Are WWTPs in Estonia ready for Tertiary Treatment?

Exemplary:

A Status Report of WWTP Paide

Agenda

1. Introduction to WWTP Paide
2. Influent hydraulics and pollutants
3. Sludge production and oxygen consumption
4. COD, N and P Balances
5. Energy efficiency
6. Issues of wastewater treatment processes
7. Suggestions for process optimization
8. Summary

WWTP Paide - Introduction

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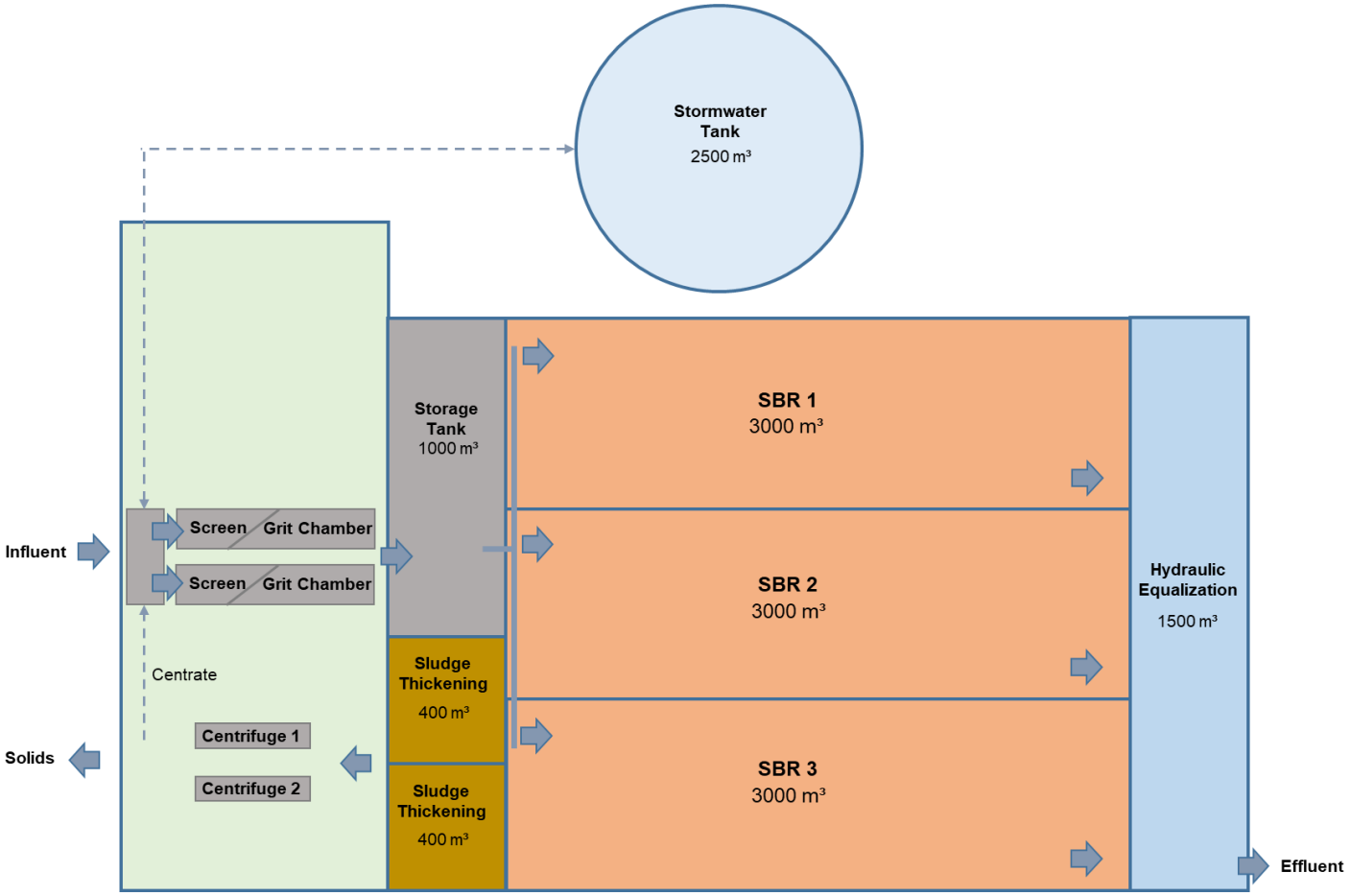

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WWTP Paide - Introduction

Influent pressure pipes

Combined screen and grit chamber

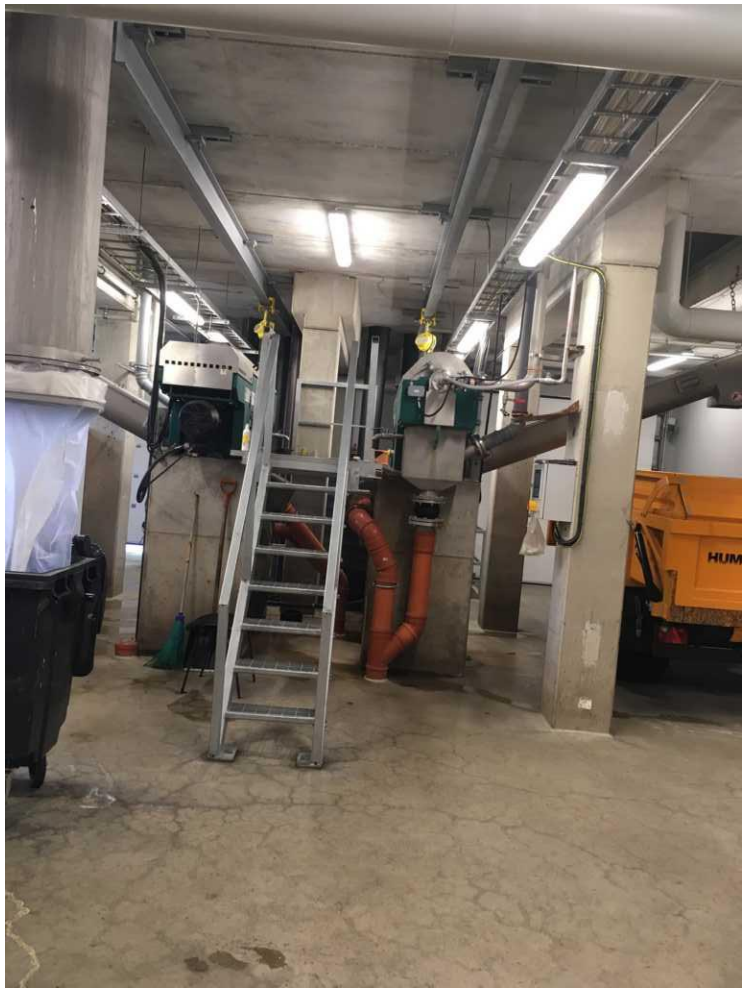
WWTP Paide - Introduction

Decanter and stirrer/aerator

Overview Sequencing Batch Reactor

WWTP Paide - Introduction

Hydraulic Equalisation Tank



Sludge dewatering

WWTP Paide - Introduction

Dewatered Sludge

Sludge Composting plant

WWTP Paide - Introduction

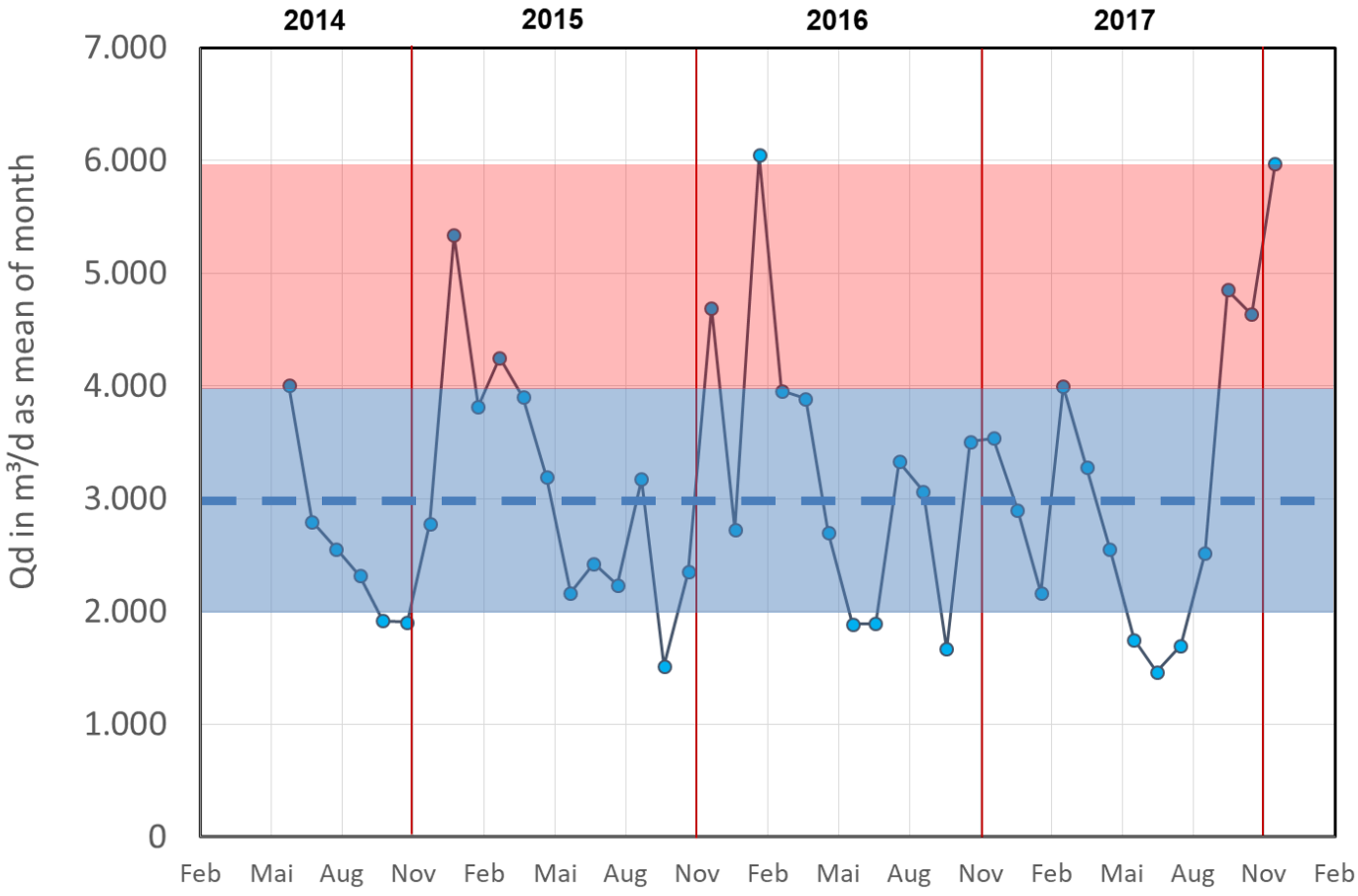
Storm water tank

Receiving water

Cycle Program

Cycle-time	Step-time	Process	Action 1	Action 2	Action 3
h	min				
3.4	205	Denitrification	Filling		Mixing
4.3	55	Nitrification	Filling	Aeration	Mixing
9.8	330	Nitrification		Aeration	Mixing
11.0	70	Sedimentation			
12.0	60	Decant	Outflow		
12.3	20	Sludge harvesting	Outflow		

Influent Hydraulics



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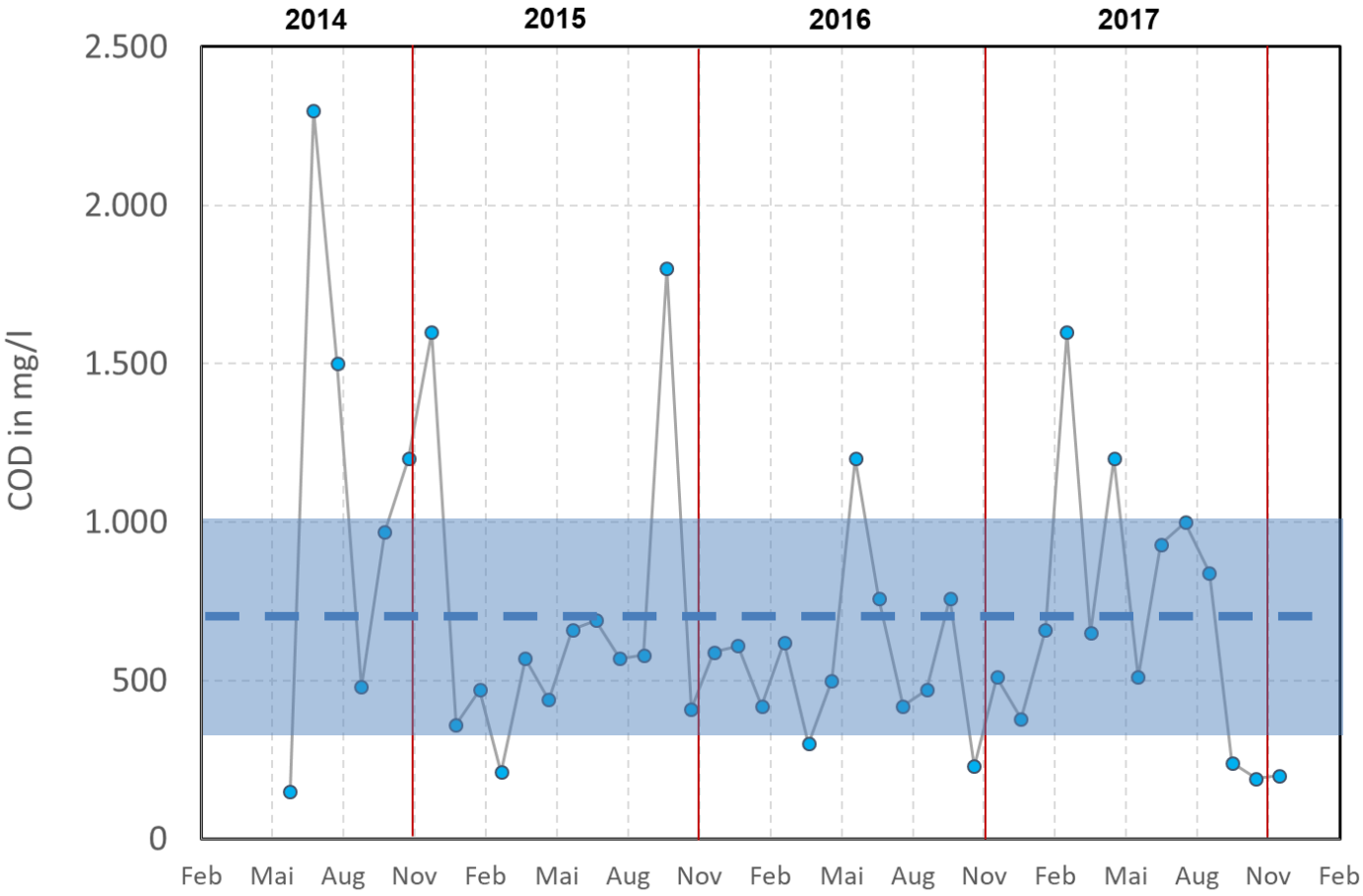
Influent Pollutants – COD-Concentration



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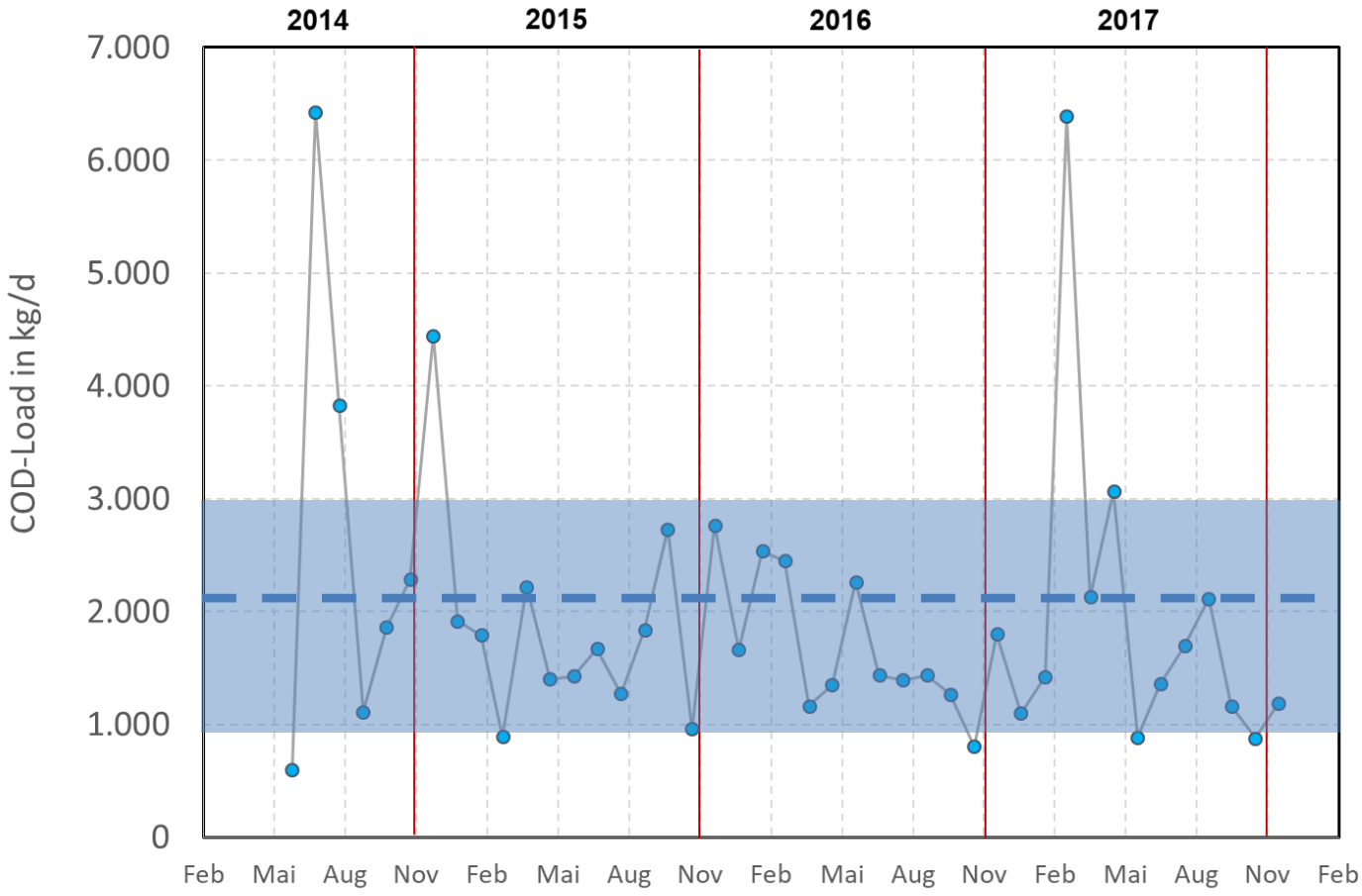
Influent Pollutants – COD-Load



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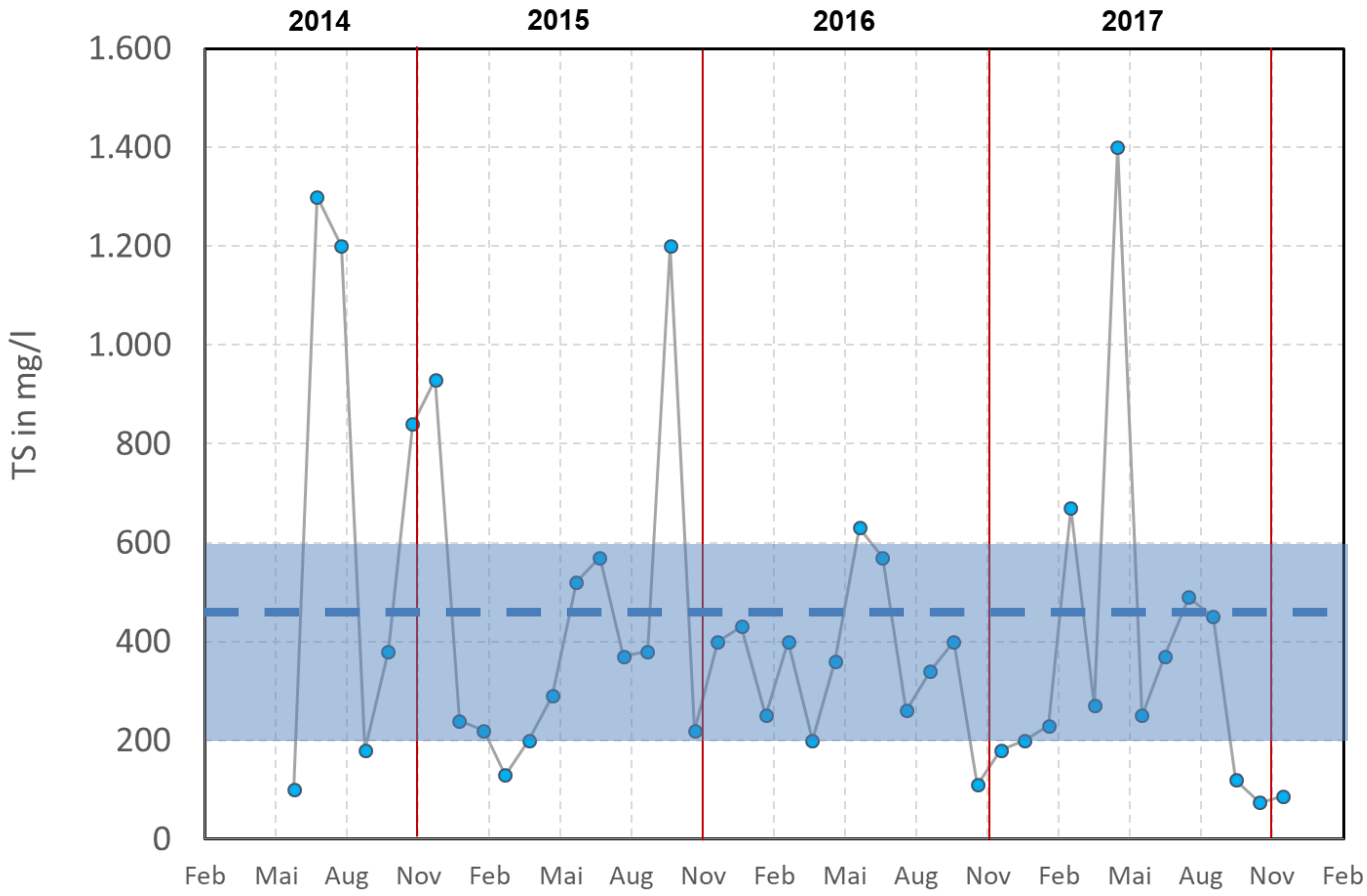
Influent Pollutants – TSS-Concentration



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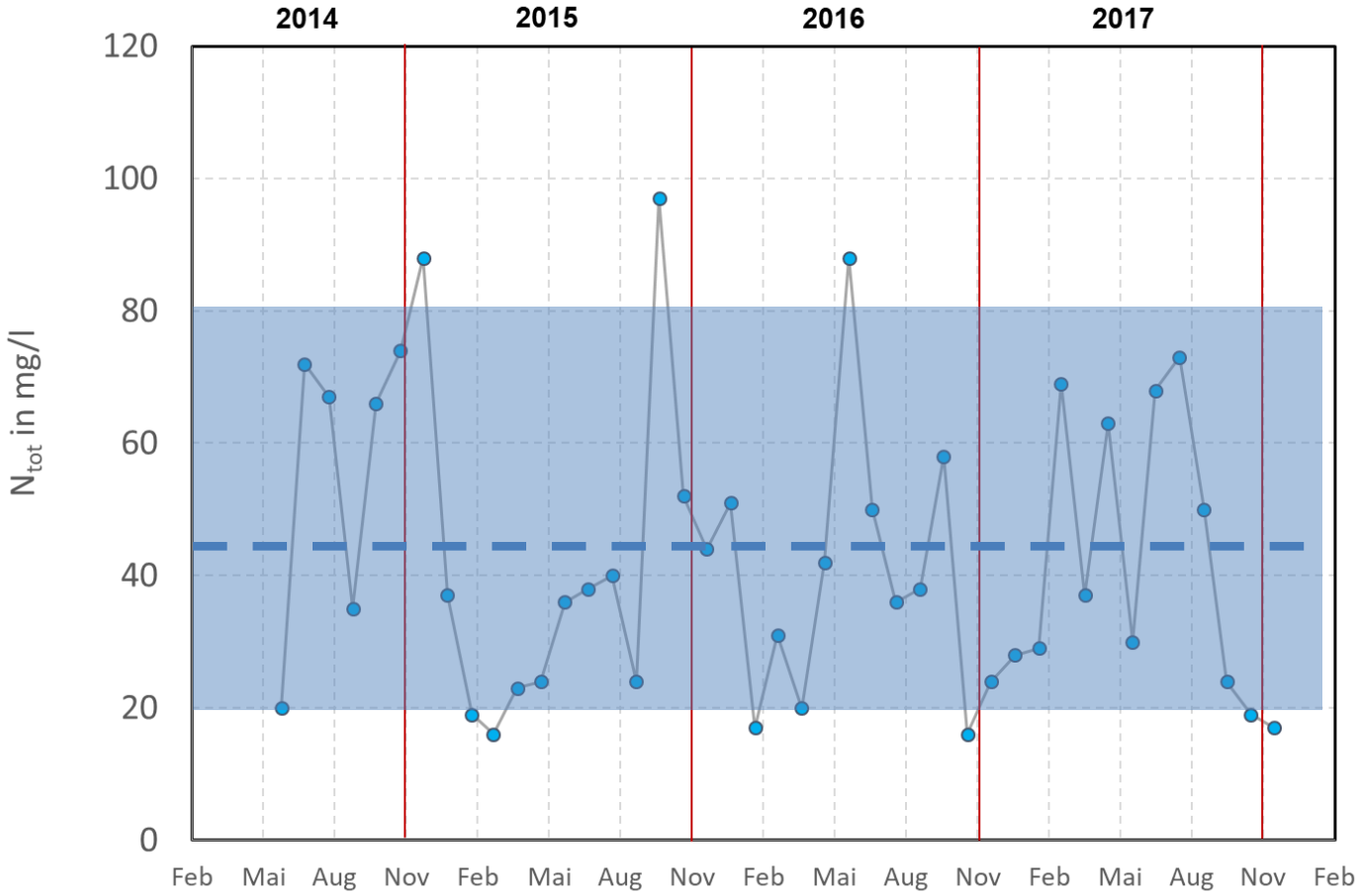
Influent Pollutants - N_{tot}-Concentration



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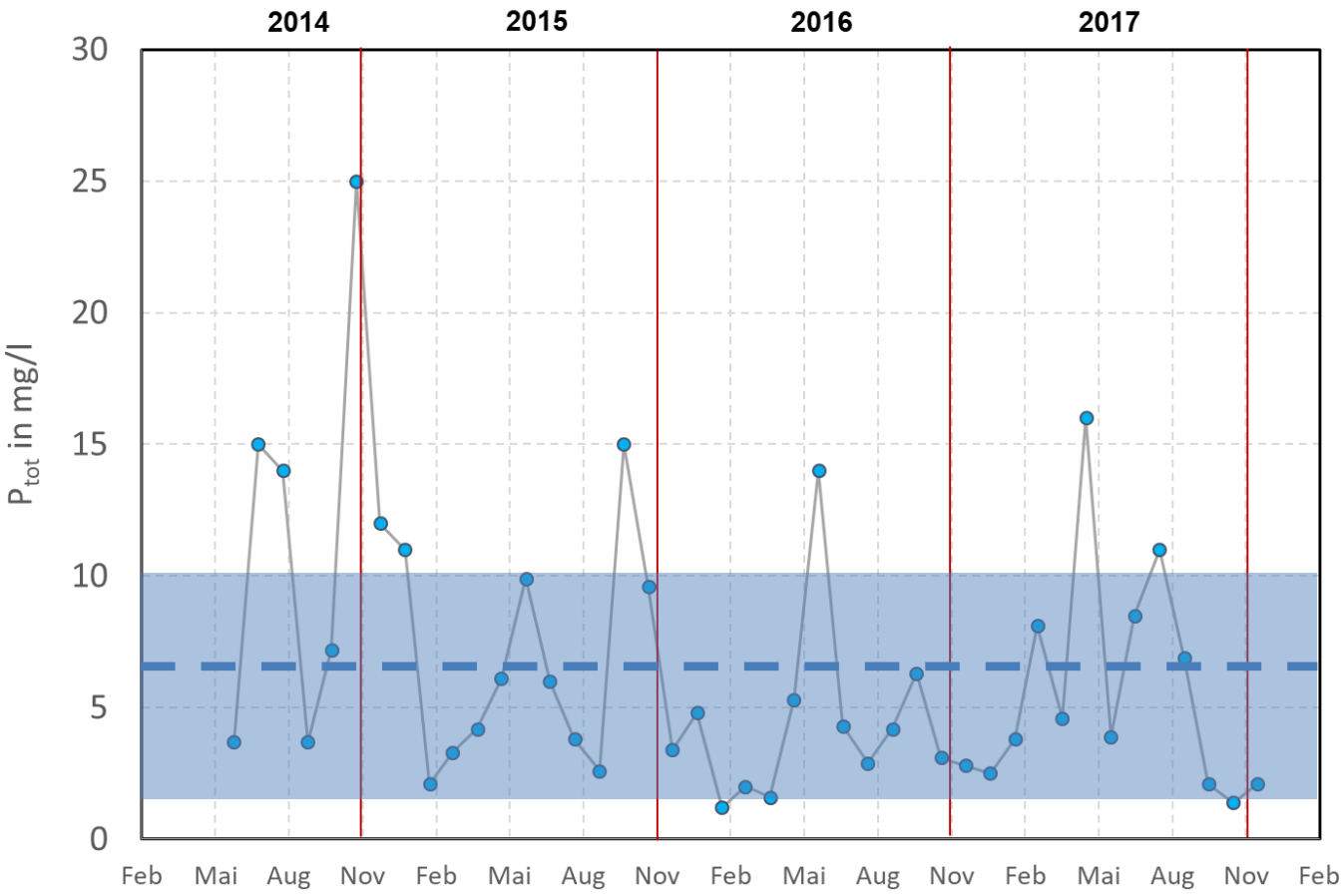
Influent Pollutants - P_{tot}-Concentration



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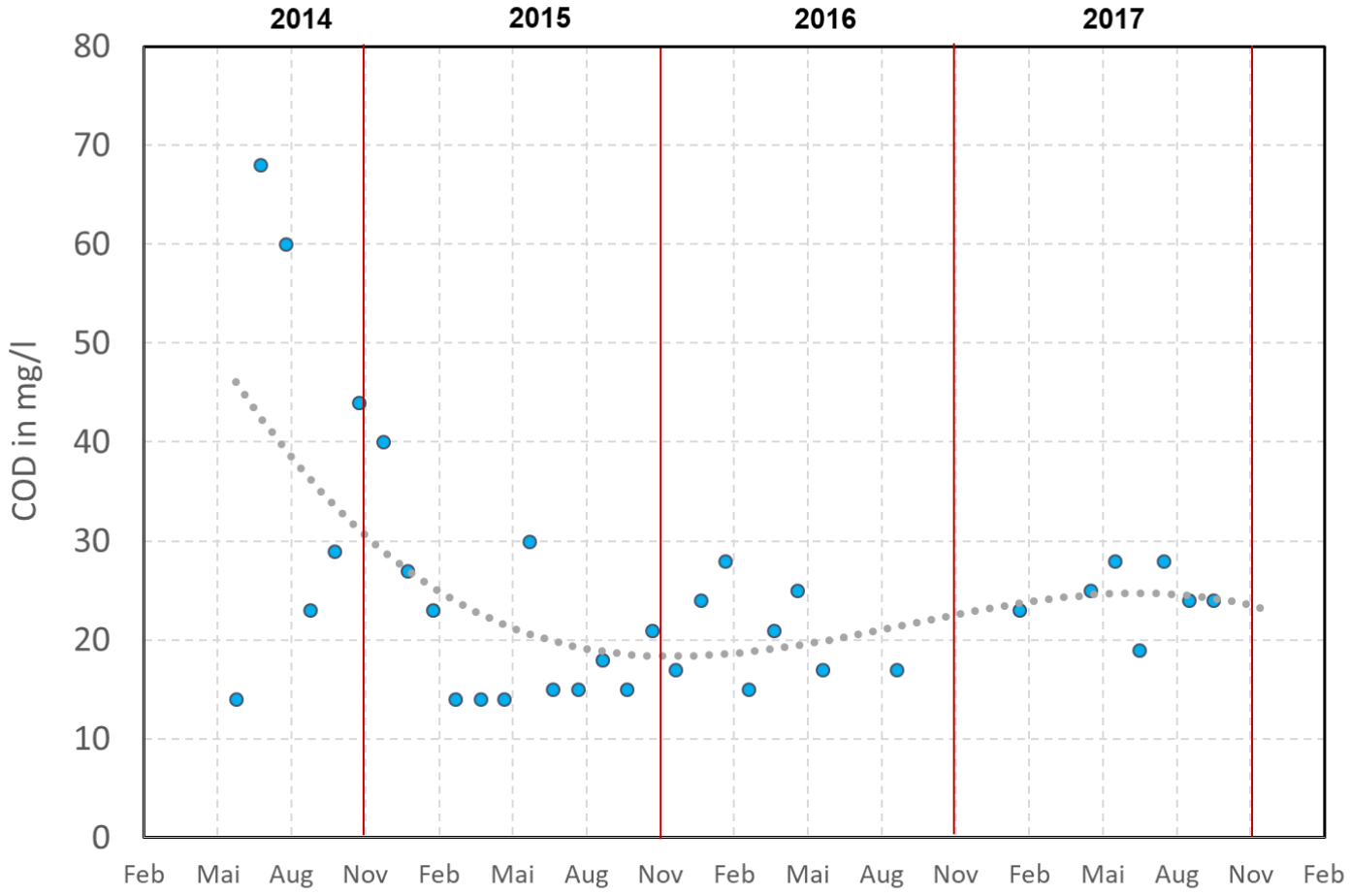
Overall Load Parameter WWTP Paide

	Sp. Load	Mean			85%-Value		
Q_d		3000 m³/d			4000 m³/d		
	PE Load	Conc.	Load	Capacity	Conc.	Load	Capacity
	g/(PE*d)	mg/l	kg/d	PE	mg/l	kg/d	PE
COD	120	739	2218	**18000**	1200	4800	**40000**
TSS	70	455	1364	19000	772	3088	44000
BOD_5	60	364	1091	18000	702	2808	47000
N_{tot}	11	43	130	12000	68	273	25000
P_{tot}	1.8	7	20	11000	13	53	29000

Effluent Pollutants – COD-Concentration



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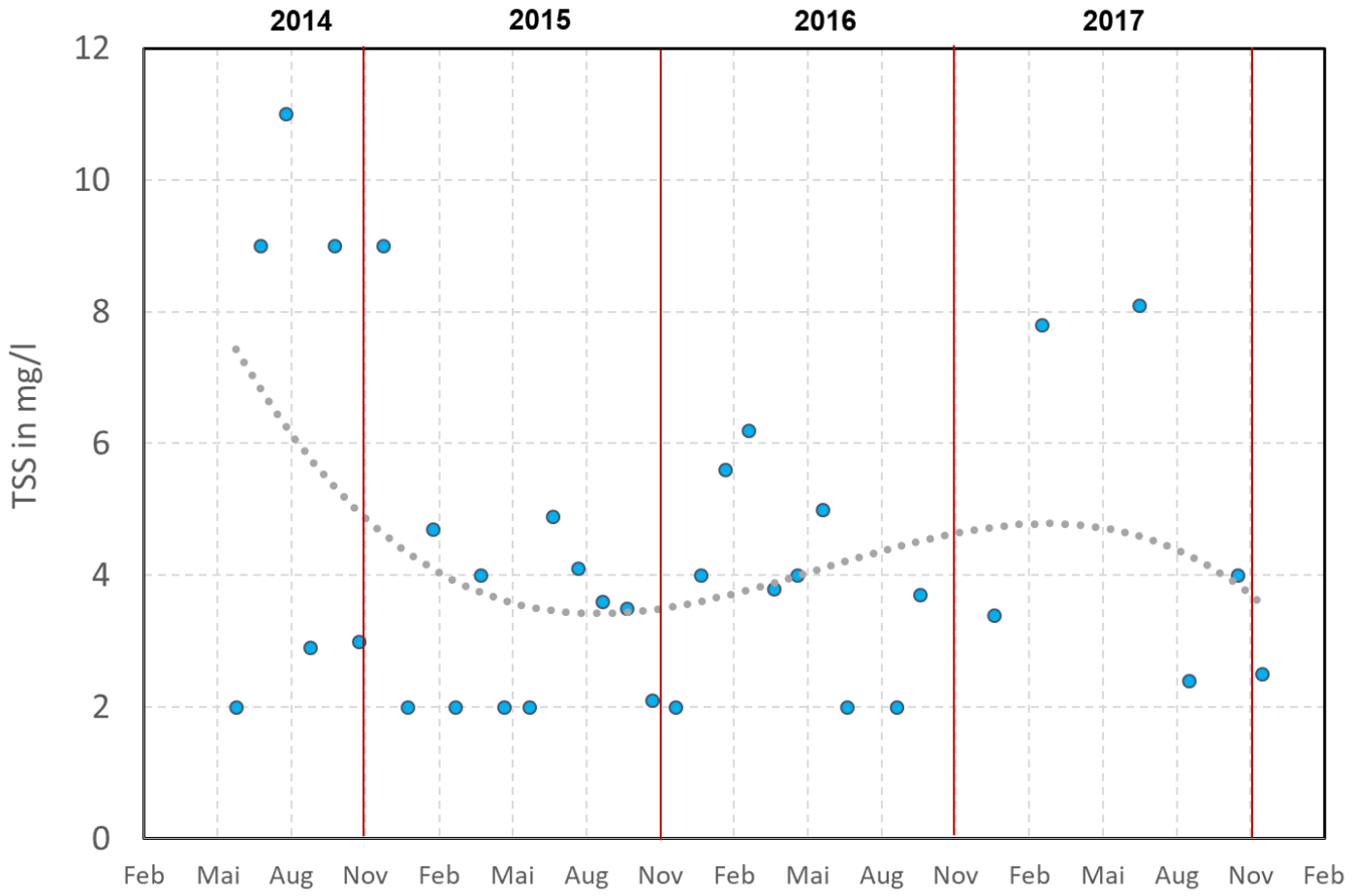
Effluent Pollutants – TSS-Concentration



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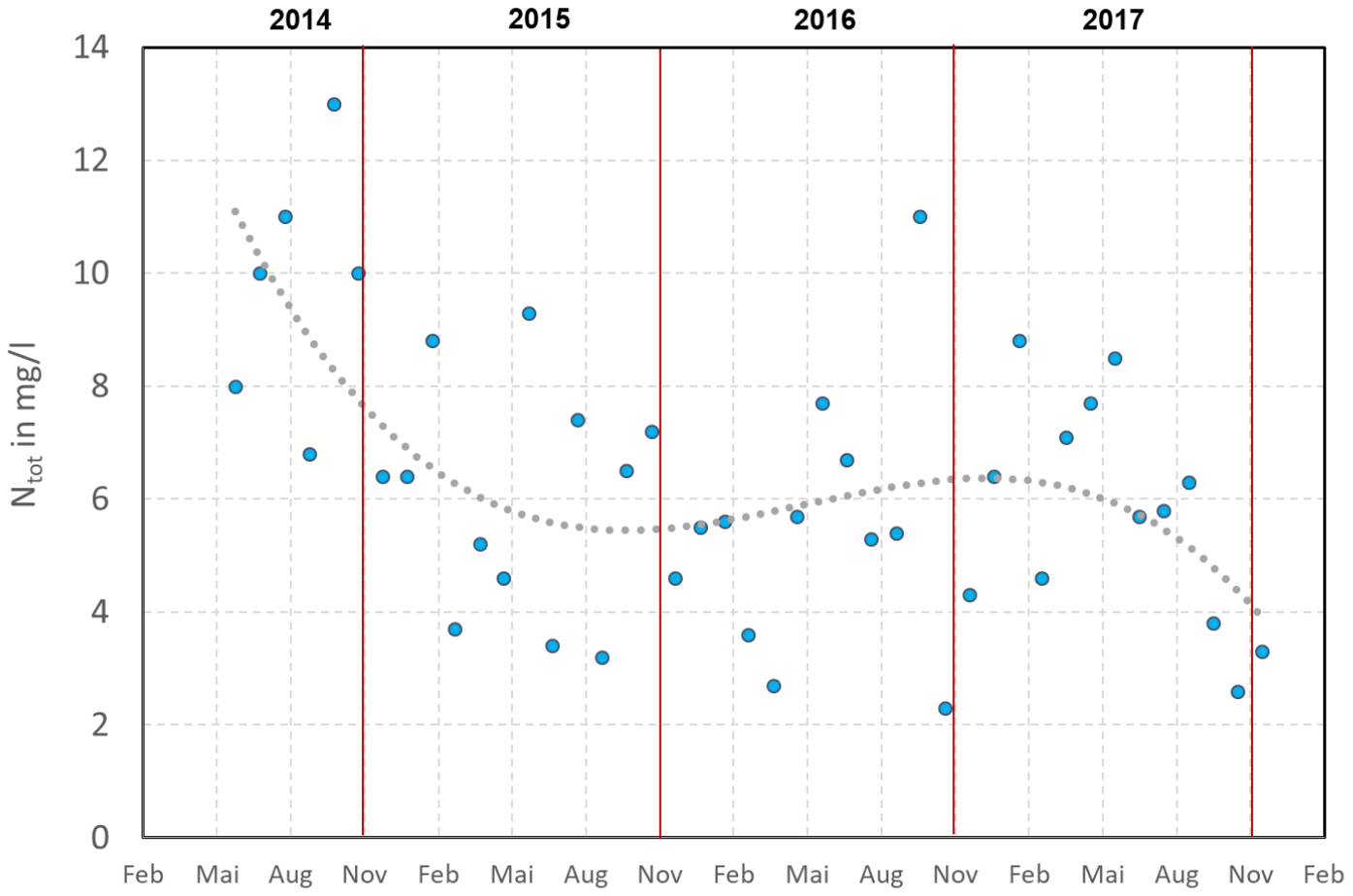
Effluent Pollutants – N_{tot}-Concentration



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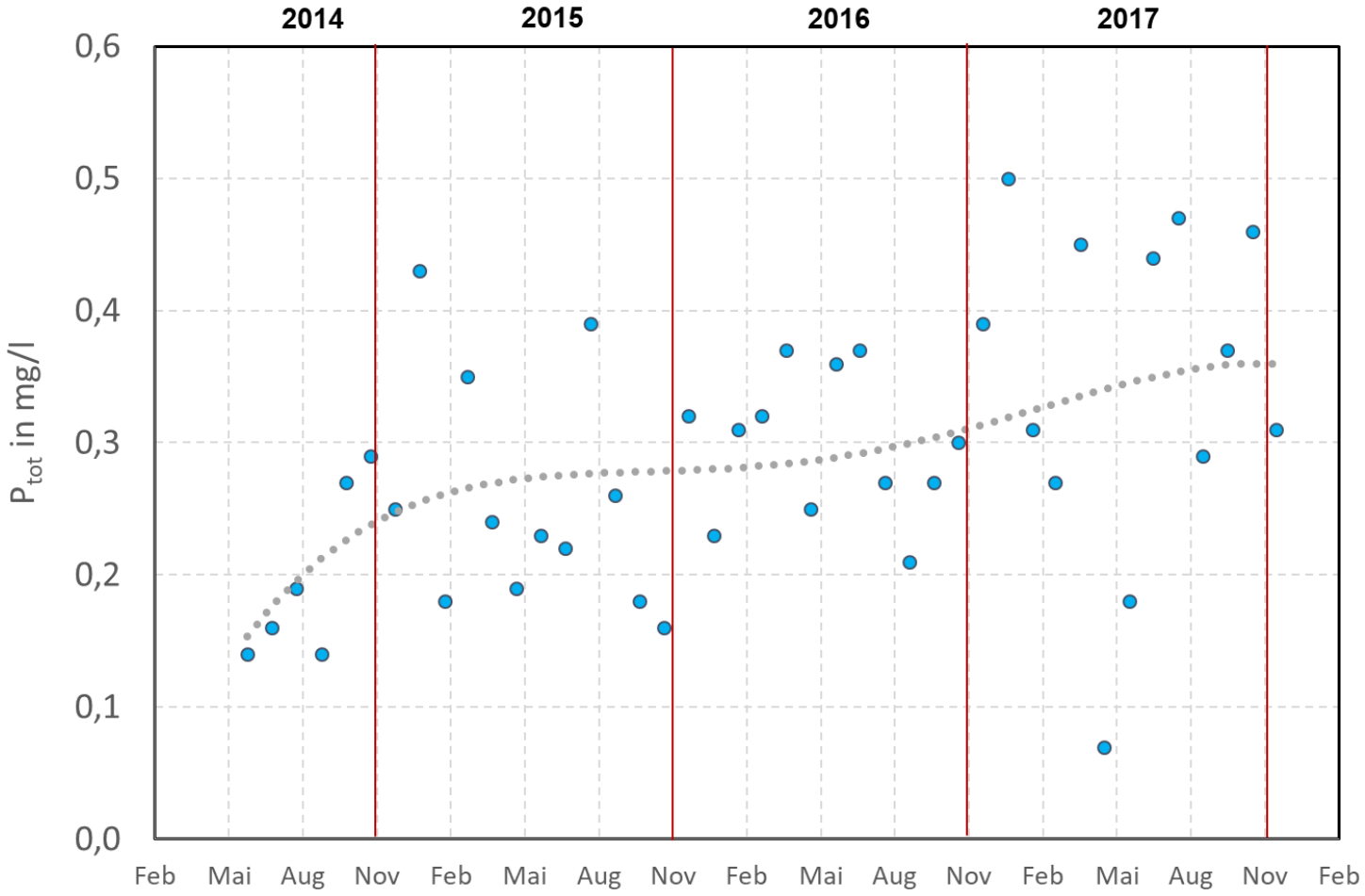
Effluent Pollutants – P_{tot}-Concentration



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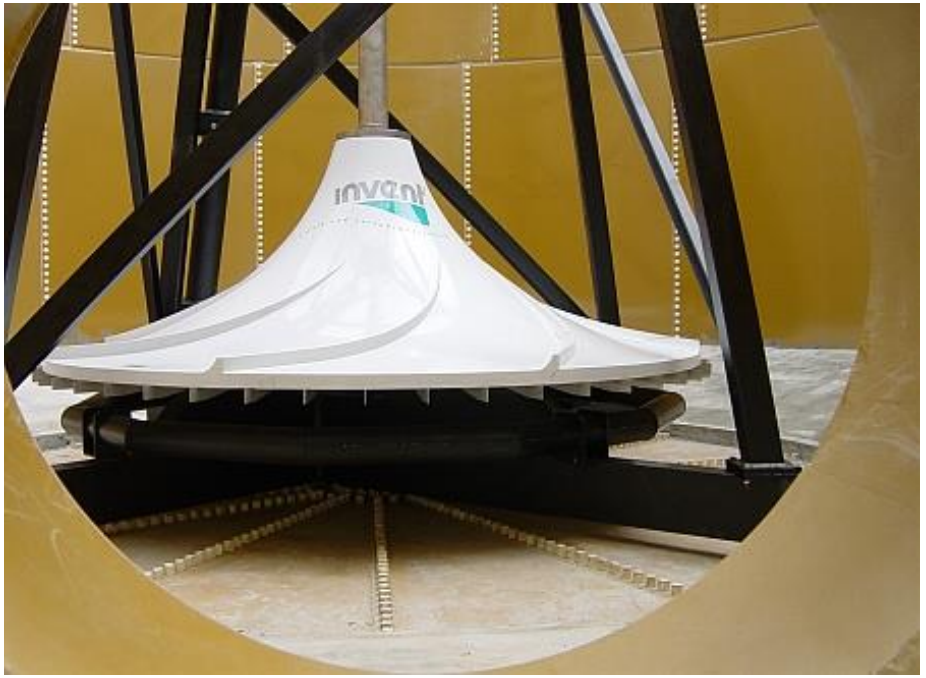
Sludge Production

- **Sludge production:** **120 t TSS/a**
- **Specific sludge production:** **9 kg TSS/(PE*a)**
- **Sludge Retention Time:** **110 d**

➔ **SRT of 25 d corresponds to a specific sludge production of 16 – 18 kg TSS/(PE*a)**

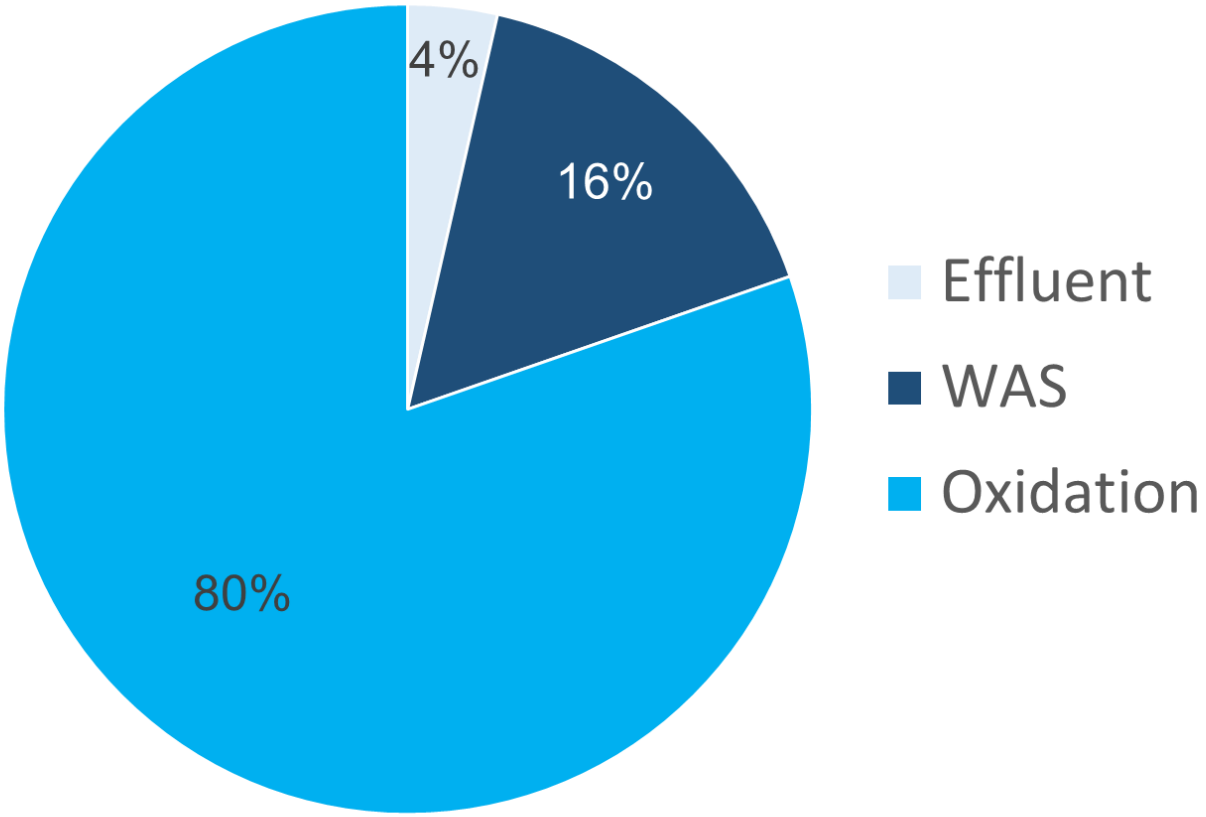
Oxygen consumption and aeration



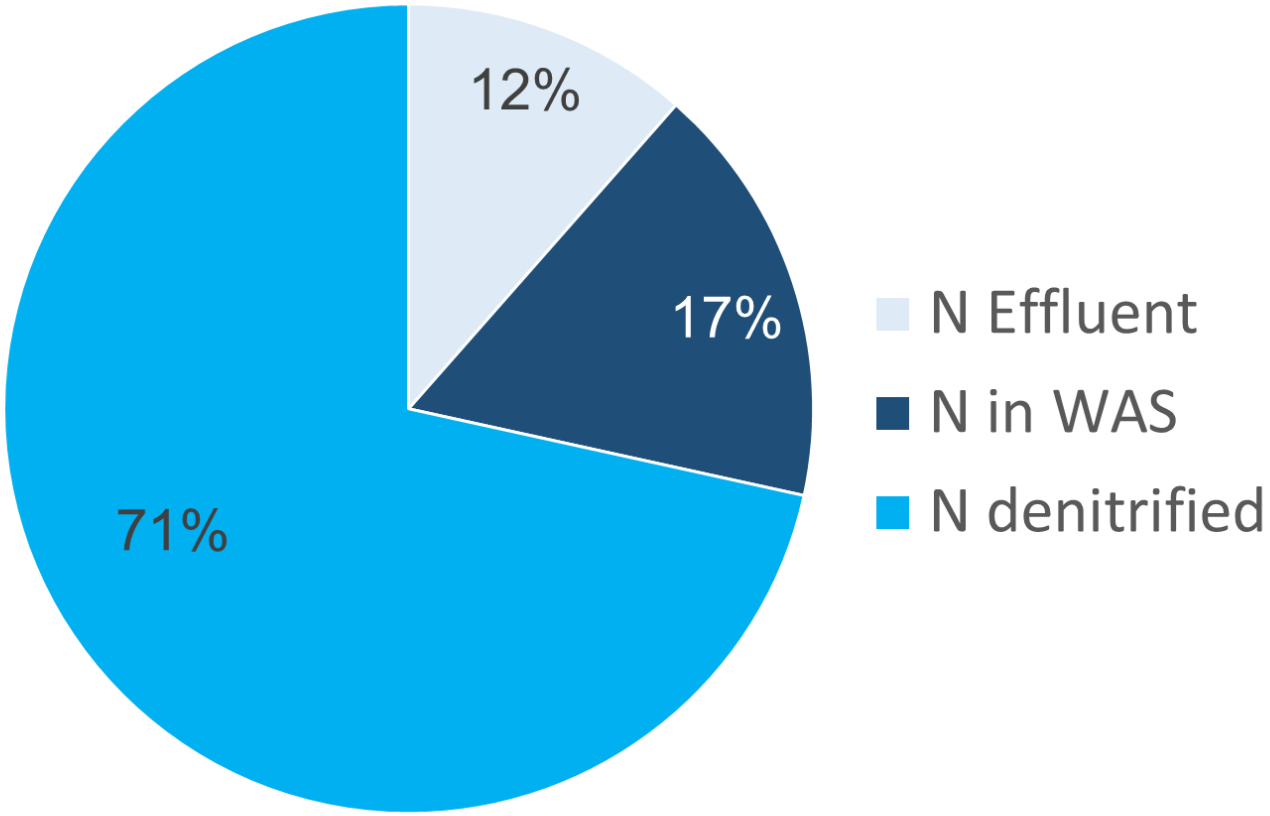
Airflow demand per SBR: **1500 Nm³/h**

Airflow available per SBR: **2000 Nm³/h**

COD Balance



Nitrogen Balance



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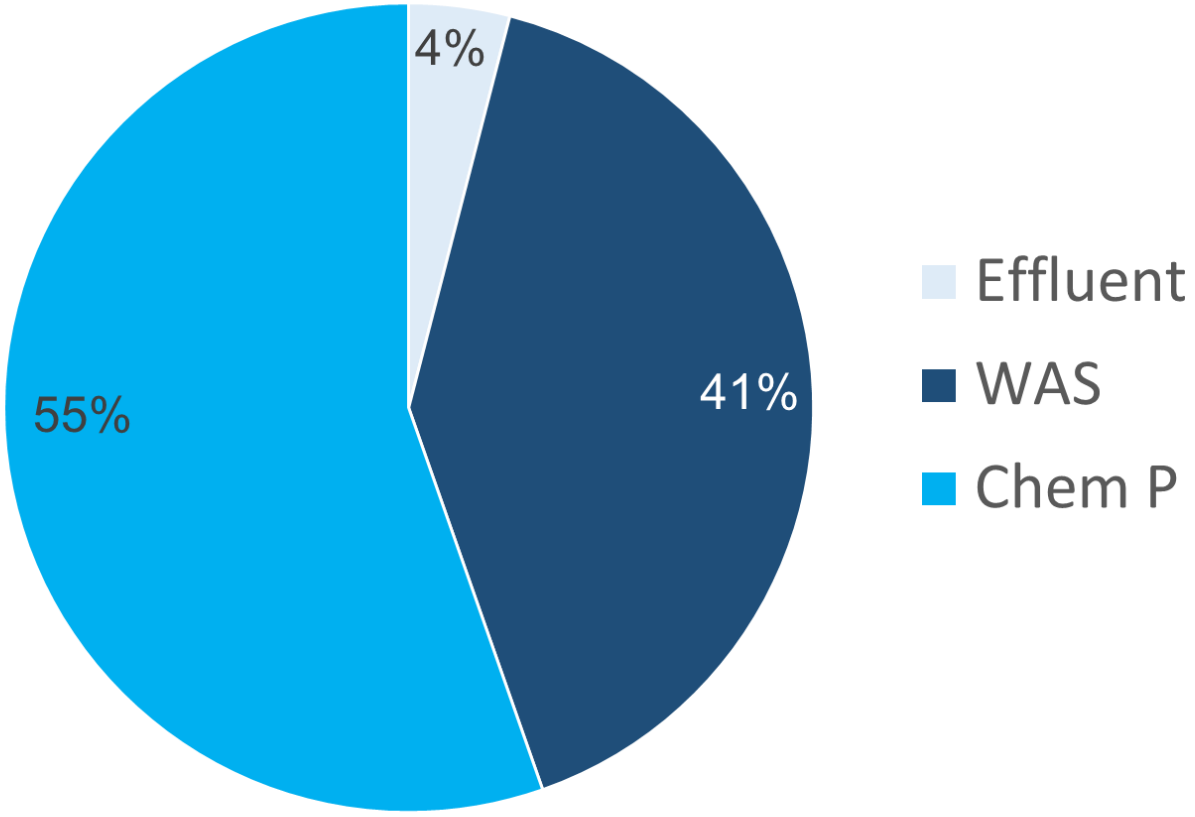
Phosphorus Balance



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Energy efficiency

- **Energy consumption:** **1,0 Mio. kWh/a**
- **COD-Load based on PE** **18.000 PE**
- **spec. Energy consumption:** **55 kWh/(PE*a)**

➔ **A typical value of a WWTP from the data of DWA in Germany has a specific energy consumption of 30 – 40 kWh/(PE*a)**

Scenarios for influent hydraulics

Parameter	Value	Unit
Mean	3000	m^3/d
85% Value	4000	m^3/d
Max	6000	m^3/d

Issues of wastewater treatment processes

In operation	SBR	1	2	3	Unit
	SBR Volume	3000	6000	9000	m^3
	Max. exchange fraction	40	40	40	%
	Max. exchange Volume	1200	2400	3600	m^3/Cycle
Dry Weather	**Cycles per day**	**2**	**2**	**2**	
	Hydr. Capacity	2400	4800	7200	m^3/day
Mean	Hydr. Demand 2 Cycle	126%	63%	42%	
85% Value	Hydr. Demand 2 Cycle	166%	83%	55%	
Max	Hydr. Demand 2 Cycle	252%	126%	84%	
Storm Weather	**Cycles per day**	**3**	**3**	**3**	
	Hydr. Capacity	3600	7200	10800	m^3/day
Mean	Hydr. Demand 3 Cycle	84%	42%	28%	
85% Value	Hydr. Demand 3 Cycle	111%	55%	37%	
Max	Hydr. Demand 3 Cycle	168%	84%	56%	

Issues of wastewater treatment processes

Cycle-time	Step-time	Process	Action 1	Action 2	Action 3
h	min				
3.4	205	Denitrification	Filling		Mixing
4.3	55	Nitrification	Filling	Aeration	Mixing
9.8	330	Nitrification		Aeration	Mixing
11.0	70	Sedimentation		idle	
12.0	60	Decant	Outflow		
12.3	20	Sludge harvesting	Outflow		

Wastewater Volume per Cycle

SBR Volume	3000	m^3
Max. exchange fraction	40	%
Max. exchange Volume	1200	m^3/Cycle
Filling time	1 x 260	min
Filling time	4,33	h
pump 1	130	m^3/h
pump 2	130	m^3/h
Total Flow	260	m^3/h
WW Volume	1127	m^3/Cycle

Suggestions for process optimization

Cycle-Time	Step-time	Step	Step	Process	Action 1	Action 2	Action 3
h	min						
0,5	50	1	1.1	Denitrification	filling		mixing
0,9	5		1.2	Denitrification			mixing
2,1	70		1.3	Nitrification		aeration	mixing
2,6	50	2	2.1	Denitrification	filling		mixing
3,0	5		2.2	Denitrification			mixing
4,2	70		2.3	Nitrification		aeration	mixing
4,7	50	3	3.1	Denitrification	filling		mixing
5,1	5		3.2	Denitrification			mixing
6,3	70		3.3	Nitrification		aeration	mixing
6,8	50	4	4.1	Denitrification	filling		mixing
7,2	5		4.2	Denitrification			mixing
8,3	70		4.3	Nitrification		aeration	mixing
9,3	60		4.4	Nitrification		aeration	mixing
10,5	70	5	5	Sedimentation		idle	
11,7	70	6	6	Emptying	outflow		
12,0	20	7	7	Sludge wastage	outflow		

Wastewater Volume per Cycle

SBR Volume	3000	m^3
Max. exchange fraction	40	%
Max. exchange Volume	1200	m^3/Cycle
Filling time	4 x 50	min
Filling time	3,33	h
pump 1	130	m^3/h
pump 2	**300**	**m^3/h**
Total Flow	430	m^3/h
WW Volume	1433	m^3/Cycle

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Suggestions for process optimization

- **4 x filling over a time of 7 h in 3 SBRs operating in a time shift:**

  ➔ a quasi permanent running of storage tank pumps.

- **Enlargement of storage tank pumps**

  ➔ low water level in storage tank

  ➔ helps to use the hydraulic capacity of the SBRs

- **Sequence of filling/stirring and aeration**

  ➔ Stabilisation of Nitrification and Denitrifkation

Summary

- **WWTP Paide is biologically underloaded and hydraulically overloaded at storm water events.**
- **The plant performance in every treatment stage is excellent.**
- **The plant is run with an extreme high SRT and therefore shows an very low sludge production.**
- **Due to the high SRT the energy efficiency is rather low.**
- **For tertiary treatment an hydraulic equalisation is necessary and possible.**

Thank you for your Attention

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