LIFE B2E4SustWWTP (LIFE16 ENV/GR/000298)

New concept for energy self-sustainable wastewater treatment process and biosolids management

Deliverable C.1.2.

Project indicators monitoring at Midterm Report

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1. OBJECTIVES

This deliverable is integrated into Task C1.2., Life Project Performance Indicators. The objective of this task is to quantify the environmental impact of the LIFE B2E4Sustainable-WWTP Project. To do this, Key Performance Indicators (KPIs) are defined, which allow the determination of that impact through its monitoring throughout the project.

Specifically, the determination of the environmental KPIs is given by the monitoring of a number of variables and operating parameters (defined as functional categories and expressed in Deliverable C1.1), carried out before and after the implementation of the project solution in the Rethymno WWTP. The comparison of the measurements carried out before and after, applying the necessary standardization procedures where appropriate to be able to properly compare said data, allows determining the KPIs, and from them, the environmental improvement that the project entails.

The objective of this deliverable is to present the results of the KPI monitoring until the middle of the Life B2E4Sustainable-WWTP project. As the technological solution has not been implemented yet in the Rethymnon WWTP, this deliverable only presents the results of the monitoring of the environmental impact of the WWTP prior to said implementation. Specifically, the results of the functional categories monitored are shown, and the environmental impacts are calculated from them.

Performance contracts signed between the service companies and their clients, or those derived from the implementation of efficiency programs, energy saving and efficiency measures, monitoring the maintenance of facilities, etc.

2. METHODS

According to the proposal and the deliverable C1.1, the environmental improvement aimed with the project implementation is fundamentally given by the reduction of GHG emissions from urban wastewater treatment, which will be achieved through the following measures:

- Reduction of electricity consumption in the WWTP. It is caused by the lower organic load which enters into the biological reactor (due to the microsieve action), because that supposes lower aeration needs and lower production of biological solids, that last implying also lower dewatering consumptions.
- Increase in the generation / use of energy from renewable sources, due to the use of the solids removed in the microsieve as a renewable energy source.

Additionally, another environmental improvement will come from the reduction in the amount of sewage sludge that is produced in the WWTP, and that is sent to landfill (way of sludge management of Rethymnon WWTP) since this method of waste disposal entails a series of impacts, among which are the emission of GHG. The reduction in the amount of sludge sent to landfill is due to the direct extraction of suspended solids from the wastewater done by the microsieve. With this solution, the organic load that reaches the biological reactor is lower, and consequently, the production of new biological sludge is lower. At the same time, the removed solids are used as a renewable energy source, thus reducing GHG emissions and the net energy consumption of the WWTP.

Considering the previous lines, and the KPIs proposed by the LIFE program as a starting point, the following KPIs are defined for the environmental assessment of the Project.

- Reduction of Global warming potential (GWP)
- Reduction of biosolids produced by the WWTP and sent to the landfill
- Production of energy from renewable sources
- Reduction in the electrical energy consumption of the WWTP
- Reduction in the net energy consumption of the of the WWTP

Energy savings derived from changes in sewage process cannot be calculated simply as the difference between the consumption before and after the implementation of these changes, since in most cases energy consumption suffers variations due to external factors. Therefore, the approach adopted for the indicator's definition is based on the application of a clear and rigorous methodology for the measurement and verification of energy savings.

Firstly, It was proposed a methodology, depicted in the Deliverable C1.1, for the measurement and verification of energy consumption reductions achieved because of the implementation of energy saving actions, according to The International Performance Measurement and Verification Protocol (IPMVP), developed by the Efficiency Valuation Organization (EVO). The objective was that the work done served as a guarantee for the parties as well as conferring greater credibility, even at the international level of energy saving reports.

Following that methodology, it was proposed several measurements and a periodicity for the same which will ultimately not be able to be carried out, due to the limited availability of information on the exploitation of the Rethymno WWTP. In any case, with the procedure followed up to this point, it is expected that energy savings can also be verified, and from them, environmental improvements.

2.1 System description

The quantification of the project's KPIs entails the measurement of the environmental impacts in a system, which is the Rethymnon WWTP, before and after the project's implementation. Furthermore, taking into account that: i) the biological sludge from this facility is currently treated by landfilling; ii) the environmental impact of said landfilling operation is significant; iii) the amount of sludge sent to this treatment will vary substantially after the implementation of the project, the studied system must include the impacts of said landfill operation. Therefore, the studied system, both before and after the project's implementation includes the wastewater treatment stage itself, plus the external treatment of landfilling for the dewatered sludge produced in the WWTP.

Before implementation, the wastewater treatment stage is equivalent to the current WWTP in Rethymno. After modifying said installation, it is studied the following system: a first stage where the pretreated wastewater influent is microsieved, being produced two streams: a primary effluent which goes towards biological treatment, and a highly concentrated stream in solids (≈35-40%DS), which goes to the thermal treatment with energy valorisation. That last stream is then dried, reaching 90%DS. The dried biosolids are treated by a gasification process, where three streams are produced. A gaseous stream of syngas, a residual stream of solid wastes (ashes), and wastewater produced in the syngas cleaning operations. These two last streams are properly treated outside the WWTP facilities, and the syngas is thermally valorized in a cogeneration engine, for producing heat and electricity. Both, electricity, and heat are self-consumed in the WWTP. Particularly, the produced heat, which comes from the engine and from the cooling operations of syngas is consumed in the biosolids drying operations.

In the case of studying the impact of landfilling, prior to said treatment it is necessary to dry the sludge. Therefore, for the two cases under study it is assumed that the dewatered sludge is previously dried up to 85% of dry matter. It is assumed that said drying operation is carried out with a conventional system, applying thermal energy (direct contact with off-gases generated with a natural gas combustion chamber), in addition to auxiliary electrical energy, necessary for the operation of pumps, fans, etc.

Once dried, the sludge is removed by landfilling. That sludge is an organic material, so it will produce biogas in the landfill, which can be valorized energetically. That stage is also considered for the study of the landfill environmental impacts. net electrical consumption is the electrical energy consumed in the drying stage minus the electrical energy generated from the biogas produced.

2.2 General calculation procedure

To calculate the indicated KPIs, a series of variables and operating parameters, called functional categories, must be monitored, as has been said.

- **Reduction of GWP**. In this case it is calculated the greenhouse gas emissions of the system before and after the implementation of the B2E4 solution, and they are expressed as mass of CO_2 equivalent (CO_2eq.). The GHG emissions included in the calculation are the following:
    - Emissions derived from the production of the electricity consumed in the WWTP, including the biosolids treatment system. The variable to be monitored is the consumption of electrical energy in the WWTP.
    - Emissions derived from the production and on-site consumption of fuels in the biosolids thermal treatment process (syngas and / or auxiliary fuel such as biodiesel or biomass). Regarding monitoring, these emissions will be measured directly, or if it is not possible, calculated from the composition of the fuel/s used.
    - Emissions (avoided) due to self-consumption in the WWTP of the electricity produced in the biosolids treatment system. The variable to be monitored is the production of electricity in the engine and the net consumption of electricity in the WWTP.
    - Emissions due to the production and consumption of fuel (natural gas) in the landfill to dry the dewatered sludge.
    - Emissions derived from the production of electricity consumed in the landfill, in the drying stage of the dewatered sludge. The variable to monitor is the consumption of electrical energy.
    - Emissions produced in the landfilling of the dried sludge / gasification ashes.
    - Emissions (avoided) due to self-consumption in the landfill of the electricity produced in engine from biogas produced as a result of landfilling of dry sludge. The variable is the production of electricity in the engine.
- **Reduction of biosolids produced by the WWTP and sent to the landfill.** In this case, only the volume of dewatered sludge produced before and after implementation, as well as its dry solids content, will be measured. The production of the gasification ashes of the modified System will also be included, since it is expected that, like the dewatered sludge, its final destination will be the landfill.
- **Production of energy from renewable sources**. In this case, production takes place only in the modified System. In this System, the energy (thermal and

electrical) produced when consuming syngas will be quantified, as well as that generated from renewable auxiliary fuels, such as biomass.

- **Reduction in the electrical energy consumption of the WWTP**. Difference between the electricity consumption in the WWTP before and after the implementation of the B2E4 solution. Said implementation will entail, on the one hand, a reduction in the electricity consumption of the WWTP, due to the lower aeration needs in the biological reactor and less quantity of sludge sent to centrifugation. On the other hand, the System after implementation will include the electrical energy consumption of the new equipment (microsieve, dryer and gasifier) and the self-consumption of the electrical energy produced in the engine. The variable to be monitored will be the electrical energy consumption in the WWTP.
- **Reduction in the net energy consumption of the WWTP**. It is included the net reduction in the electricity consumption of the facility (see previous point), in addition to the thermal energy produced from external fuels. In the latter case, their consumption will be monitored.

Taking into account that the energy consumptions of the WWTP depends on the organic matter and nitrogen load removed, and that this can vary over time, for being able to compare the impacts of the facility before and after the implementation of the B2E4 solution is necessary to refer them to the same amount of treated or removed matter. In this case, the impacts are normalized with respect to the equivalent inhabitant treated in one year and also with respect to the removed BOD.

This deliverable only includes the results of the evaluation at the WWTP before the B2E4 implementation. Therefore, the environmental impact assessment is limited to the following actions:

- Current GWP of Rethymnon WWTP. The following emissions is considered:
  - Emissions derived from the current electricity consumption.
  - Emissions derived from the production and consumption of fuel (natural gas) in the landfill to dry the dewatered sludge.
  - Emissions derived from the production of the electricity consumed in the in the landfill for drying the dewatered sludge.
  - Emissions derived from the landfilling of the produced dried sludge.
  - Emissions (avoided) due to self-consumption in the landfill of the electricity produced in engine from biogas produced as a result of landfilling of dry sludge.
- Current production of biosolids in Rethymnon WWTP sent to landfill
- Current electrical energy consumption in Rethymnon WWTP.

As indicated before, the obtained results refer to the amount of organic load treated in one year (equivalent inhabitant-year) and also to the amount of BOD removed.

2.3 Calculation factors and resources used

This section includes the sources of information, as well as the parameters used to calculate the impacts referred to in the previous point. This calculation is limited to the current wastewater treatment carried out at the Rethymnon WWTP, together with the drying and subsequent landfilling of the dewatered sludge produced at the mentioned WWTP.

To calculate the impacts that originate in the Rethymnon plant itself, it is only necessary to know the electricity consumption and the biological sludge production of said facility, for a certain period of time, as well as the organic load treated or eliminated during said period.

To characterize the performance and consumptions of the WWTP, exploitation data from the same during the period 2017-2019, are used. This information is provided by DEYAR and can be found in its entirety in the Annex to this document. The problem is that not all the information handled is available for every year. Specifically:

- There are only available data on the treated wastewater flow for the years 2018 and 2019 (and only volume treated annually). There is no data for 2017.
- The sludge production is only available for 2017 (and annual production data only), but not for 2018 or 2019. There is also no data on the dry matter content of the sludge produced in 2018 and 2019.
- There is only one electricity consumption data for the plant for 2017 (only the total annual consumption, there is no monthly billing data). There is no data for 2018 and 2019.

Considering the available data, to complete the necessary information on the performance and consumptions of the Rethymnon WWTP in the period 2017-2019, the following is done:

1. It has been assumed that the volume of wastewater treated in 2017 is the average of that treated in 2018 and 2019.
2. From the data on electricity consumption in 2017 and the load of BOD removed that year, a ratio (kWh per kg of BOD removed in 2017) has been calculated. Then, same ratio value has been used in 2018 and 2019, to calculate electrical consumption from the load of BOD removed in those years.

3. From the BOD load removed in 2017 and the sludge produced in that year (dry matter) a ratio (kg of DS produced per kg of BOD removed in 2017) has been calculated. The calculated value has been considered the same for 2018 and 2019, and then, the dry solids produced in those two years has been calculated with it and the value of BOD removed. Assuming the same moisture as in the 2017 sludge, the amount of dewatered sludge produced in 2018 and 2019 is calculated.

From the exploitation data of the WWTP, the impacts of the biosolids sent to the landfill and of electricity consumption in the WWTP are obtained directly. On the other hand, to obtain the Current GWP of Rethymnon WWTP it is necessary to calculate the emissions indicated in the previous point. These calculations are detailed below.

- GWP from the emissions derived from the WWTP electricity consumption. To calculate the emissions related to the production and distribution of the electrical energy consumed in the WWTP, and from them, the GWP, it is taken the following process, included in the databases of the GaBi ts 9.5 software, which is a tool for developing Life Cycle Assessment of products and processes.
    - **GR Electricity grid mix; AC, technology mix; consumption mix, to consumer; 1kV-60kV**. This process includes the energy mix of Greece, with a reference year 2016, and valid until 2022. Detailed information on the consumptions and emissions included in this process can be found at: http://gabi-documentation-2020.gabi-software.com/xml-data/processes/88f51b8a-3e69-4213-9f65-760723f2ca40.xml

- GWP from the derived from the consumption of fuel in the landfill to dry the dewatered sludge. To calculate the associated emissions, both the emissions generated in the production of the necessary fuel (indirect emissions) and the direct emissions produced when combusting said fuel in situ to generate the necessary heat are considered. The fuel considered is natural gas. To calculate the net energy required for drying, a yield of 1,100 kWh per m^3 of evaporated water is set. This performance is similar to that of most direct contact off-gases dryers on the market today. To calculate the volume of evaporated water, a final dryness in the dried sludge of 85% of dry matter is set. Once determined the net thermal energy necessary for drying, to calculate the emissions and the GWP derived from it, it is taken the following process, included in the databases of the GaBi software.
    - **GR Thermal energy from natural gas; technology mix regarding firing and flue gas cleaning; production mix, at heat plant; 100% efficiency.** The Greek energy carrier mix is used for the thermal energy production,

for the reference year of 2016, and valid until 2022. Detailed information on the consumptions and emissions included in this process can be found at: http://gabi-documentation-2020.gabi-software.com/xml-data/processes/9b4a91c6-947e-4ea0-b449-2b22f6b12345.xml

- GWP from the emissions derived from the electricity consumption in the landfill to dry the dewatered sludge. Considering the characteristics of direct contact dryers, in addition to thermal energy, there are also electrical energy consumption during drying. These consumptions are due to necessary equipment such as pumps, fans, etc. To calculate the net energy required for drying, a yield of 200 kWh per m^3 of evaporated water is set. This performance is similar to that of most direct contact off-gases dryers on the market today. The volume of evaporated water is calculated according to the procedure described in the previous point. Once determined the electrical energy necessary for drying, to calculate the emissions and the GWP derived from it, it is taken the following process, included in the databases of the GaBi ts 9.5 software.
  - **GR Electricity grid mix; AC, technology mix; consumption mix, to consumer; 1kV-60kV**.

- GWP from the emissions derived from landfilling of the produced dried sludge. Dry sludge landfilling carries direct and indirect emissions. These emissions depend on the amount and type of waste landfilled. The amount of dry sludge is calculated according to the amount of dewatered sludge and the final dryness reach, which in this case is 85% DS.To calculate those emissions and the GWP derived from them, the following process, included in the databases of the GaBi software is taken.
  - **EU-28 Municipal solid waste on landfill; landfill including landfill gas utilisation and leachate treatment, without collection, transport, and pre-treatment; ES, GR, PT production mix (region specific sites), at landfill site; Net calorific value 9,7 MJ/kg.** Spain, Greek and Portugal energy production mix are considered. The year of reference of the data is 2019, and they are valid until 2022. Detailed information on the consumptions and emissions included in this process can be found at: http://gabi-documentation-2020.gabi-software.com/xml-data/processes/89863fcc-3306-11dd-bd11-0800200c9a66.xml

  This process has been selected because it is a biodegradable product, assimilable to WWTP sewage sludge, with a LHV (9.7 MJ / kg) similar to that of a WWTP sludge with 0.75 SV / ST, as is that of Rethymno, and 85% of DS. On the other hand, this process includes the production of electrical energy in engine using the biogas generated in the landfill from the sludge. The exploitation of the thermal energy generated is not considered as this is not a common practice in these facilities. The electrical energy generated is subtracted from the electrical energy demand of the drying stage.

3. RESULTS

Table 1 includes the results obtained from the information provided and following the methodology described. For all variables, average values have been calculated for the years 2017, 2018 and 2019, as well as the average for said period. The average concentrations of TSS and BOD are provided separately for winter and summer periods, as they are particularly important parameters, and seasonal variation maters.

Table 1 – Results obtained about exploitation data of Rethymno WWTP

			2017	**2018**	**2019**	**Average**
Wastewater treated	m^3/y		3,380,000	3,260,000	3,500,000	3,380,000
TSS in WWTP influent*	mg/l	winter	217	265	158	213
		summer	232	446	265	314
TSS in WWTP effluent	mg/l		6	4	3	4
BOD in WWTP influent*	mg/l	winter	406	360	301	356
		summer	384	431	456	424
BOD in WWTP effluent	mg/l		8	6	6	7
BOD load to WWTP	kgBOD/y		1,352,000	1,271,400	1,281,000	1,301,466
Equivalent population treated	p-e		62	58	58	59
BOD load removed	kgBOD/y		1,324,960	1,251,840	1,260,000	1,278,933
Dewatered sludge produced	t/y		3,900	3,681	3,705	3,762
Solids content in dewatered sludge	%		17	17	17	17
Dry solids produced	t/y		663	626	630	640
Ratio DS produced - BOD removed	kgDS/kgBOD		0.50	0.50	0.50	0.50
Electrical consumption of WWTP	kWh/y		3,000,000	2,829,158	2,847,600	2,892,253
Ratio kWh_e consumed - treated m^3	kWh/m^3		0.89	0.87	0.81	0.86
Dried sludge (85%DS) produced	t/y		780	736	741	753
Thermal energy for sludge drying	kWh/y		3,432,000	3,240,056	3,261,176	3,311,078
Electrical energy for sludge drying	kWh/y		3,689	3,704	3,700	3,698
Electrical energy produced in landfill	kWh/y		120	120	120	120
Electrical net consumption in landfill	kWh/y		3,569	3,583	3,580	3,577

Winter:* November-May; **Summer: June-October*

Table 2 includes the environmental impacts calculated from the WWTP exploitation data. Absolute data are included and also referred to the equivalent inhabitant-year and the kg of BOD removed. Those impacts include the treatment in landfill of the dewatered sludge produced.

The GWP output is distributed among four processes, all of them having direct or indirect emissions. The total impact is distributed among these processes in the following way.

- 54% of the total GWP comes to the production of the electrical energy consumed in the WWTP
- 21% comes from the production and consumption of the natural gas used in the landfill for drying the dewatered sludge.
- 14% comes from the production of the electricity consumed in the landfill for drying the dewatered sludge. This consumption includes the electrical energy that is generated in the landfill, and that is self-consumed in the drying stage.
- 11% comes from the landfilling of the dried sludge.

Table 2 – Environmental impacts of Rethymno WWTP

		2017	2018	2019	Average
Global Warming Potential (GWP)	tCOeq/y	3,975	3,745	3,774	3,831
	kgCO2eq/pe-y	64.4	64.5	64.5	64.5
	kgCO2eq/kgBOD	3.0	2.9	2.9	3.0
Biosolids produced and sent to the landfill	t/y	3,900	3,681	3,705	3,762
	kg/pe-y	63.2	63.4	63.4	63.3
	kg/kgBOD	2.94	2.94	2.94	2.94
Electrical energy consumption in the WWTP	kWh_e/y	3,000,000	2,829,158	2,847,600	2,892,253
	$kWh_e/pe\text{-}y$	48.6	48.7	48.7	48.7
	$kWh_e/kgBOD$	2.26	2.26	2.26	2.26

ANNEX

Exploitation data of Rethymno WWTP

A.1. Wastewater treated

Year	2017	2018	2019
Volume (m^3)	Not available	3,260,000	3,500,000

Besides, the plant, which applies an extended aeration activated sludge process, has an average daily flow of 13,000 to 15,000 m^3, and its peak flow capacity is some 17,000 m^3/day". These data about Rethymnon WWTP is included in the following resources:

- http://astikalimata.ypeka.gr/Services/Pages/View.aspx?xuwcode=GR433001019
- (http://www.ypeka.gr/Default.aspx?tabid=251&locale=el-GR&language=en-US).

A.2. Electrical consumption

Year	2017	2018	2019
Consumption (kWh)	3,000,000	Not available	Not available

In the 2017 data, 70% of the total consumption (2,100,000 kWh) comes from the biological reactors and aerobic digesters operation, and the remaining 30% (900,000 kWh) is due to the remaining consumers of the WWTP.

A.3. Chemicals consumption

The following data are all from 2017.

- NaOH (48%): 300 t/y for digesters and 100 t/y for scrubbers
- NaClO (50%): 200 t/y for disinfection and 70 t/y for scrubbers
- Polyelectrolyte (s). 20 t/y for dewatering

A.4. Characteristics of influent and effluent of WWTP

The following tables include some characterization data (punctual measures) of these streams.

chemical input analysis 2017																								
month	january						february						march						april					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																								
3													595	380	48,5	63,1	7,1	169	821	650	51	77	9,01	289
4																								
5																								
6																								
7							385	240	30,6	48,3	6,2	140												
8																								
9																								
10	281	180	33,4	50,8	4,6	120																		
11																								
12																								
13																								
14																								
15																								
16																								
17	361	200	34,6	57,6	5,1	134																		
18																								
19																								
20																								
21							411	260	33,4	52,8	6	150	583	400	46,7	62,8	7,5	171						
22																								
23																								
24																								
25																			615	360	48,6	65,3	6,8	141
26																								
27																								
28																								
29																								
30																								
31	362	220	35,1	58,2	4,8	131																		
TOTAL	1004	600	103,1	167	14,5	385	796	500	64	101	12,2	290	1178	780	95,2	126	14,6	340	1436	1010	99,6	142	15,8	430
MAX	362	220	35,1	58,2	5,1	134	411	260	33,4	52,8	6,2	150	595	400	48,5	63,1	7,5	171	821	650	51	77	9,01	289
MIN	281	180	33,4	50,8	4,6	120	385	240	30,6	48,3	6	140	583	380	46,7	62,8	7,1	169	615	360	48,6	65,3	6,8	141
AVERAGE	335	200	34	56	5	128	398	250	32	51	6	145	589	390	48	63	7	170	718	505	50	71	8	215

chemical input analysis 2017

month	may					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2						
3						
4						
5						
6						
7						
8	720	400	51,6	72,5	8,86	248
9						
10						
11						
12						
13						
14						
15						
16	1306	920	60,3	105	14,5	461
17						
18						
19						
20						
21						
22						
23	697	380	64,2	83,1	10,9	310
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL	2723	1700	176,1	261	34,3	1019
MAX	1306	920	64,2	105	14,5	461
MIN	697	380	51,6	72,5	8,86	248
AVERAGE	908	567	59	87	11	340

month	june					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2						
3						
4						
5						
6						
7	1124	780	43,8	80,1	19,7	480
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26	1071	400	51,3	78,7	13,7	442
27						
28						
29						
30						
31						
TOTAL	2195	1180	95,1	159	33,4	922
MAX	1124	780	51,3	80,1	19,7	480
MIN	1071	400	43,8	78,7	13,7	442
AVERAGE	1098	590	48	79	17	461

month	july					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2						
3						
4	770	420	51,9	81,8	9,9	287
5						
6						
7						
8						
9						
10						
11						
12						
13	899	420	36	59,6	10,4	315
14						
15						
16						
17						
18	761	340	16,74	49	7,02	261
19						
20						
21						
22						
23						
24						
25	576	440	34,8	51,8	8,05	198
26						
27						
28						
29						
30						
31						
TOTAL	3006	1620	139,4	242	35,4	1061
MAX	899	440	51,9	81,8	10,4	315
MIN	576	340	16,74	49	7,02	198
AVERAGE	752	405	35	61	9	265

month	august					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1	682	300	31,2	54,1	10,1	267
2						
3						
4						
5						
6						
7						
8						
9	585	360	33,6	55,1	9,5	231
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24	742	480	56,1	72,3	8,46	275
25						
26						
27						
28						
29						
30						
31						
TOTAL	2009	1140	120,9	182	28,1	773
MAX	742	480	56,1	72,3	10,1	275
MIN	585	300	31,2	54,1	8,46	231
AVERAGE	670	380	40	61	9	258

chemical input analysis 2017

month	september					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2						
3						
4						
5	1040	480	39,6	71,1	16,7	500
6						
7						
8						
9						
10						
11	987	340	40,5	55,4	15,5	333
12						
13						
14						
15						
16						
17						
18	860	320	42,6	51,7	11,4	385
19						
20	903	300	42	63,2	7,53	444
21						
22						
23						
24						
25						
26	792	360	42,6	76,8	7,84	238
27						
28						
29	926	380	24,72	53,2	7,66	435
30						
31						
TOTAL	5508	2180	232	371	66,6	2335
MAX	1040	480	42,6	76,8	16,7	500
MIN	792	300	24,72	51,7	7,53	238
AVERAGE	918	363	39	62	11	389

month	october					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2	734	280	27,27	75,7	6,64	195
3						
4						
5						
6						
7						
8						
9	856	300	78,9	87,2	13,3	666
10						
11	698	320	25,83	59,7	5,87	215
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25	712	320	28,57	58,4	6,72	250
26						
27						
28						
29						
30	718	340	29,98	48,6	5,62	224
31						
TOTAL	3718	1560	190,6	330	38,2	1550
MAX	856	340	78,9	87,2	13,3	666
MIN	698	280	25,83	48,6	5,62	195
AVERAGE	744	312	38	66	8	310

month	november					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1	742	280	20,79	54,8	7,49	133
2						
3						
4						
5						
6	1158	440	39,74	61,3	13,7	450
7						
8						
9	793	360	18,75	50,7	9,82	120
10						
11						
12						
13	1317	860	21,69	45,1	8,64	375
14						
15						
16						
17						
18						
19						
20	1282	540	22,59	53,9	7,54	130
21						
22	890	400	21,42	50,2	6,42	295
23						
24						
25						
26						
27	801	260	13,05	49,5	4,13	177
28						
29						
30						
31						
TOTAL	6983	3140	158	366	57,7	1680
MAX	1317	860	39,74	61,3	13,7	450
MIN	742	260	13,05	45,1	4,13	120
AVERAGE	998	449	23	52	8	240

month	december					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1						
2						
3						
4						
5	1174	480	15,12	50,9	5,37	247
6						
7						
8						
9						
10						
11						
12	798	320	12,9	48,5	3,44	175
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL	1972	800	28,02	99,4	8,81	422
MAX	1174	480	15,12	50,9	5,37	247
MIN	798	320	12,9	48,5	3,44	175
AVERAGE	986	400	14	50	4	211

Chemical input analysis 2018

month	January						February						March						April					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																								
3																								
4																								
5													587	380	48,6	65,2	8,1	190						
6																								
7																								
8							481	280	41,5	62,7	8,5	185												
9																								
10																								
11	295	180	38,1	54,6	8,5	131																		
12																								
13																								
14																								
15																								
16																								
17																			765	440	50,2	71	9,3	291
18																								
19																								
20							531	360	44,7	67,3	9,1	220												
21																								
22	330	200	35,7	58,4	8,8	140																		
23																								
24																								
25																								
26													595	400	47,3	64,3	9,5	195						
27																								
28																								
29																								
30																			681	400	48,7	68,3	9	258
31																								
TOTAL	625	380	73,8	113	17,3	271	1012	640	86,2	130	17,6	405	1182	780	95,9	130	17,6	385	1446	840	98,9	139	18,3	549
MAX	330	200	38,1	58,4	8,8	140	531	360	44,7	67,3	9,1	220	595	400	48,6	65,2	9,5	195	765	440	50,2	71	9,3	291
MIN	295	180	35,7	54,6	8,5	131	481	280	41,5	62,7	8,5	185	587	380	47,3	64,3	8,1	190	681	400	48,7	68,3	9	258
AVERAGE	313	190	37	57	9	136	506	320	43	65	9	203	591	390	48	65	9	193	723	420	49	70	9	275

Chemical input analysis 2018

month	May						June						July						August					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																			931	420	60,3	78,5	16,1	384
2																								
3																								
4																								
5																								
6							985	460	56,4	78,3	13,6	485												
7																								
8																								
9																								
10	735	400	58,7	80,1	11,6	310							868	440	55,1	77,3	14,6	410						
11																								
12																								
13																								
14																								
15																								
16																			815	380	49,6	65,7	11,7	309
17	814	420	55,9	78,3	10,5	323																		
18																								
19																								
20																								
21							1056	480	60,4	85	10,9	437												
22																								
23																								
24													791	400	57,6	81,2	10,8	391						
25	1158	500	61,4	83,3	12,6	487																		
26																								
27																			1018	480	58,7	73,6	15,8	507
28																								
29																								
30																								
31																								
TOTAL	2707	1320	176	242	34,7	1120	2041	940	116,8	163	24,5	922	1659	840	112,7	159	25,4	801	2764	1280	168,6	218	43,6	1200
MAX	1158	500	61,4	83,3	12,6	487	1056	480	60,4	85	13,6	485	868	440	57,6	81,2	14,6	410	1018	480	60,3	78,5	16,1	507
MIN	735	400	55,9	78,3	10,5	310	985	460	56,4	78,3	10,9	437	791	400	55,1	77,3	10,8	391	815	380	49,6	65,7	11,7	309
AVERAGE	902	440	59	81	12	373	1021	470	58	82	12	461	830	420	56	79	13	401	921	427	56	73	15	400

Chemical input analysis 2018

month	September						October						November						December					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																								
3																								
4																								
5																			787	360	34,6	57,4	8,5	284
6													751	360	55,8	70,3	12,8	375						
7	988	420	61	87	16,5	476																		
8							748	400	68	91,4	23,8	464												
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																			680	340	31,6	55,2	5,5	214
19							834	380	71,6	89,5	17,6	491												
20													851	380	44,2	61,4	11,5	378						
21																								
22																								
23																								
24																								
25																								
26																								
27	959	480	69	86,3	18,6	556																		
28																								
29																								
30																								
31																								
TOTAL	1947	900	130	173	35,1	1032	1582	780	139,6	181	41,4	955	1602	740	100	132	24,3	753	1467	700	66,2	113	14	498
MAX	988	480	69	87	18,6	556	834	400	71,6	91,4	23,8	491	851	380	55,8	70,3	12,8	378	787	360	34,6	57,4	8,5	284
MIN	959	420	61	86,3	16,5	476	748	380	68	89,5	17,6	464	751	360	44,2	61,4	11,5	375	680	340	31,6	55,2	5,5	214
AVERAGE	974	450	65	87	18	516	791	390	70	90	21	478	801	370	50	66	12	377	734	350	33	56	7	249

Chemical input analysis 2019

month	Jan						Feb						Mar						Apr					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																								
3																								
4																								
5																			447	260	37,3	51,2	6,8	147
6																								
7							364	220	34,1	50,1	6,1	131												
8													415	240	41,6	58,7	6,5	141						
9																								
10	272	180	35,3	51,8	4,2	115																		
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																			483	280	42	57,1	7,3	151
19																								
20													462	260	43,4	59,1	5,9	145						
21							351	200	33,5	51,6	4,8	135												
22																								
23																								
24	345	200	31,8	49,6	5,6	129																		
25																								
26																								
27																								
28																								
29																								
30																								
31																								
TOTAL	617	380	67,1	101	9,8	244	715	420	67,6	102	10,9	266	877	500	85	118	12,4	286	930	540	79,3	108	14,1	298
MAX	345	200	35,3	51,8	5,6	129	364	220	34,1	51,6	6,1	135	462	260	43,4	59,1	6,5	145	483	280	42	57,1	7,3	151
MIN	272	180	31,8	49,6	4,2	115	351	200	33,5	50,1	4,8	131	415	240	41,6	58,7	5,9	141	447	260	37,3	51,2	6,8	147
AVERAGE	309	190	34	51	5	122	358	210	34	51	5	133	439	250	43	59	6	143	465	270	40	54	7	149

Chemical input analysis 2019

month	May						Jun						Jul						Aug					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																			871	480	65,4	80,1	11,2	271
3																								
4																								
5																								
6																								
7	585	380	47,6	61,5	6,9	153																		
8																								
9													856	500	56,1	71,8	11,7	235						
10																								
11							731	480	55,6	70,4	8,3	231												
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								
21	637	420	51,2	62,1	7	181																		
22																								
23																			739	480	57,1	72,8	8,7	275
24													823	440	60,2	77,5	12	227						
25																								
26							791	460	54,8	70,6	9,1	219												
27																								
28																								
29																								
30																								
31																								
TOTAL	1222	800	98,8	124	13,9	334	1522	940	110,4	141	17,4	450	1679	940	116,3	149	23,7	462	1610	960	122,5	153	19,9	546
MAX	637	420	51,2	62,1	7	181	791	480	55,6	70,6	9,1	231	856	500	60,2	77,5	12	235	871	480	65,4	80,1	11,2	275
MIN	585	380	47,6	61,5	6,9	153	731	460	54,8	70,4	8,3	219	823	440	56,1	71,8	11,7	227	739	480	57,1	72,8	8,7	271
AVERAGE	611	400	49	62	7	167	761	470	55	71	9	225	840	470	58	75	12	231	805	480	61	76	10	273

Chemical input analysis 2019

month	Sept						Oct						Nov						Dec					
date	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS	COD	BOD_5	NH_4-N	T.N.	T.P.	SS
1																								
2																								
3																								
4																								
5																								
6																								
7													680	420	55,1	63	8,1	185						
8							848	480	61	76,6	12,5	295												
9																			700	400	58,1	64,5	9,3	235
10	961	460	51,8	67,6	15,2	335																		
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19													570	380	45,5	61	8,5	171						
20																								
21																								
22																								
23							725	400	54,6	67,8	9,5	277							655	380	56,7	62,8	8,8	197
24	785	380	48,5	62,3	13,7	281																		
25																								
26																								
27																								
28																								
29																								
30																								
31																								
TOTAL	1746	840	100,3	130	28,9	616	1573	880	115,6	144	22	572	1250	800	100,6	124	16,6	356	1355	780	114,8	127	18,1	432
MAX	961	460	51,8	67,6	15,2	335	848	480	61	76,6	12,5	295	680	420	55,1	63	8,5	185	700	400	58,1	64,5	9,3	235
MIN	785	380	48,5	62,3	13,7	281	725	400	54,6	67,8	9,5	277	570	380	45,5	61	8,1	171	655	380	56,7	62,8	8,8	197
AVERAGE	873	420	50	65	14	308	787	440	58	72	11	286	625	400	50	62	8	178	678	390	57	64	9	216

Chemical output analysis 2017

month	january							february							march							april						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1																												
2								6	18,1	7,83	0	9,1	2,7	5,7														
3	7	20,1	8,2	0	11,3	2,5	5,8								7	24,5	3,28	2,65	8,7	1,8	5,6	6	28,6	2,34	0,736	5,1	1,3	5,9
4																												
5	7	19,5	8,96	0	12,1	2,6	5,4																					
6																												
7																												
8																												
9																												
10																												
11	6	18,3	9,94	0	13,5	2,5	5,5																					
12																												
13																												
14																												
15																												
16																												
17																												
18	6	17,8	5,39	0,23	9,2	2,1	5,1																					
19																												
20								9	45,6	2,98	0,876	5,20	2,9	6,8														
21																						7	33,2	1,31	0,13	4,3	2	6,1
22																												
23																												
24																												
25																												
26																												
27																												
28																												
29																												
30															6	17,8	4,54	1,93	8,9	2,1	5,3							
31																												
TOTAL	26	75,7	32,49	0,23	46,1	9,7	21,8	15	63,7	10,81	0,876	14	5,6	12,5	13	42,3	7,82	4,58	17,6	3,9	10,9	13	61,8	3,65	0,866	9,4	3,3	12
MAX	7	20,1	9,94	0,23	13,5	2,6	5,8	9	45,6	7,83	0,876	9,1	2,9	6,8	7	24,5	4,54	2,65	8,9	2,1	5,6	7	33,2	2,34	0,736	5,1	2	6,1
MIN	6	17,8	5,39	0	9,2	2,1	5,1	6	18,1	2,98	0	5,2	2,7	5,7	6	17,8	3,28	1,93	8,7	1,8	5,3	6	28,6	1,31	0,13	4,3	1,3	5,9
AVERAGE	7	19	8	0	12	2	5	8	32	5	0	7	3	6	7	21	4	2	9	2	5	7	31	2	0	5	2	6

Chemical output analysis 2017

month / date	may BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5	11	21,3	2,68	0,976	7,37	0	6,5
6							
7							
8	10	22,6	5,23	0,219	8,54	1,2	5,8
9							
10							
11							
12	8	26,7	1,44	1,15	4,1	0,48	6,6
13							
14							
15							
16	7	25,2	3,55	0,887	6,94	0,6	6,5
17							
18							
19							
20							
21							
22							
23	7	24,8	3,09	1,59	6,74	0,81	5,2
24							
25							
26							
27							
28							
29							
30							
31	8	25,3	4,45	0,257	7,85	1,5	5,4
TOTAL	51	146	20,44	5,079	41,5	4,59	36
MAX	11	27	5,23	1,59	8,54	1,5	6,6
MIN	7	21	1,44	0,219	4,1	0	5,2
AVERAG	9	24	3	1	7	1	6

month / date	june BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6							
7	8	29,4	5,24	0,597	7,65	8,81	7,1
8							
9							
10							
11							
12							
13							
14	8	29,1	4,6	<0,2	7,81	2,15	7
15							
16							
17							
18							
19							
20	9	29,3	1,7	0,736	4,7	1,23	7,5
21							
22							
23	9	30,3	1,25	0,889	4,89	2,4	7,3
24							
25							
26							
27	10	29,7	2,15	0,662	4,48	1,91	6,9
28							
29							
30							
31							
TOTAL	44	148	14,94	2,884	29,5	16,5	35,8
MAX	10	30	5,24	0,889	7,81	8,81	7,5
MIN	8	29	1,25	0,597	4,48	1,23	6,9
AVERAG	9	30	3	1	6	3	7

month / date	july BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5	8	26,7	0,809	0,411	3,22	1,1	7,3
6							
7							
8							
9							
10							
11							
12							
13	11	43,0	4,81	0,416	8,72	5,7	8,3
14							
15							
16							
17	13	46,0	4,27	0,303	7,75	2,61	9,4
18							
19							
20							
21	9	36,4	2,77	0,692	6,16	0,48	8,1
22							
23							
24	10	37,2	3,11	0,693	6,77	0,79	7,9
25							
26							
27							
28	9	39,7	2,53	0,63	5,04	1,14	8,5
29							
30							
31	9	38,6	2,99	0,42	6,31	1,64	7,7
TOTAL	69	268	21,29	3,565	44	13	57,2
MAX	13	46	4,81	0,693	8,72	5,7	9,4
MIN	8	27	0,809	0,303	3,22	0,5	7,3
AVERAG	10	38	3	1	6	2	8

month / date	august BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1	10	39	4,17	0,321	7,36	1,68	8
2							
3							
4	8	41,5	2,69	0,34	5,2	1,72	8,5
5							
6							
7	10	39,8	4,98	0,286	7,41	2,30	8,3
8							
9							
10							
11	12	40	6,5	0,347	9,2	1,35	8,6
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24	13	43,2	3,12	0,239	6,33	1,97	8,8
25							
26							
27							
28	9	33,8	1,39	0,619	4,02	1,31	6,8
29							
30							
31	9	34,1	0,872	1,32	3,8	2,65	1,7
TOTAL	71	271	23,72	3,472	43,3	13	50,7
MAX	13	43,2	6,5	1,32	9,2	2,65	8,8
MIN	8	33,8	0,872	0,239	3,8	1,31	1,7
AVERAG	10	39	3	0	6	2	7

Chemical output analysis 2017

month	september							october						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1														
2								7	36,7	2,19	0,117	4,15	3,53	6,5
3								8	35,7	2,38	0,197	5,21	2,41	6,6
4	8	37,2	1,13	0,703	4,75	2,75	7,3							
5														
6	8	36,4	1,11	1,06	5,1	3,83	7,1							
7														
8														
9														
10								7	31,4	2,25	0,344	6,09	2,19	6,1
11	7	39,7	2,08	0,319	3,76	3,21	7,8							
12								6	33,9	2,07	0,138	5,81	1,4	6,4
13														
14														
15	9	35,8	1,41	0,919	3,76	1,73	8,5							
16														
17														
18	8	41,4	2,15	0,433	4,4	0,79	8,2							
19														
20														
21	7	31,9	1,08	1,24	4,99	0,95	7,5							
22														
23														
24								6	38,5	1,3	1,48	6,32	3,3	4,8
25														
26	7	43,1	1,31	1,53	5,98	0,85	7,3	7	37,4	2,93	0,868	6,71	3,48	5,28
27														
28														
29														
30								8	41,4	4,26	1,69	9,22	1,24	5,76
31														
TOTAL	54	266	10,27	6,204	32,7	14,1	53,7	49	255	17,38	4,834	43,5	17,6	41,4
MAX	9	43,1	2,15	1,53	5,98	3,83	8,5	8	41,4	4,26	1,69	9,22	3,53	6,6
MIN	7	31,9	1,08	0,319	3,76	0,79	7,1	6	31,4	1,3	0,117	4,15	1,24	4,8
AVERAGE	8	38	1	1	5	2	8	7	36	2	1	6	3	6

month	november							december						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1	8	41,2	3,95	1,51	9,5	2,00	7,4							
2														
3														
4								5	34,7	1,36	1,21	5,55	0,2	1,2
5														
6	9	43	3,7	1,44	7,76	2,09	8,1							
7								7	37,9	1,55	1,69	5,81	1,10	3,2
8														
9														
10														
11														
12														
13								8	35	6,09	0,176	9,3	2,8	4,5
14														
15														
16														
17														
18														
19								8	39,6	2,84	0,647	6,12	1,60	4,8
20														
21														
22														
23	8	53,7	5,9	0,295	11,4	2,44	8							
24														
25														
26														
27	4	40,7	4,14	0,343	9,86	0,40	4,63							
28														
29														
30	7	41	0,576	2,77	7,84	0,37	4,25							
31														
TOTAL	36	220	18,27	6,358	46,4	7,3	32,4	28	147	11,84	3,723	26,8	5,7	13,7
MAX	9	53,7	5,9	2,77	11,4	2,4	8,1	8	39,6	6,09	1,69	9,3	2,8	4,8
MIN	4	40,7	0,576	0,295	7,76	0,4	4,25	5	34,7	1,36	0,176	5,55	0,2	1,2
AVERAGE	7	44	4	1	9	1	6	7	37	3	1	7	1	3

Chemical output analysis 2018

month date	January BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11	9	38,4	2,64	0,073	4,81	2,1	6,2
12							
13							
14							
15	8	28,0	5,92	0,038	8,1	2,5	5,7
16							
17							
18							
19	6	22,1	5,41	0,423	7,82	2,4	5,4
20							
21							
22	6	25,8	4,18	1,88	8,23	2,4	5,5
23							
24							
25							
26							
27							
28							
29							
30	7	27,1	7,48	1,23	10,31	2,3	5,6
31							
TOTAL	36	141	25,63	3,644	39,27	12	28,4
MAX	9	38,4	7,48	1,88	10,31	2,5	6,2
MIN	6	22,1	2,64	0,038	4,81	2,1	5,4
AVERAGE	7	28	5,1	0,7	7,9	2,3	5,7

month date	February BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5	7	29,5	9,4	1,8	13,41	2,4	6
6							
7							
8	6	27,9	5,1	1,76	8,34	2,1	5,7
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20	5	18,1	6,23	0,482	9,15	1,8	4,9
21							
22							
23							
24							
25							
26	5	19,4	4,48	0,24	7,71	1,6	5,1
27							
28							
29							
30							
31							
TOTAL	23	94,9	25,21	4,282	38,61	7,9	21,7
MAX	7	29,5	9,4	1,8	13,41	2,4	6
MIN	5	18,1	4,48	0,24	7,71	1,6	4,9
AVERAGE	6	24	6,3	1,1	9,7	2,0	5,4

month date	March BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2	6	20,2	8,12	0,042	9,75	2,7	3
3							
4							
5	5	18,5	1,84	0,055	3,81	2,1	4,2
6							
7							
8							
9							
10							
11							
12							
13							
14	5	18,7	1,34	0,098	3,56	0,9	3,5
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26	5	19,1	1,74	0,041	3,23	1,8	4,3
27							
28							
29							
30							
31							
TOTAL	21	76,5	13,04	0,236	20,4	7,5	15
MAX	6	20,2	8,12	0,098	9,75	2,7	4,3
MIN	5	18,5	1,34	0,041	3,23	0,9	3
AVERAGE	5	19	3,3	0,1	5,1	1,9	3,8

month date	April BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17	5	18,3	1,75	0,261	3,14	1,5	1,81
18							
19	5	18,6	2,049	0,253	3,67	1,8	1,54
20	6	18,4	0,342	0,308	2,81	2	1,61
21							
22							
23							
24							
25	5	19,8	0,653	1,55	5,17	2,5	2,3
26							
27							
28							
29							
30	6	19,5	5,6	0,911	8,25	2,2	2,15
31							
TOTAL	27	94,6	10,39	3,283	23	10	9,41
MAX	6	19,8	5,6	1,55	8,25	2,5	2,3
MIN	5	18,3	0,342	0,253	2,81	1,5	1,54
AVERAGE	5	19	2,1	0,7	4,6	2,0	1,9

Chemical output analysis 2018																												
month	May							June							July							August						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1																						5	24	2,1	0,72	3,9	1,4	6
2															6	23,7	1,6	0,855	4,14	3,5	5,8							
3	5	19,5	1,41	0,696	3,88	1,5	2,8																					
4	5	19,8	3,03	0,34	5,61	1,6	3,1																					
5															6	22,5	1,84	0,337	4,23	2,7	5,1							
6								6	20,5	1,35	1,24	4,31	1,87	5,4														
7																						5	19,6	0,968	0,623	3,58	2,75	3,5
8																												
9																												
10	6	20,1	0,783	0,1	2,98	2,8	5,1								7	24,5	1,17	0,753	4,37	3,8	6,2							
11	5	20,5	1,35	0,08	3,21	2,5	4,9	6	21,8	2,42	0,05	4,89	1,92	5,2														
12								7	25,6	1,25	1,75	5,31	2,18	6,1														
13								6	23,2	0,606	0,494	3,12	2,31	5,8														
14	5	18,3	0,081	1,43	3,44	2,2	1,8																					
15																												
16																						6	23,4	1,81	1,27	4,78	4,30	4,7
17	6	20,8	0,5	0,439	3,09	2,6	5,4																					
18																												
19																												
20																												
21								6	22,8	1,76	0,931	4,93	3,1	4,7														
22																												
23	7	21,2	1,56	0,146	4,14	1,6	4,9																					
24															6	25,2	1,42	0,307	4,16	4,10	5,8							
25	7	20,6	2,04	0,47	4,43	2,1	5,1																					
26																												
27																						6	22	2,18	1,29	5,26	3,95	5,1
28																												
29	6	19,9	2,42	0,05	4,2	2	2,7																					
30																												
31																												
TOTAL	52	181	13,17	3,751	35	18,9	35,8	31	114	7,386	4,465	22,6	11,4	27,2	25	96	6,03	2,252	16,9	14	22,9	22	89	7,058	3,903	17,5	12,4	19,3
MAX	7	21	3,03	1,43	5,61	2,8	5,4	7	26	2,42	1,75	5,31	3,1	6,1	7	25	1,84	0,855	4,37	4,1	6,2	6	24	2,18	1,29	5,26	4,3	6
MIN	5	18	0,081	0,05	2,98	1,5	1,8	6	21	0,606	0,05	3,12	1,87	4,7	6	23	1,17	0,307	4,14	2,7	5,1	5	19,6	0,968	0,623	3,58	1,4	3,5
VERAG	6	20	1,5	0,4	3,9	2,1	4,0	6	23	1,5	0,9	4,5	2,3	5,4	6	24	1,5	0,6	4,2	3,5	5,7	6	22	1,8	1,0	4,4	3,1	4,8

Chemical output analysis 2018

month	September						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3	5	17	5,4	0,24	7,1	3	3
4							
5							
6							
7	5	19	3,1	0,23	4,8	2,8	6
8							
9							
10							
11							
12							
13	6	19	1,8	0,93	3,6	4,1	2,1
14							
15							
16							
17							
18							
19							
20	4	17	1,9	0,16	4	3,7	3
21							
22							
23							
24							
25							
26							
27	5	17	1,8	0,12	4,6	4	3
28							
29							
30							
31							
TOTAL	25	89	14	1,68	24,1	17,6	17,1
MAX	6	19	5,4	0,93	7,1	4,1	6
MIN	4	17	1,8	0,12	3,6	2,8	2,1
AVERAGE	5	18	2,8	0,3	4,8	3,5	3,4

month	October						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6							
7							
8	5	19	3	0,12	4,6	2,8	2
9							
10							
11							
12							
13							
14							
15	5	18,6	4,2	0,046	6,8	3,1	2,3
16							
17							
18							
19	5	21,8	6,43	0,036	8,56	3,6	2,5
20							
21							
22							
23							
24							
25							
26							
27							
28							
29	6	19,7	1,35	0,985	4,61	4,2	3,8
30							
31							
TOTAL	21	79,1	14,98	1,187	24,6	13,7	10,6
MAX	6	21,8	6,43	0,985	8,56	4,2	3,8
MIN	5	18,6	1,35	0,036	4,6	2,8	2
AVERAGE	5	20	3,7	0,3	6,1	3,4	2,7

month	November						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6	6	19,5	1,67	1,15	5,21	3,90	4,3
7							
8							
9							
10							
11							
12	6	21,5	2,15	0,831	5,35	3,80	3,7
13							
14							
15							
16							
17							
18							
19	7	23,5	3,14	0,546	6,13	2,15	5,1
20							
21							
22							
23							
24							
25							
26							
27	6	20,7	2,81	0,781	7,37	1,24	4,35
28							
29							
30							
31							
TOTAL	25	85,2	9,77	3,308	24,1	11	17,5
MAX	7	23,5	3,14	1,15	7,37	3,9	5,1
MIN	6	19,5	1,67	0,546	5,21	1,2	3,7
AVERAGE	6	21	2,4	0,8	6,0	2,8	4,4

month	December						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4	5	19,1	1,37	1,14	4,56	2,1	2,5
5							
6							
7							
8							
9							
10							
11	5	18,9	2,12	0,974	5,14	1,9	2,8
12							
13							
14							
15							
16							
17							
18	6	20,3	2,21	0,896	5,87	1,3	3,1
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
TOTAL	16	58,3	5,7	3,01	15,6	5,3	8,4
MAX	6	20,3	2,21	1,14	5,87	2,1	3,1
MIN	5	18,9	1,37	0,896	4,56	1,3	2,5
AVERAGE	5	19	1,9	1,0	5,2	1,8	2,8

Chemical output analysis 2019

month	Jan							Feb						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1														
2														
3														
4														
5								6	22,7	4,2	0,756	7,55	1,61	3,1
6														
7														
8														
9														
10														
11	6	18,5	2,14	0,974	5,22	1,5	2,1							
12								5	18,3	2,33	1,27	5,42	1,75	2,8
13														
14														
15	4	17,9	1,75	1,14	4,83	1,80	2,5							
16														
17														
18														
19								7	23,5	0,665	1,815	4,81	2,41	2,5
20														
21	7	20,3	3,45	0,315	6,5	0,95	2,8							
22														
23														
24														
25														
26								6	19,1	1,54	0,581	5,33	1,63	1,8
27														
28	5	18,0	1,81	0,298	3,26	1,75	2,4							
29														
30														
31														
TOTAL	22	74,7	9,15	2,727	19,82	6	9,8	24	83,6	8,735	4,422	23,11	7,4	10,2
MAX	7	20,3	3,45	1,14	6,51	1,8	2,8	7	23,5	4,2	1,815	7,55	2,4	3,1
MIN	4	17,9	1,75	0,298	3,26	1	2,1	5	18,3	0,665	0,581	4,81	1,6	1,8
AVERAGE	6	19	2,3	0,7	5,0	1,5	2,5	6	21	2,2	1,1	5,8	1,9	2,6

month	Mar							Apr						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1														
2								5	18,6	2,031	0,306	4,19	1,55	2,15
3														
4	6	18,5	5,15	0,145	7,88	2,74	2,2							
5														
6														
7														
8								6	19,6	2,81	0,085	5,05	3,11	1,91
9														
10														
11														
12	6	19	4,31	0,091	7,43	1,84	2							
13														
14														
15								5	18,2	3,56	0,187	5,27	3	2,41
16														
17														
18														
19	7	21,1	2,33	0,761	5,51	2,12	2,4							
20														
21														
22								6	22,3	1,44	0,071	3,21	3,78	3,7
23														
24														
25														
26	6	20,6	2,45	0,881	6,14	2,33	2,5							
27														
28														
29														
30														
31														
TOTAL	25	79,2	14,24	1,878	27	9	9,1	22	78,7	9,841	0,649	17,7	11	10,2
MAX	7	21,1	5,15	0,881	7,88	2,7	2,5	6	22,3	3,56	0,306	5,27	3,8	3,7
MIN	6	18,5	2,33	0,091	5,51	1,8	2	5	18,2	1,44	0,071	3,21	1,6	1,91
AVERAGE	6	20	3,6	0,5	6,7	2,3	2,3	6	20	2,5	0,2	4,4	2,9	2,5

Chemical output analysis 2019

month	May						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6	6	20,7	0,61	0,525	3,32	2,5	4,1
7							
8							
9	5	19,7	1,27	1,65	5,23	2,18	2,85
10							
11							
12							
13							
14	5	18,8	2,31	0,917	5,01	2,31	2,65
15							
16							
17							
18							
19							
20	6	21,3	4,14	0,06	5,81	1,58	3,12
21							
22							
23							
24							
25							
26							
27	5	19,5	1,74	1,03	4,89	1,65	2,28
28							
29							
30							
31							
TOTAL	27	100	10,07	4,182	24,3	10,2	15
MAX	6	21	4,14	1,65	5,81	2,5	4,1
MIN	5	19	0,61	0,06	3,32	1,58	2,28
VERAG	5	20	2,0	0,8	4,9	2,0	3,0

month	Jun						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4	6	21,8	1,15	1,34	4,63	1,93	3,61
5							
6							
7							
8							
9							
10	7	24,5	1,37	1,07	4,51	2,26	4,81
11							
12							
13							
14							
15							
16							
17							
18	6	22,2	2,18	0,965	5,14	3,12	3,91
19							
20							
21							
22							
23							
24							
25	7	23,5	0,718	0,846	3,24	2,81	3,11
26							
27							
28							
29							
30							
31							
TOTAL	26	92	5,418	4,221	17,5	10,1	15,4
MAX	7	25	2,18	1,34	5,14	3,12	4,81
MIN	6	22	0,718	0,846	3,24	1,93	3,11
VERAG	7	23	1,4	1,1	4,4	2,5	3,9

month	Jul						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3	7	24,1	1,58	0,881	3,81	3,81	3,41
4							
5							
6							
7							
8							
9	6	23,6	1,31	0,414	3,55	3,15	3,6
10							
11							
12							
13							
14							
15							
16	7	25,7	1,54	0,556	3,46	2,81	5,1
17							
18							
19							
20							
21							
22							
23							
24							
25	6	22,2	2,17	0,925	4,84	4,31	2,55
26							
27							
28							
29							
30							
31							
TOTAL	26	96	6,6	2,776	15,7	14	14,7
MAX	7	26	2,17	0,925	4,84	4,3	5,1
MIN	6	22	1,31	0,414	3,46	2,8	2,55
VERAG	7	24	1,7	0,7	3,9	3,5	3,7

month	Aug						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2	6	22	2,12	1,01	4,18	3,74	3,8
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22	6	23,8	0,935	1,81	4,31	4,21	2,9
23							
24							
25							
26	7	31,3	2,67	0,719	5,61	2,91	4,8
27							
28							
29							
30	7	30	3,13	1,76	6,01	2,50	3,5
31							
TOTAL	26	107	8,855	5,299	20,1	13,4	15
MAX	7	31,3	3,13	1,81	6,01	4,21	4,8
MIN	6	22	0,935	0,719	4,18	2,5	2,9
VERAG	7	27	2,2	1,3	5,0	3,3	3,8

Chemical output analysis 2019

month	Sept						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4	6	27	1,14	0,512	3,24	2,15	3,74
5							
6							
7							
8							
9							
10	5	19,8	4,75	0,186	6,81	3,15	2,41
11							
12							
13							
14							
15							
16							
17							
18	6	21,3	3,25	0,531	5,15	2,74	2,65
19							
20							
21							
22							
23							
24	4	18,8	2,04	0,741	4,41	3,56	1,91
25							
26							
27							
28							
29							
30	5	21,5	1,81	0,589	3,65	4,14	2,65
31							
TOTAL	26	108	12,99	2,559	23,3	15,7	13,4
MAX	6	27	4,75	0,741	6,81	4,14	3,74
MIN	4	18,8	1,14	0,186	3,24	2,15	1,91
AVERAGE	5	22	2,6	0,5	4,7	3,1	2,7

month	Oct						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6							
7	5	22,3	1,45	0,674	3,27	2,33	1,5
8							
9							
10							
11							
12							
13							
14							
15	6	27	2,73	0,51	4,93	2,65	2,9
16							
17							
18							
19							
20							
21							
22	5	20,5	1,42	0,916	3,74	1,78	2,71
23							
24							
25							
26							
27							
28							
29	5	19,3	1,74	1,13	4,63	2,23	1,8
30							
31							
TOTAL	21	89,1	7,34	3,23	16,6	8,99	8,91
MAX	6	27	2,73	1,13	4,93	2,65	2,9
MIN	5	19,3	1,42	0,51	3,27	1,78	1,5
AVERAGE	5	22	1,8	0,8	4,1	2,2	2,2

month	Nov						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3							
4							
5							
6	6	27,8	0,846	0,095	3,09	1,07	2,11
7							
8							
9							
10							
11							
12	6	26,5	0,488	0,107	1,61	0,51	2,15
13							
14							
15							
16							
17							
18	5	20,4	3,11	0,327	4,05	2,02	2,12
19							
20							
21							
22							
23							
24							
25	5	23,1	0,666	0,152	1,68	1,11	1,81
26							
27							
28							
29							
30							
31							
TOTAL	22	97,8	5,11	0,681	10,4	4,7	8,19
MAX	6	27,8	3,11	0,327	4,05	2	2,15
MIN	5	20,4	0,488	0,095	1,61	0,5	1,81
AVERAGE	6	24	1,3	0,2	2,6	1,2	2,0

month	Dec						
date	BOD	COD	NO_3-N	NH_4-N	T.N.	T.P.	SS
1							
2							
3	4	15,8	3,74	0,268	4,37	2,9	1,94
4							
5							
6							
7							
8							
9	4	17,4	6,18	0,192	6,24	2,4	1,85
10							
11							
12							
13							
14							
15							
16	4	18,5	5,77	0,013	6,05	2	1,74
17							
18							
19							
20							
21							
22							
23							
24	7	37,5	0,894	0,079	1,21	2,4	3,11
25							
26							
27							
28							
29							
30							
31							
TOTAL	19	89,2	16,58	0,552	17,9	9,8	8,64
MAX	7	37,5	6,18	0,268	6,24	2,9	3,11
MIN	4	15,8	0,894	0,013	1,21	2	1,74
AVERAGE	5	22	4,1	0,1	4,5	2,4	2,2

A.5. TSS in WWTP influent

The following table and chart show the TSS in WWTP influent.

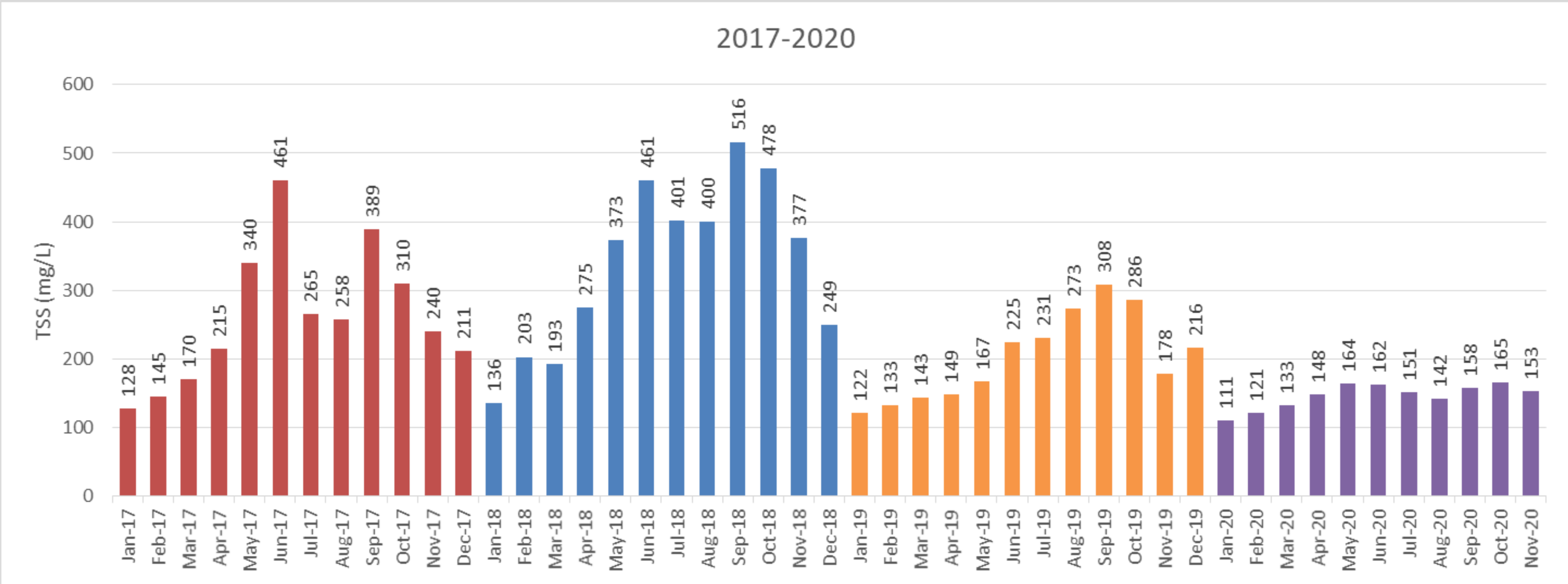
As it can be seen in the chart, the inlet TSS concentration presents high fluctuation, which may be attributed to different seasonal conditions (winter and summer average values for 2017-2020 is shown at the table).

Also, the TSS content is lower during the last two years (2019 and 2020) in comparison with 2017 and 2018. Regarding 2019, the low TSS content may be possibly due to dilution upstream of the final pumping station, as well as to addition of rural areas which produce dilute wastewater. For 2020, the reduction of the inlet TSS concentration is a consequence of the COVID-19 pandemic, as the tourism was much lower this year, and the hotels and the restaurants did not operated as usually, due to restrictive measures.

Year	Season	TSS (mg/L)
2017	Winter*	217
	Summer**	332
2018	Winter	265
	Summer	446
2019	Winter	158
	Summer	265
2020	Winter	138
	Summer	155

**Winter: November-May*

***Summer: June-October*


2017-2020
TSS (mg/L)
600
500
400
300
200
100
0
128 145 170 215 340 461 265 258 389 310 240 211
136 203 193 275 373 461 401 400 516 478 377 249
122 133 143 149 167 225 231 273 308 286 178 216
111 121 133 148 164 162 151 142 158 165 153
Jan-17 Feb-17 Mar-17 Apr-17 May-17 Jun-17 Jul-17 Aug-17 Sep-17 Oct-17 Nov-17 Dec-17
Jan-18 Feb-18 Mar-18 Apr-18 May-18 Jun-18 Jul-18 Aug-18 Sep-18 Oct-18 Nov-18 Dec-18
Jan-19 Feb-19 Mar-19 Apr-19 May-19 Jun-19 Jul-19 Aug-19 Sep-19 Oct-19 Nov-19 Dec-19
Jan-20 Feb-20 Mar-20 Apr-20 May-20 Jun-20 Jul-20 Aug-20 Sep-20 Oct-20 Nov-20

A.6. Sludge streams' characteristics

The following data are all from 2017.

- Average flow of sludge purged: 130 m^3/d
- Solids content of thickened sludge: 20 g/l of DS (0.78 VS/TS)
- Solids content of aerobically digested sludge: 15 g/l of DS (0.70 VS/VT)

A.7. Dewatered sludge production and characteristics

Year	2017	2018	2019
Production (t)	3,900	Not available	Not available
Solids content (%DS)	17	Not available	Not available
Destination	Landfill	Landfill	Landfill

The following tables include some characterization data (punctual measures) of the dewatered sludge.

DEYA Rethymnon heavy metals concentration in sludge (mgr/Kgr DS)							
METAL **LABORATORY-DATE**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**
limits	5 mg/Kg	500 mg/Kg	800 mg/Kg	5 mg/Kg	200 mg/Kg	500 mg/Kg	2500 mg/Kg
ΛΑΓΚΟΥΒΑΡΔΟΥ /12-1-17		138					
ΛΑΓΚΟΥΒΑΡΔΟΥ / 24-3-17		90					
ΛΑΓΚΟΥΒΑΡΔΟΥ / 3-4-17		105					
ΛΑΓΚΟΥΒΑΡΔΟΥ / 28-4-17		287					
ΛΑΓΚΟΥΒΑΡΔΟΥ / 2-5-17	1,3	115	251	1,1	24,2	57	604
ΛΑΓΚΟΥΒΑΡΔΟΥ / 12-6-17	1,8	139	310	1,52	33	95	874
AGENT/ 13-6-2017	1,92	164	343	1,34	31,8	95,2	854
ΛΑΓΚΟΥΒΑΡΔΟΥ / 7-12-17	1,4	160	219	1,68	28	88	842
AGENT/ 7-12-2017	1,15	149	195	0,62	21,2	59,9	634
ΛΑΓΚΟΥΒΑΡΔΟΥ / 21-11-18	1,7	253	227	1,68	33	85	823
ΛΑΓΚΟΥΒΑΡΔΟΥ / 5-4-19	1,1	78	203	< 0,5	36	57	511
ΛΑΓΚΟΥΒΑΡΔΟΥ / 29-7-19	1,5	442	213	< 0,5	30	77	716
ΛΑΓΚΟΥΒΑΡΔΟΥ / 11-12-19	1,4	1120	308	< 0,5	38	88	788
MAX	**1,92**	**1120**	**343**	**1,68**	**38**	**95,2**	**874**
MIN	**1,1**	**78**	**195**	**0,62**	**21,2**	**57**	**511**
AVERAGE	**1,47**	**249,23**	**252,11**	**1,32**	**30,58**	**78,01**	**738,44**

DEYA Rethymnon concentration of nitrogen and phosphorus in sludge (% DS)					
ELEMENT / LABORATORY	TOTAL N	TOTAL P	TOTAL P_2O_5	TOTAL K	TOTAL K_2O
ΛΑΓΚΟΥΒΑΡΔΟΥ / 12-6-2017	5,00	1,30	3,10	0,32	0,39
ΛΑΓΚΟΥΒΑΡΔΟΥ / 7-12-2017	6,10	2,03	4,61	0,41	0,49
ΛΑΓΚΟΥΒΑΡΔΟΥ / 21-11-2018	1,70	0,26	0,60	0,42	0,51
ΛΑΓΚΟΥΒΑΡΔΟΥ / 29-7-2019	4,80	2,80	6,40	0,27	0,32
ΛΑΓΚΟΥΒΑΡΔΟΥ / 11-12-2019	4,70	2,53	5,80	0,23	0,27
MAX	**6,10**	**2,80**	**6,40**	**0,42**	**0,51**
MIN	**1,70**	**0,26**	**0,60**	**0,23**	**0,27**
AVERAGE	**4,46**	**1,78**	**4,10**	**0,33**	**0,40**

DEYA Rethymnon concentration of organic micropollutants in sludge (mgr/Kgr DS)							
PARAMETER / LABORATORY	PCB	PAH	AOX	PCDD/F	LAS	DEHP	NPE
LIMITS	0,8 mg/Kg	6 mg/Kg	500 mg/Kg	100 ng TE/Kg	2600 mg/Kg	100 mg/Kg	50 mg/Kg
ΛΑΓΚΟΥΒΑΡΔΟΥ / 12-6-17	< 0,06	< 1,6	380	7,05	< 51	0,9	< 1,3
ΛΑΓΚΟΥΒΑΡΔΟΥ / 7-12-17	< 0,06	< 1,6	440	7,23	< 44	< 2	< 1,3
ΛΑΓΚΟΥΒΑΡΔΟΥ / 21-11-18	< 0,06	< 1,6	410	7,34	< 46	< 1,7	< 1,3
ΛΑΓΚΟΥΒΑΡΔΟΥ / 29-7-19	< 0,06	1,62	380	7,15	< 48	< 1	< 1,3
ΛΑΓΚΟΥΒΑΡΔΟΥ / 11-12-19	< 0,06	< 1,6	350	7,12	< 44	< 1	< 1,3

A.8. Costs

Year	2017	2018	2019
NaOH, 48 % (€/t)*	400	Not available	Not available
NaClO, 50 % (€/t)*	210	Not available	Not available
Sludge management (disposal in landfill) (€/t)	40	Not available	Not available

* Including shipping