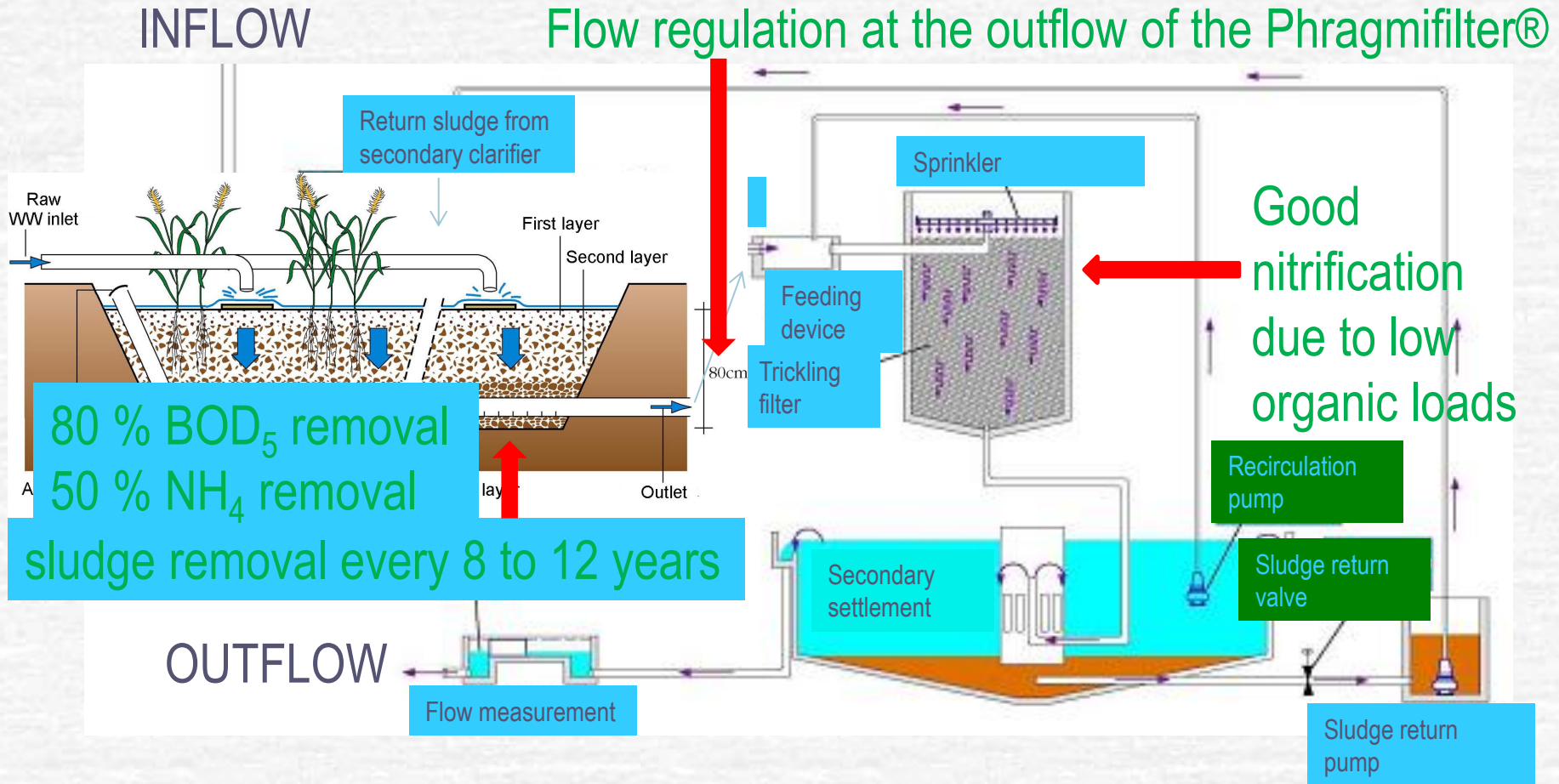
INFLOW



Frequent problems of trickling filters



And how to resolve them...



COST SAVINGS DUE TO THE REUSE OF EXISTING ASSETS !



Upgrading of waste stabilization ponds with Phragmifilters®

About 4 600 waste stabilisation ponds in France

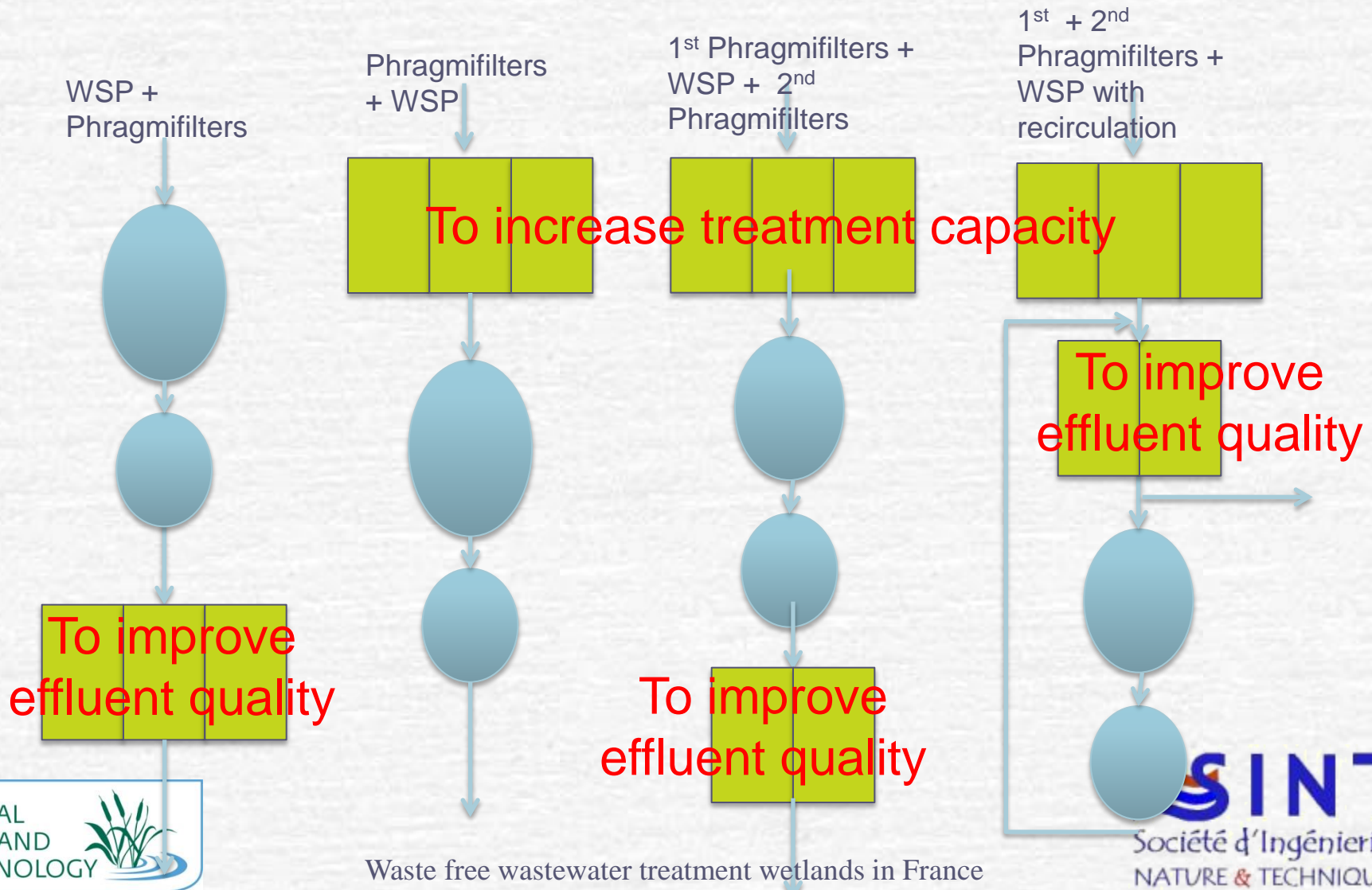
Treatment ponds getting old (most of them built in the late 80's and 90's):

- need to increase the treatment capacity
- need to improve the effluent quality / removal efficiencies

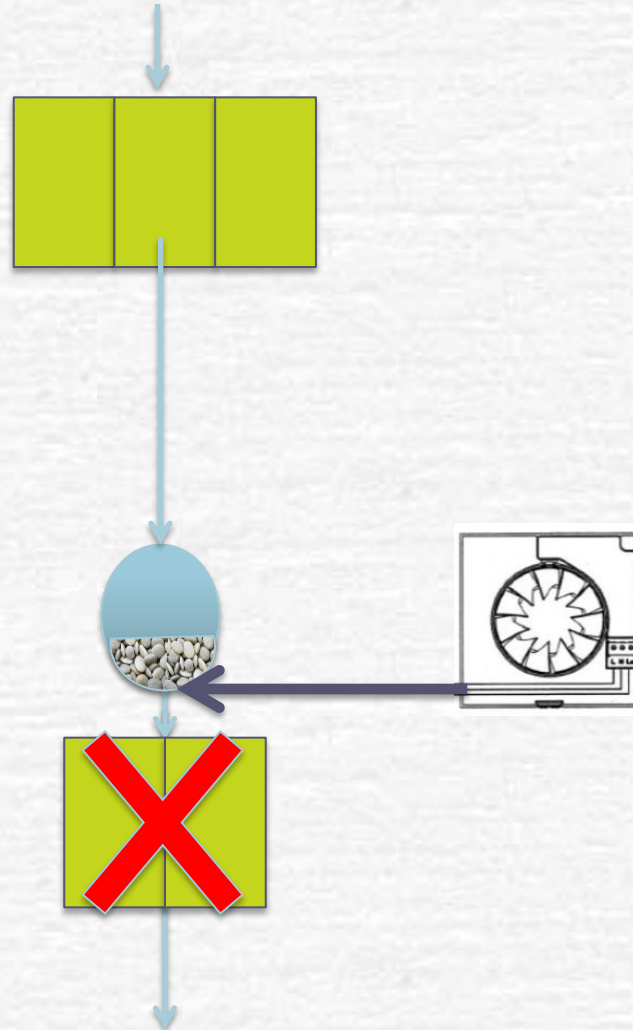
Mix waste stabilisation ponds with Phragmifilters®

- 1st stage Phragmifilter upstream of ponds : to increase the treatment capacity
- 2nd stage Phragmifilter downstream of ponds: to improve the effluent quality
- Double objective: ponds between the two stages

Possible configurations



A cheaper alternative to improve the effluent quality of ponds : the rock filter



Aerated if
nitrification is
required

Advantages of keeping ponds in Phragmifilter configurations

- ☞ Ponds provide some treatment of total P and N, especially during summer (when receiving waters are most fragile)

		DBO	DCO	MES	NK	NH4	NO3	NG	Pt
Outlet Conc. (mg/l)	Average	13,7	82,3	24,7	27,0	21,3	2,4	29,2	4,2
	SD	2,9	7,0	6,7	0,7	1,5	1,6	1,5	1,5
Removal (%)	Average	94%	88%	92%	71%	67%	-	69%	60%
	SD	2,2%	2,7%	4,1%	7,3%	4,5%	-	8,2%	5,8%

- ☞ Ponds can provide good pathogen removal, if required

Dziękuję !



www.epurnature.fr
www.synteanature.com
www.sinbio.fr
www.globalwettech.com

Roussillon