Report defining software and communication architecture for IT infrastructure deployment

Deliverable DA1.3

Real-time pollution-based control of urban drainage and sanitation systems for protection of receiving waters

With the contribution of the LIFE + financial instrument of the European Commission

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1 Introduction

In this action, the global framework that will structure LIFE RUBIES are considered. It will clearly define what is planned to be demonstrated, what are the steps to reach the KPIs and how to evaluate the results.

The main objective of this deliverable is to provide technical details about the future implementation of LIFE RUBIES solution on the French pilot. The idea is to provide the technical information to deploy the full LIFE RUBIES solution anticipating every step and data required for when the deployment actions will be reached. In addition to the technical information, the goal of this deliverables is to draw the whole project steps schedule through a detailed calendar.

The technical information is mainly related to the pilot site detailed description in terms of actuators such as the valves, gates pumping chambers or retention tank infrastructures. The document will provide accurate description of location, operation and interaction with other actuators. The document also provides information on the way the system is currently operated and monitored, i.e. current assessment of system performance and environment impact. The existing tools that encapsulate this knowledge are presented, such as the GIS or the existing urban drainage simulator.

In the second step, the IT architecture of the LIFE RUBIES solution is fully detailed mainly through the AQDV UD description. The innovative tools developed within LIFE EFFIDRAIN plus the evolution to be performed within this project are also described here. Eventually, a detailed schedule of the implementation, including virtual tests, is provided.

The final step consists in detailing the environmental monitoring strategy, mainly describing the how the Deûle river monitoring strategy will be applied and how the multiple monitoring stations will be operated and/or moved within the time life of the project.

2 Lille pilot description

2.1 Lille Metropolitan sewage management overview

The European Metropolitan of Lille manages the sewerage of an agglomeration of 1.2 million inhabitants spread over 95 municipalities. The territory is divided into 17 sewerage agglomerations where the largest is Lille (Figure 1). It is this agglomeration that is the focus of the French pilot of this European project. The Lille agglomeration is located in the north of France, on the border with Belgium. The CPBO (gross organic pollution load) of the agglomeration is 540,933 PE and the nominal capacity of the treatment plant is 533,333 PE.

Figure 1 : MEL territory and sewerage agglomerations.

2.2 Lille city sewerage network

The Lille sewerage agglomeration covers 35 municipalities and 163 km², with a population of 523,466 inhabitants. It is a highly urbanised area with a few agricultural zones to the north and south of the agglomeration. Many industrial companies are present in the area. 21 industrialists are monitored. The Lille sewerage agglomeration is composed of seven main branches:

- Bateliers branch: 335,000 PE, 5,000 ha
- Left bank branch of the Deûle river
- South canalised Marque river branch
- North canalized Marque river branch
- Bondues Linselles branch
- Quesnoy Wambrechies branch
- Gravity branch
- The sewerage system of Lille city includes:
- 191 pumping stations
- 220 storm overflow weirs
- 7 storage basins for rainy weather pollution control
- 51 self-monitored A1 discharge points (25 of which > 10,000 p.e.)
- 18 R2 characteristic points
- 6 rain gauges
- A wastewater treatment plant (nominal capacity 553,333 p.e.) with a reference flow of 258,249 m3/d (percentile 95 2020). It was commissioned in 2015. The treatment plant is located in the commune of Marquette (Figure 2).
- The plant comprises :
    - A biological treatment line with a maximum flow of 2.8 m3/s. The discharge is into the canalized Marque river at the outlet of the decanters
    - A stormwater treatment line with a maximum flow of 5.3 m3/s. The discharge is into the canalized Marque river downstream of the Marcq-en-Barœul lock.

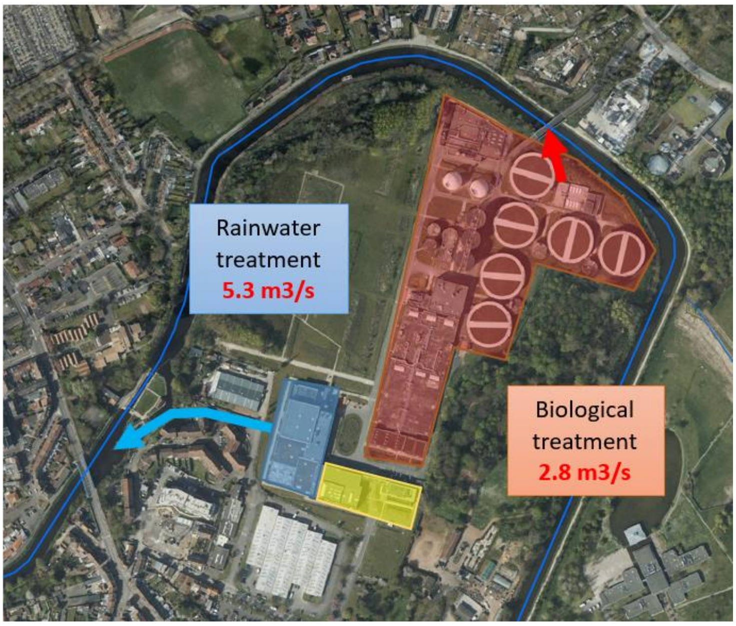


Figure 2 : Lille Marquette wastewater treatment plant - Biological treatment line - Rain treatment line - Discharge points to the canalized Marque river.

2.3 MEL pilot receiving body

2.3.1 General description

The receiving body consists in:

- -The Deûle canal
- -The Marque canal (other name: Roubaix canal)

The water bodies (Figure 3) concerned are:

- Water body FRAR32: Deûle Canal from the confluence with the Aire Canal to the confluence with the Lys river. This is a heavily modified water body. The objective is to achieve good chemical status and good ecological potential in 2027.
- -Water body FRAR34: Marque river. This is a natural water body. The objective is to achieve good chemical status and good ecological potential in 2027.

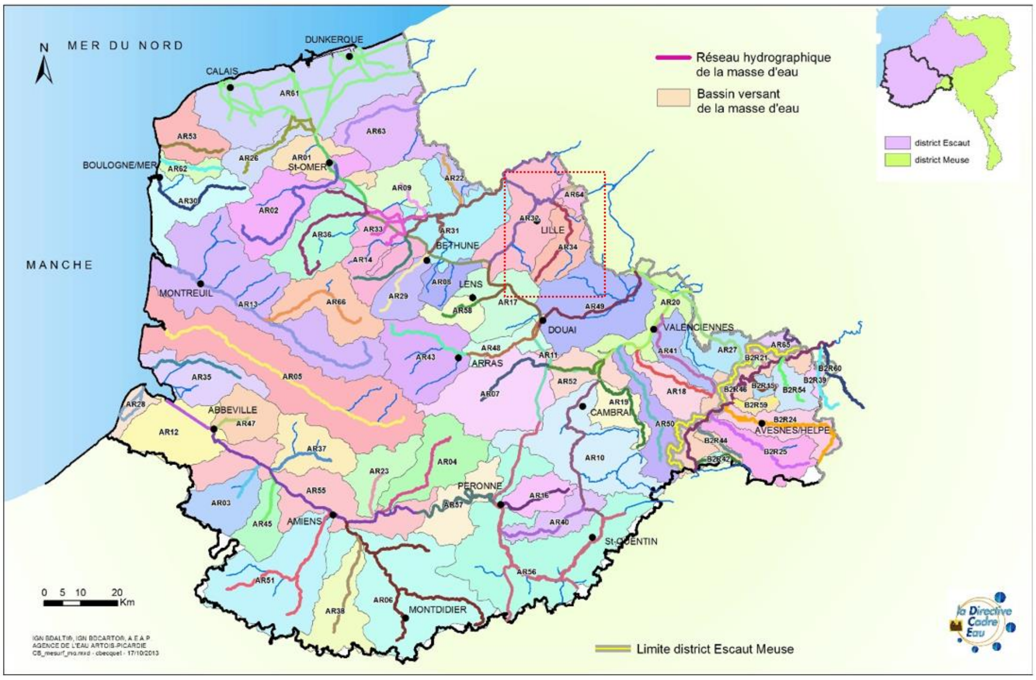


Figure 3 : Inland surface water body

2.3.2 Quality of the receiving water body

Data on the quality of the Deûle river and the Marque canal are available on the website of the Artois Picardie water agency. We show here the evolution of the quality of the Deûle river between Haubourdin city, which is located upstream of the agglomeration of Lille, and Deulemont city, which is located downstream (Figure 4). The quality measurement point on the Marque is located downstream of the Marquette lock. The values taken into account are those for TSS, BOD, COD, ammonium, total phosphorus and dissolved oxygen. A measurement is made once a month. The values are plotted on graphs. For better readability, the variation of the average value is also shown, which makes it easier to see the trend. The graphs also show the quality classes (very good, good, average, mediocre, bad) and the discharge standard of the treatment plant.

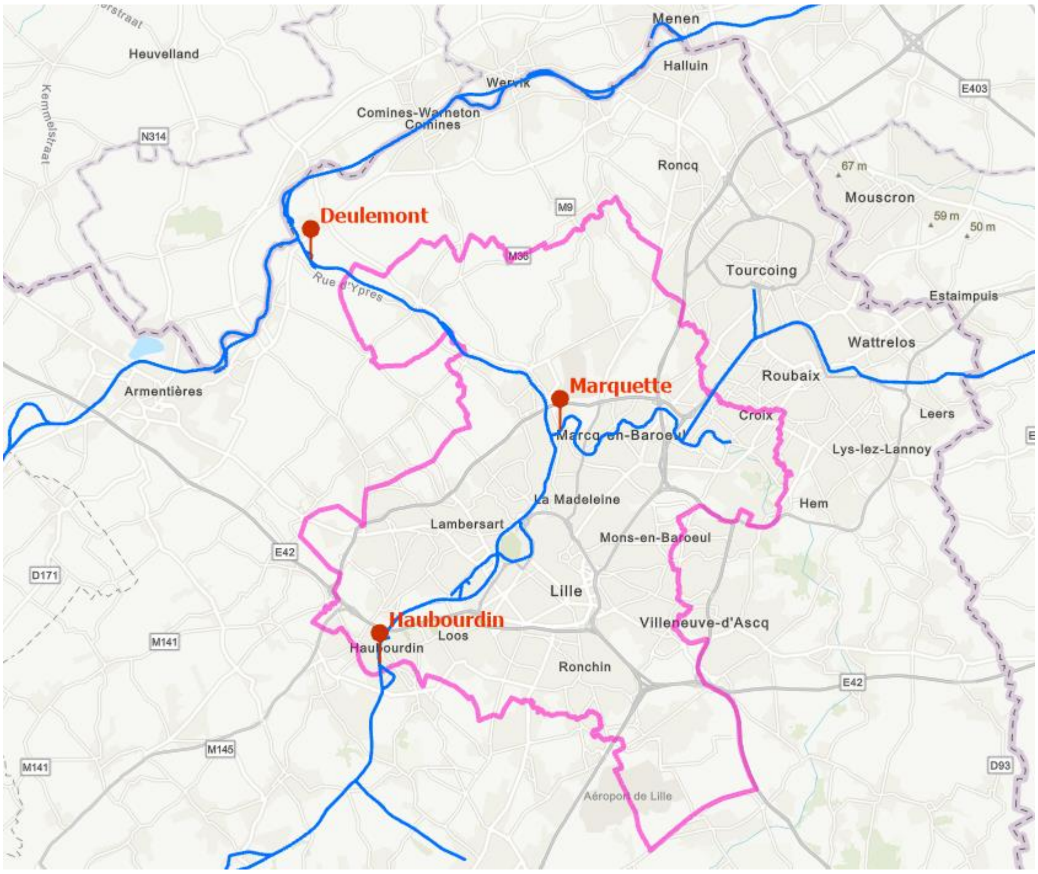


Figure 4 : Location of the Water Agency's measuring points

2.3.2.1 Suspended solids

The curve shows a constant decrease in TSS between 1970 and 1980, and then a practically constant value since then. The construction of the new wastewater treatment plant has made it possible to lower the TSS content in the Marque (Figure 5, Figure 6). The impact on the Deûle is low.

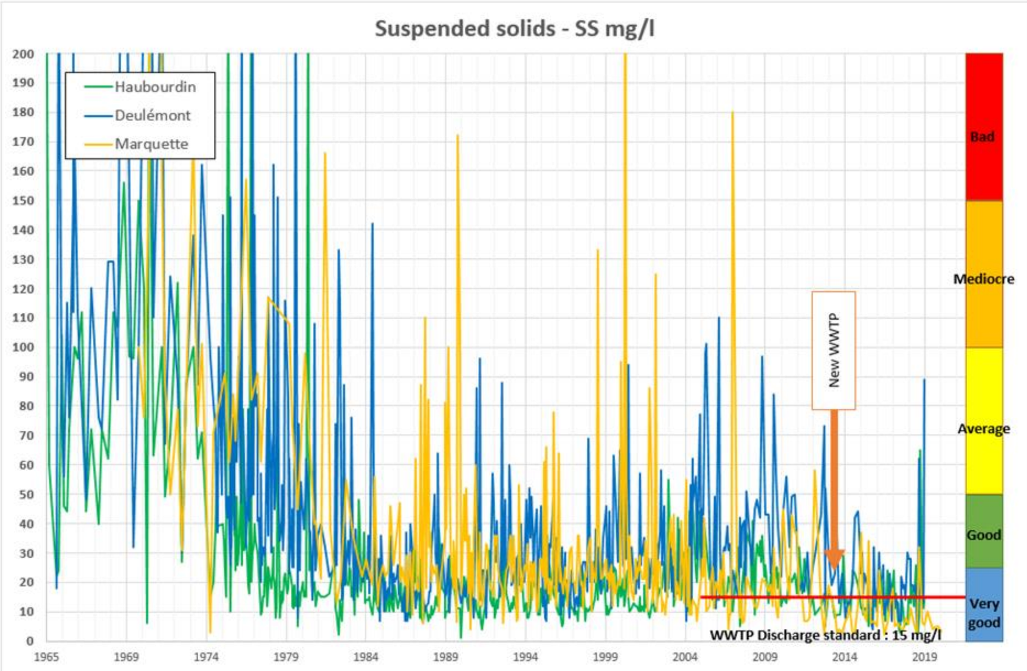


Figure 5 : River suspended solids over the years

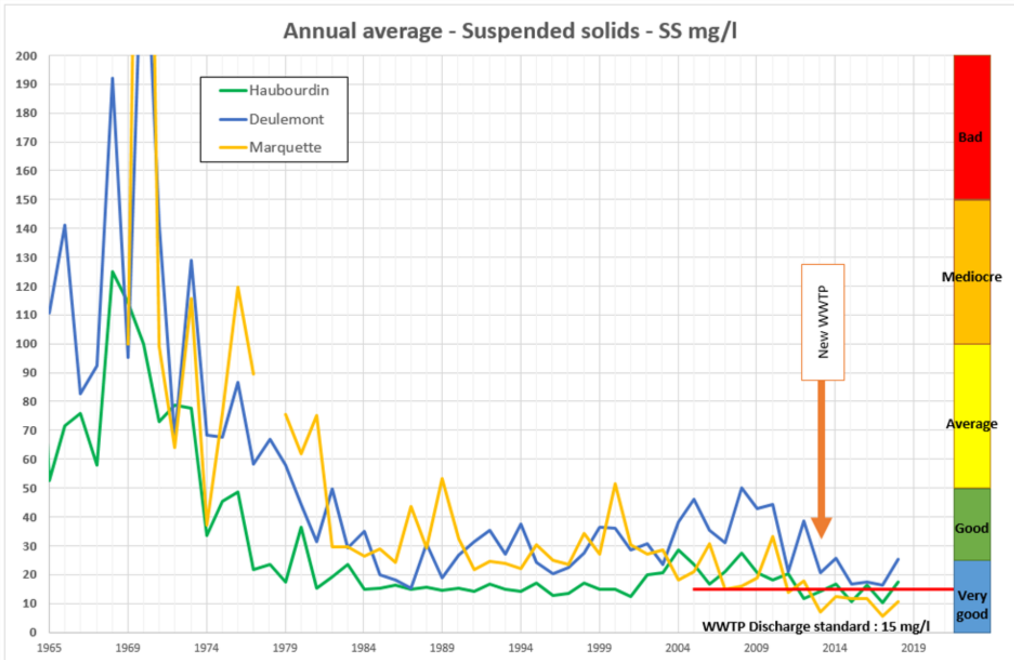


Figure 6 : River average suspended solids over the years

2.3.2.2 Biological Oxygen Demand (BOD)

BOD levels have been falling since the 1970s. The construction of the new treatment plant has made it possible to reduce the dispersion observed in the value of this parameter and to tighten the values towards a constant quality. Today, the quality of the Deûle river and the Marque canal is good to very good for this parameter (Figure 7, Figure 8).

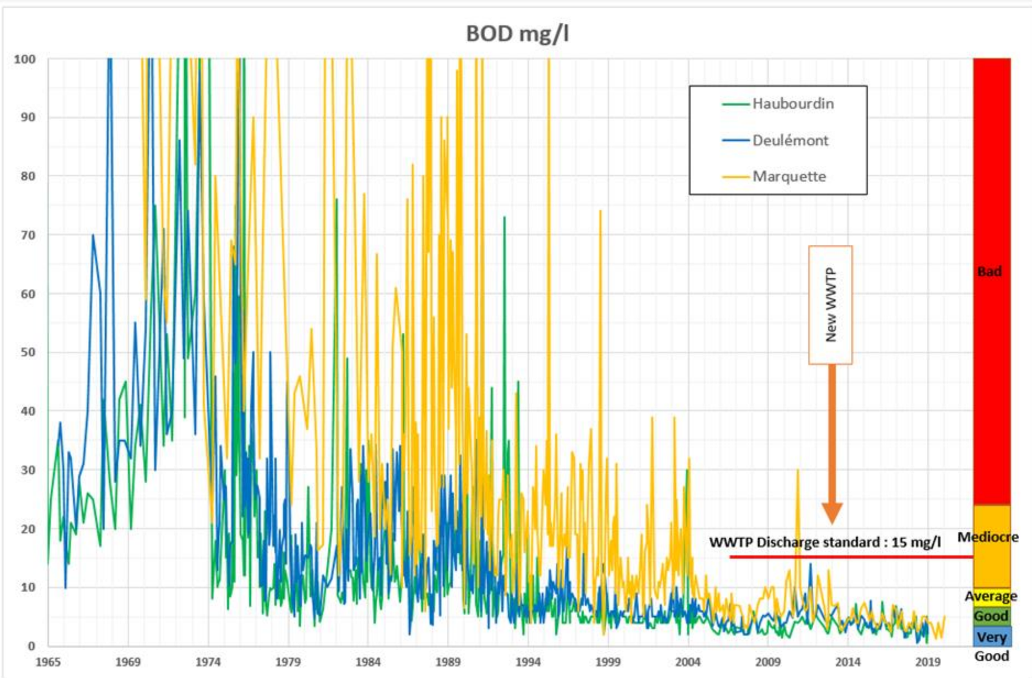


Figure 7 : River BOD over the years

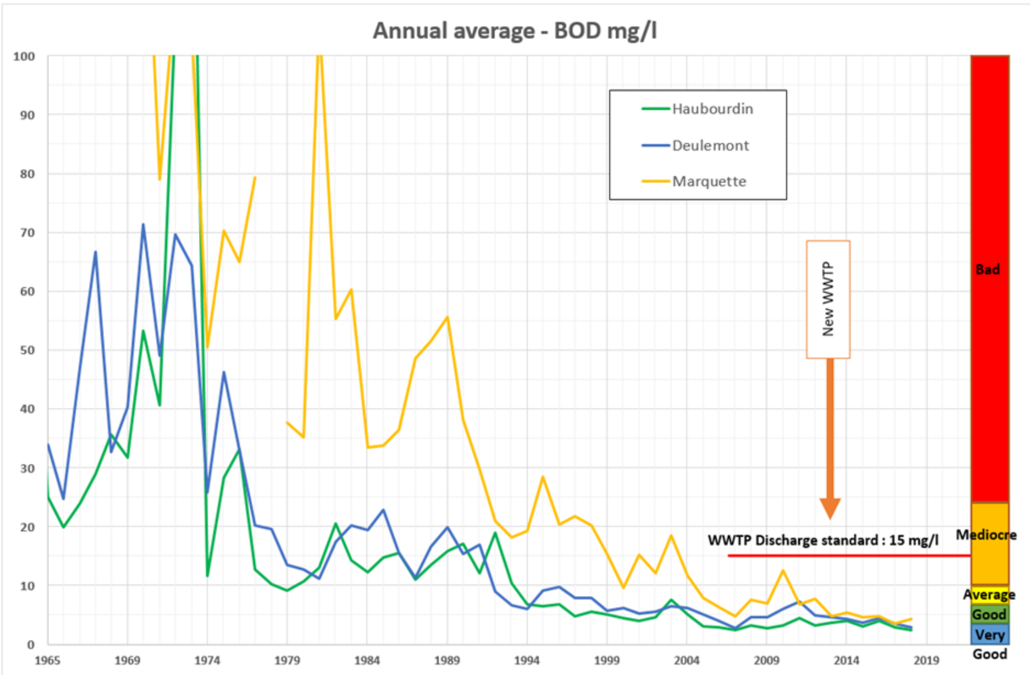


Figure 8 : Average river BOD over the years

2.3.2.3 Chemical Oxygen Demand (COD)

COD levels have been falling since the 1970s. The construction of the new wastewater treatment plant has made it possible to significantly reduce the concentration of COD in the Marque, halving the levels. Today, the quality of the Deûle river is very good for this parameter. The quality of the Marque river is good (Figure 9, Figure 10).

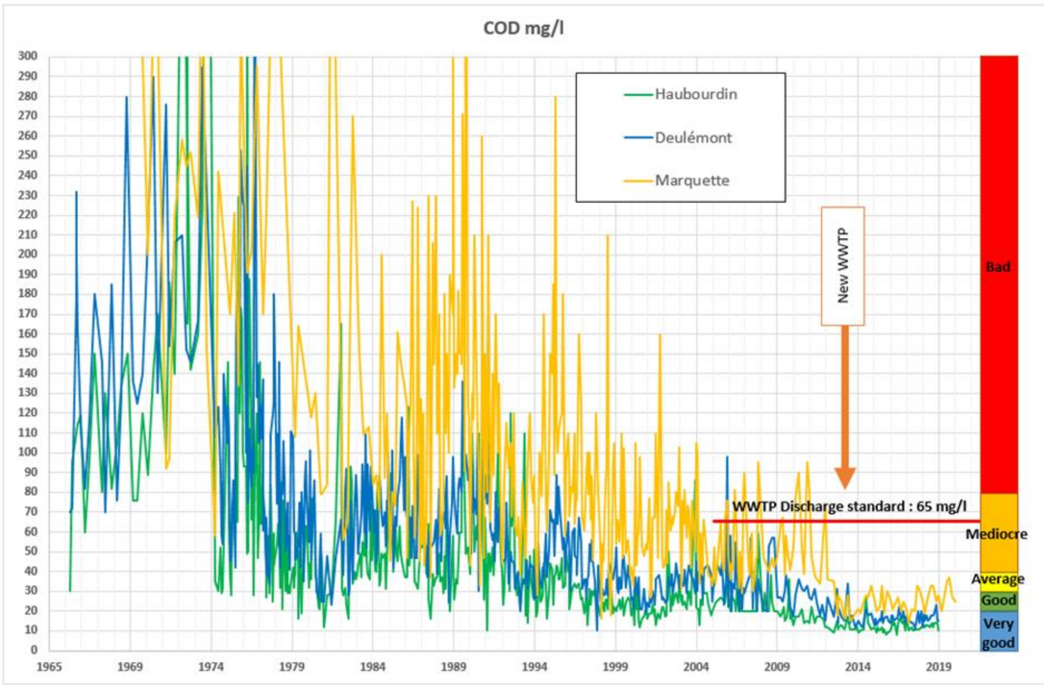


Figure 9 : River COD over the years

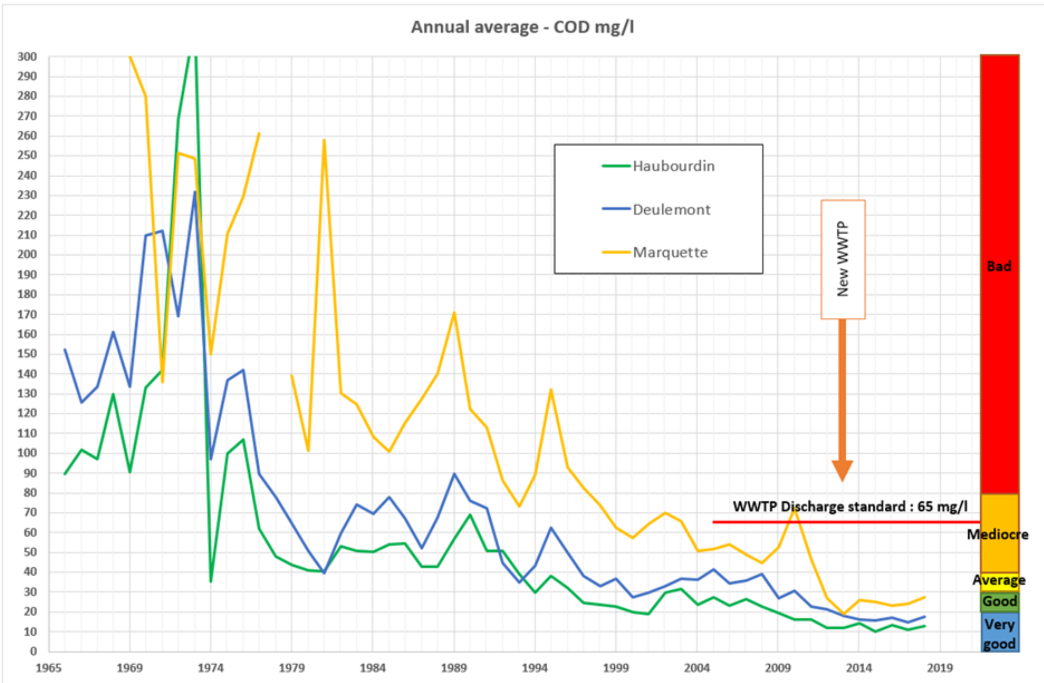


Figure 10 : Average river COD over the years

2.3.2.4 Ammonium (NH4)

The quality of the Deûle river and the Marque canal has long been bad for this parameter. The construction of the new wastewater treatment plant has made it possible to significantly improve the quality of the water for this parameter by dividing the levels by 6. However, the quality remains average to mediocre (Figure 11, Figure 12).

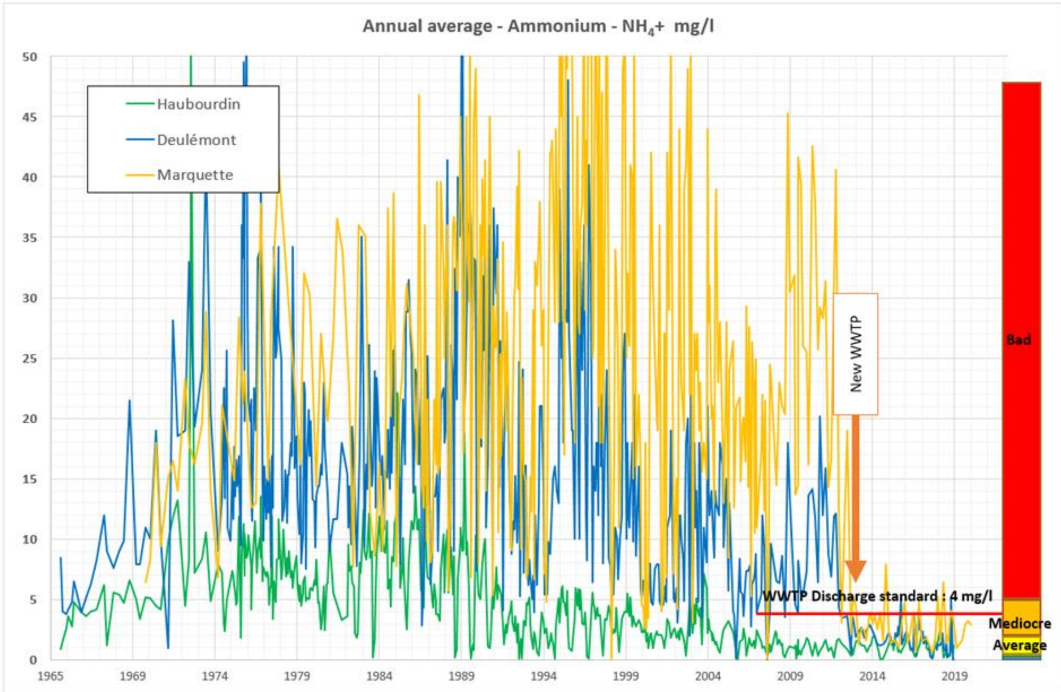


Figure 11 : River NH4 over the years

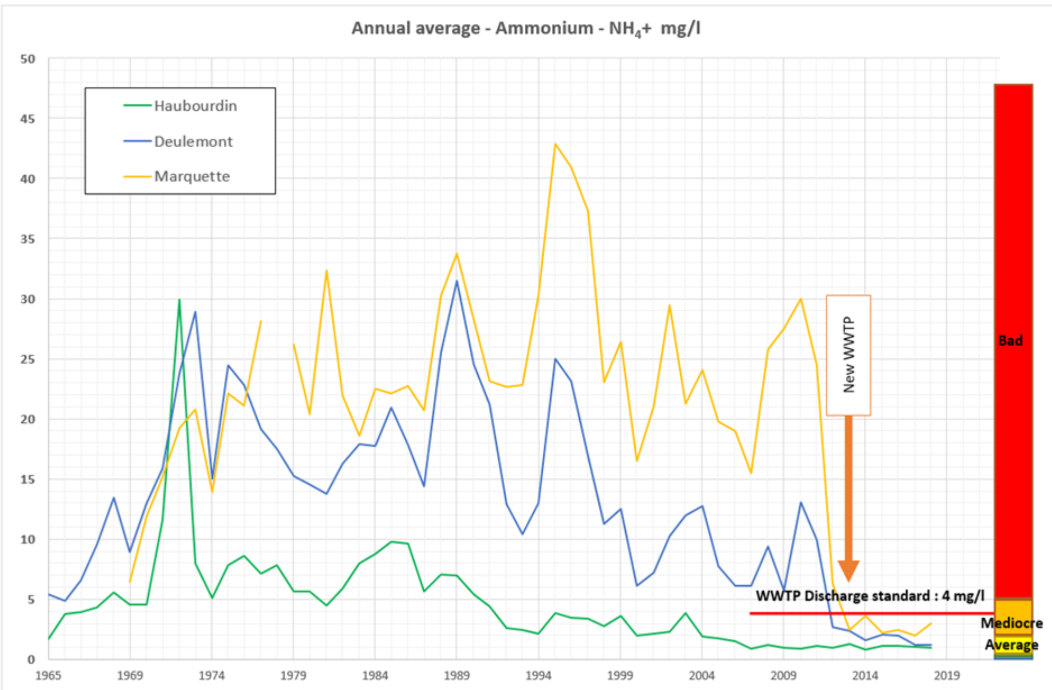


Figure 12 : Average river NH4 over the years

2.3.2.5 Total phosphorus (TP)

The quality of the Deûle river and the Marque canal has long been mediocre to bad for this parameter. The construction of the new wastewater treatment plant has made it possible to significantly improve the quality of the water for this parameter by dividing the levels by 2.5. However, the quality of the Marque canal remains mediocre to poor. The quality of the Deûle river is average to mediocre (Figure 13, Figure 14).

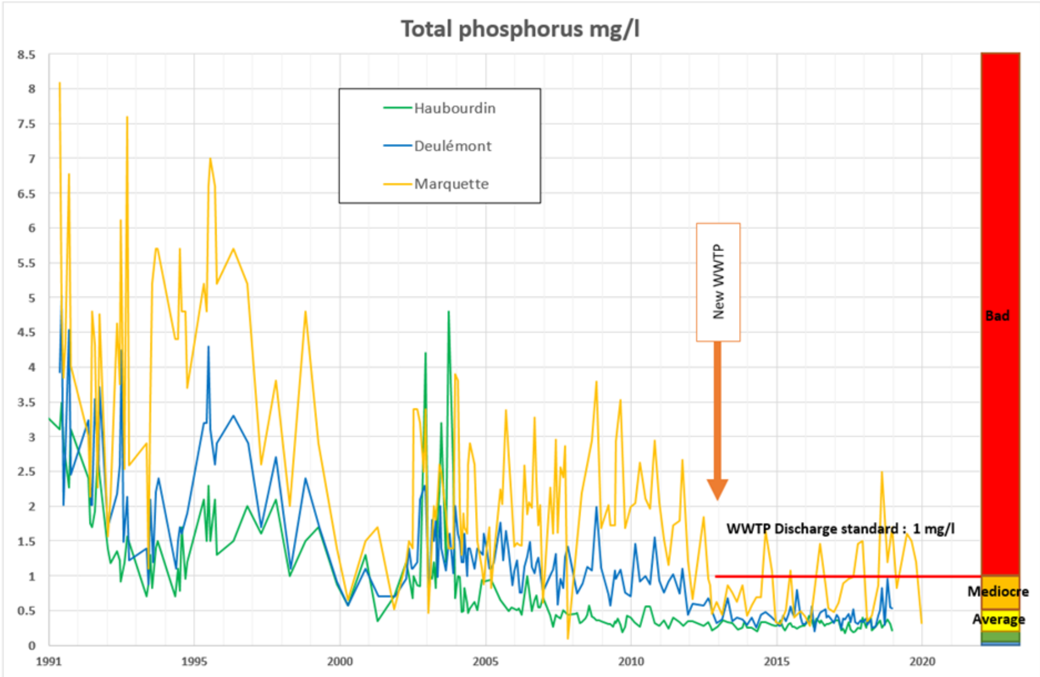


Figure 13 : River phosphorus over the years

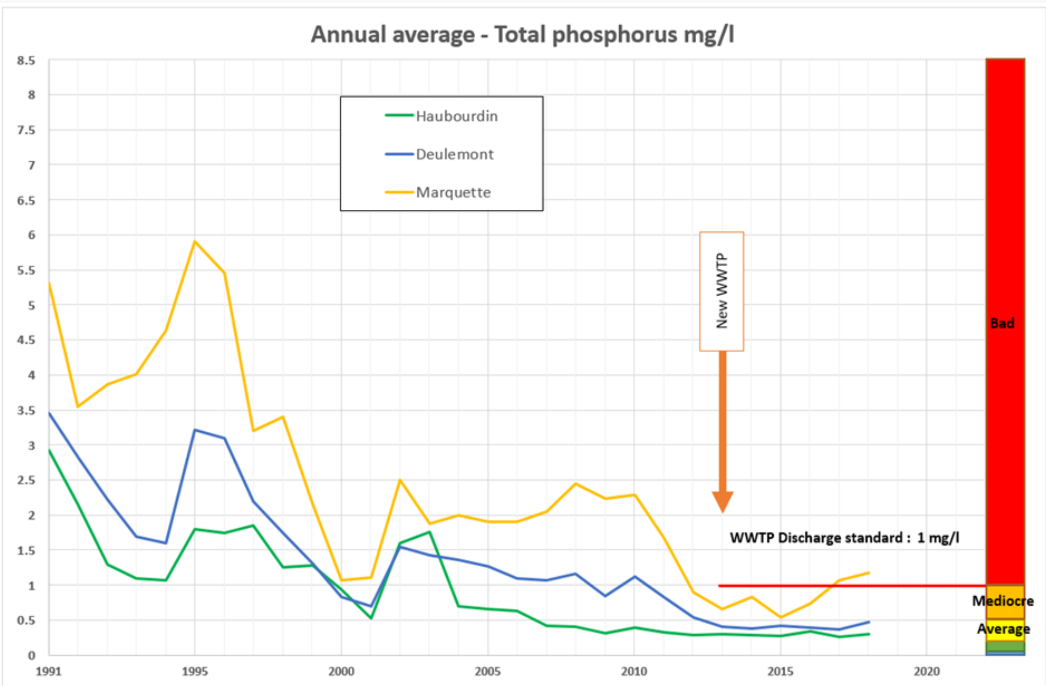


Figure 14 : Average river phosphorus over the years

2.3.2.6 Dissolved oxygen (DO)

The curves show a constant increase in dissolved oxygen since 1990. Today, the water quality for this parameter is very good. The curves show regular oscillations of this parameter between summer and winter, the concentration of dissolved oxygen also being linked to temperature (higher concentration in winter than in summer) (Figure 15, Figure 16).

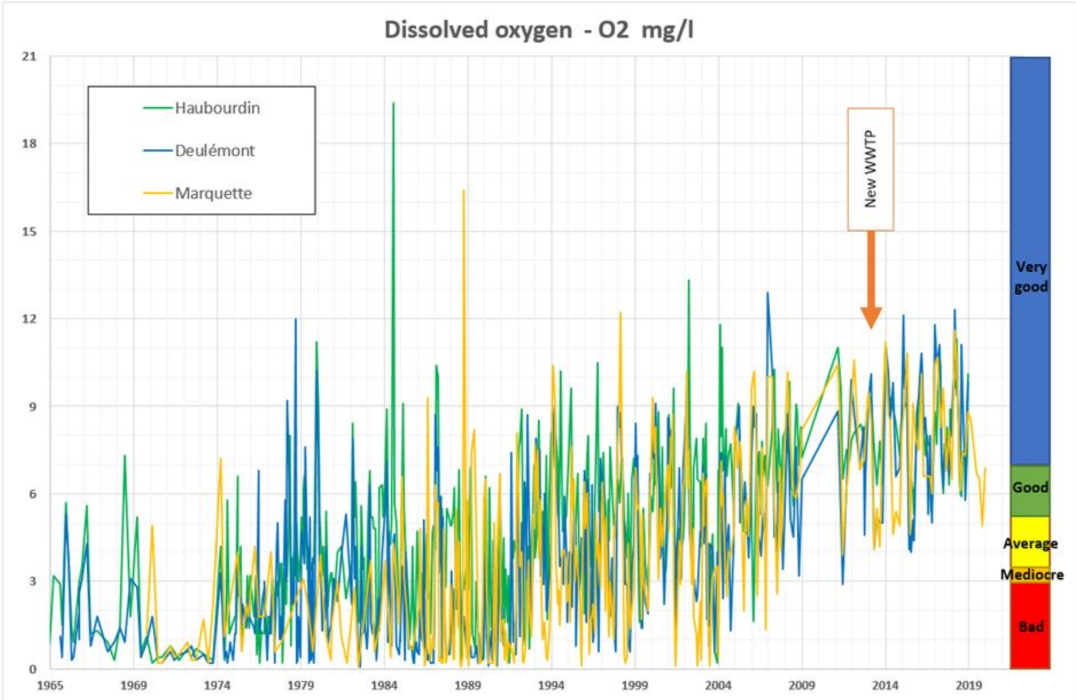


Figure 15 : River DO over the years

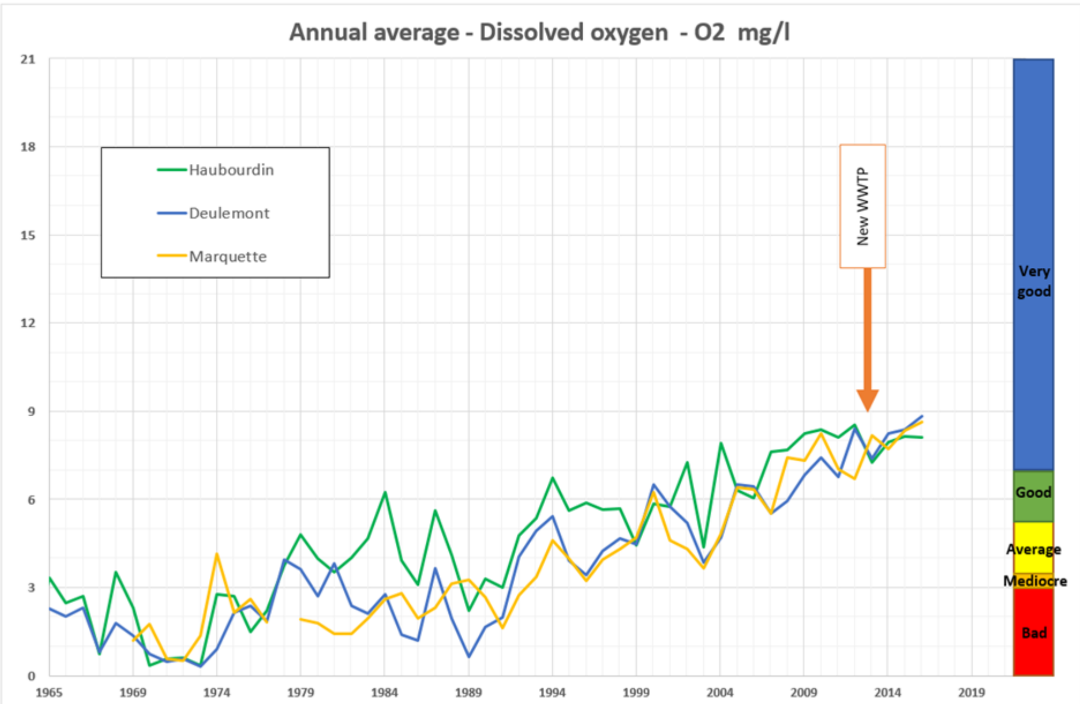


Figure 16 : Average river DO over the years

2.4 Description of the pilot site

The pilot site is composed of the wastewater treatment plant and the two associated weirs “WWTP main inlet overflow weir” and « Denis du Péage weir» as illustrated on Figure 17.

- On the left bank branch :
  - Guy Lefort storage basin (28,000 m3)
  - Café des Fleurs pumping station (500 l/s)
  - Café des Fleurs, Thiers and Pasteur overflow weirs
  - Pont de l'Abbaye pumping station (1 m3/s)
- On the Bateliers branch :
  - Bateliers pumping station (5 m3/s)
  - Bateliers basin (20,000 m3)
  - Bateliers overflow weir
  - Maracci overflow weir

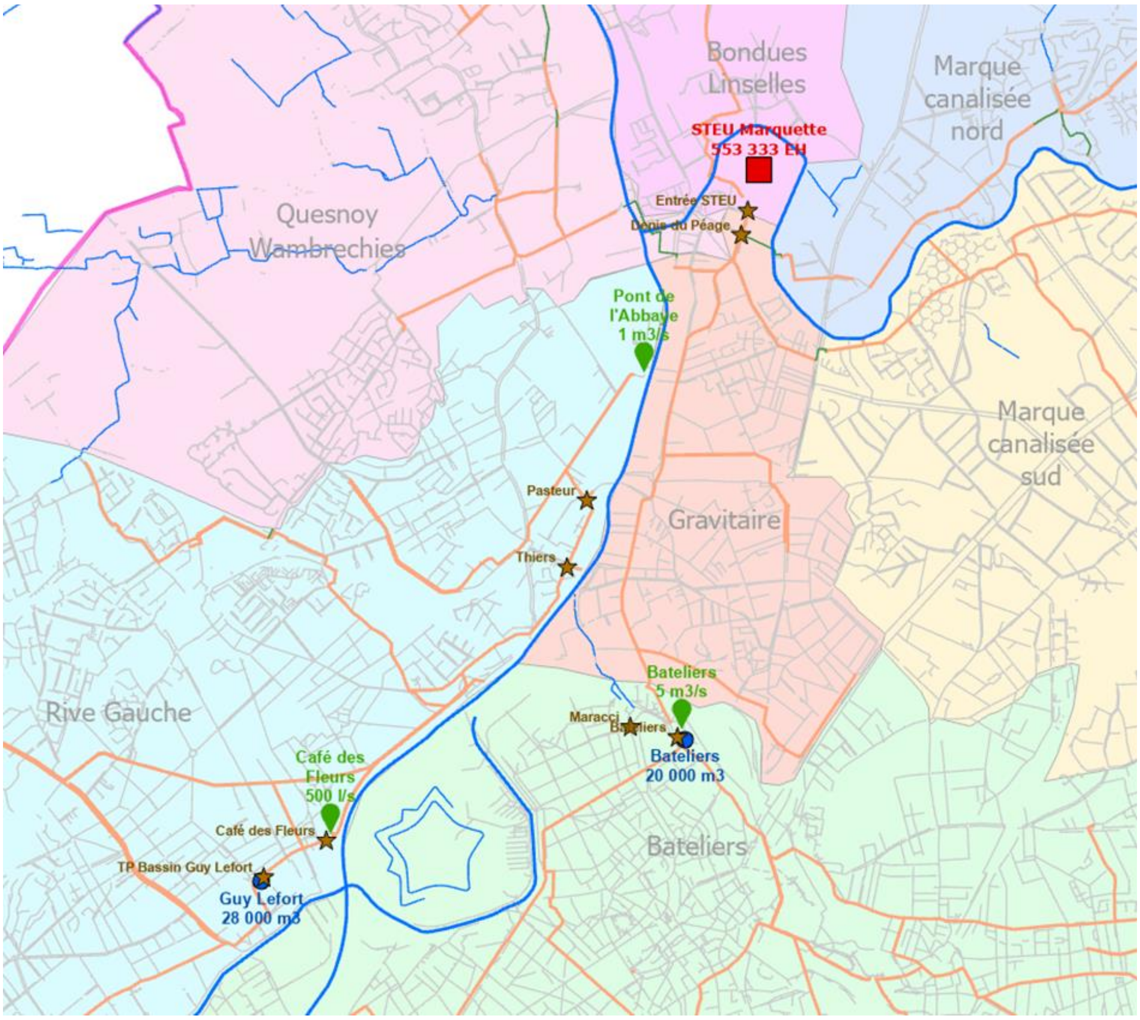


Figure 17 : Location of the structures of interest in LIFE RUBIES MEL pilot site

2.5 Description of the sewer pilot infrastructures

2.5.1 Weir at the head of the wastewater treatment plant DO 386-001

The weir at the head of the treatment plant is a safety weir. It only discharges when the plant is stopped or when the bar screens at the plant inlet are clogged. Discharges through this weir are rare.

2.5.2 Denis du Péage weir DO 386-001

This is a fixed weir 4.0 m long and 1.67 m high. It is set at 16.69 m NGF. It is equipped with a flow measurement point on the outfall pipe (1500 x 750 frame). This consists of a height measurement using a piezometric probe and a velocity measurement using a Doppler sensor installed on the invert of the pipe (Figure 18, Figure 19).

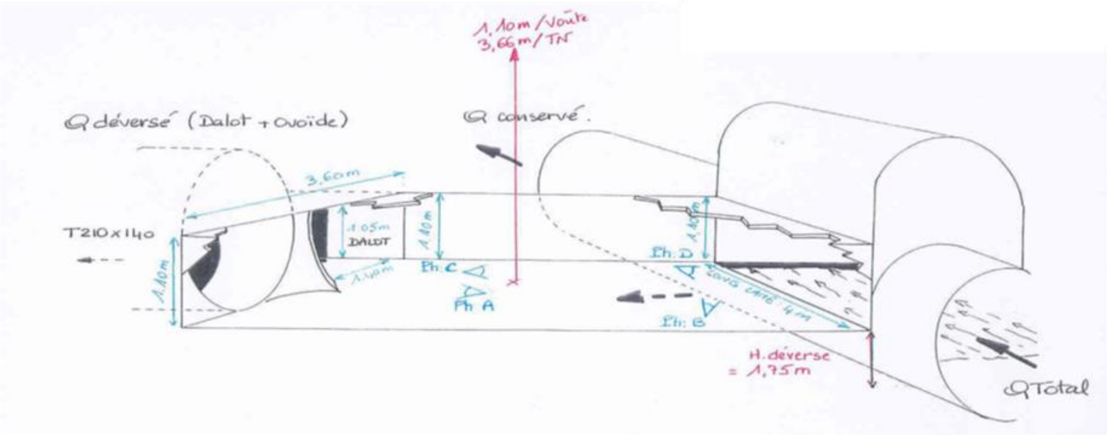


Figure 18 : Sketch of the Denis du Péage weir

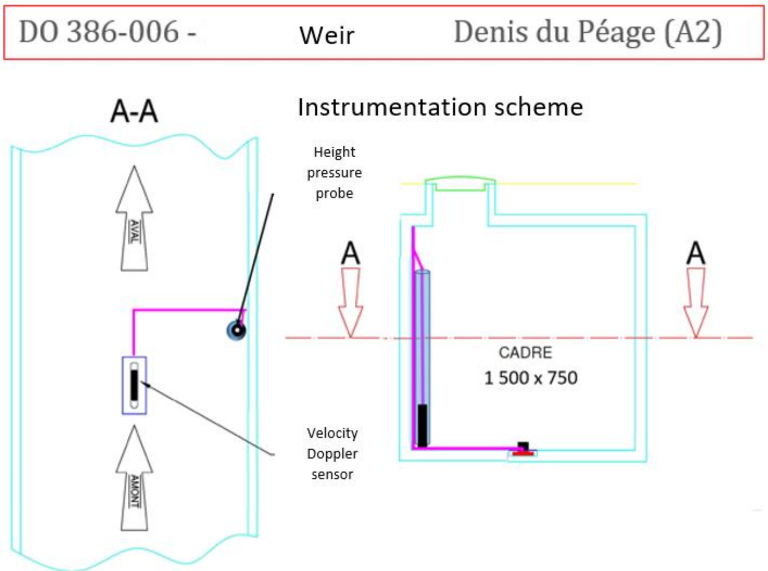


Figure 19 : Denis du Péage instrumentation scheme

2.5.3 Structures of the left bank branch

2.5.3.1 Guy Lefort storage basin (28,000 m3)

This is a dual-mode basin, i.e. a basin designed to combat both flooding and pollution in rainy weather. It is a compartmentalized basin (Figure 20). 7,000 m3 are dedicated to pollution control and 21,000 m3 are dedicated to flood control. The basin is fed by a mobile weir that allows part of the feed weir to be adjusted in order to use the basin for flood control (valve in the high position) or for rainy weather pollution control (valve in the low position). It is therefore a structure that can be managed remotely. The completion of the RUBIES project will make it possible to optimise the operation of this basin, in particular to limit discharges to the Deûle river in wet weather.

In terms of regulation, for the moment, the basin's feed valve is controlled by the water level in the basin. In automatic mode, the valve is in the low position. When it rains enough to fill the pond, the valve is raised when the volume in the pond reaches 7,000 m3. When the rain stops, the basin is emptied into the sewerage system. The volume removed from the tank is treated in the wastewater treatment plant. In case of heavy rain, the basin can be used in flood control mode for a volume of 21,000 m3.

In the event of heavy rainfall, the valve can be forced to the upper position. The 28,000 m3 of storage can thus be reserved for flood control. However, this is to the detriment of pollution control, since the basin can no longer avoid discharges during the rainy episode. Dynamic management of the network will optimise the performance of the basin.

Figure 20 : View of the basin under construction. Above, feeder structure (weir and stepped drop well) and pollution compartment

Cleaning
The invert of the basin is cleaned by flush valves (Figure 21).

Figure 21 : Illustration of the flush valves for cleaning the basin

Emptying control
The emptying of the basin is carried out by the following equipment:

- Distribution valves
  - 3 butterfly valves on the DN500 discharge.
- Compartment 1 :
  - 2 wastewater pumps PEU1 / PEU2 (Qn : 60 l/s) ;
  - 2 sludge pumps PB1 / PB2 (Qn: 40 l/s).
- Compartment 2 :
  - 1 wastewater pump PEU3 (Qn: 60 l/s) ;
  - 3 stormwater pumps PEP1 / PEP2 / PEP3 (Qn: 150 l/s).
- Communication valves between compartments C1/C2:
  - Low valve VBC1;
  - High valve VBS1.

1. Discharge valve management on DN500

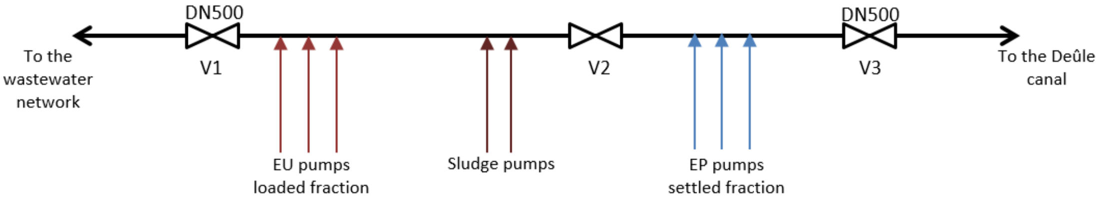


Figure 22 : Automatic operation mode schematic

In automatic operation, there are 2 possibilities of valve meshing:

- Configuration n°1: no ban on discharge into the Deûle canal :
    - Valve 1 is open to allow the return of charged water to the sewerage system;
    - Valve 2 is closed to prevent the discharge of waste water into the Deûle canal;
    - Valve 3 is open to allow the discharge of wastewater pumps into the Deûle canal.

Configuration n°1, allows the emptying of the basin in pollution mode, normal emptying of the basin and early emptying of the basin.

- Configuration n°2: prohibition of discharge into the Deûle :
    - Valve 1 is open to allow the return of the loaded water to the sewerage system;
    - Valve 2 is open to allow the discharge of the wastewater pumps into the sewerage system;
    - Valve 3 is closed to prevent the discharge of the loaded water and the EP pumps into the Deûle canal.

Configuration n°2 allows the emptying of the basin in depollution mode and the normal emptying of the basin.

2. Emptying of the basin in pollution mode (Compartment 1)

- Phase 1: PEU pumping

In pollution mode, only compartment 1 is used (C1 level < 6.40 m NGF).

The level in compartment 1 is measured by probes US1 and SP1.

The basin is emptied using the 2 EU 1 and 2 pumps in compartment C1 (1 + 1). The pumps are operated simultaneously to drain the tank as quickly as possible.

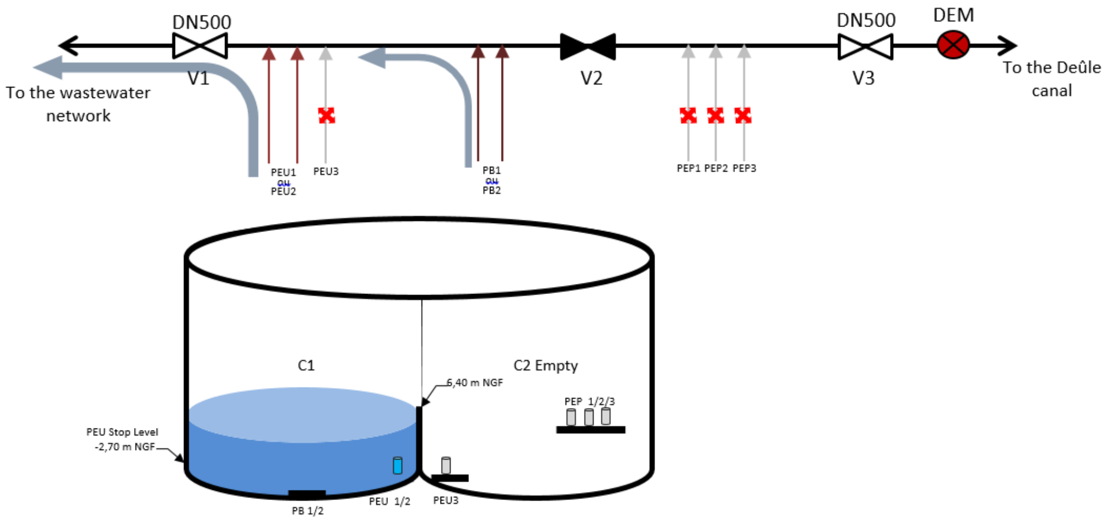


Figure 23 : Pollution mode - Phase 1 schematic

- Phase 2: Rinse cycle for compartment 1

The end of the emptying of compartment 1 starts the flushing cycle of the invert of compartment 1. The flushing is done by successively opening the flush valves.

Rinsing water emptying
The flushing water is removed by the PB1 and PB2 sludge pumps. The operation of the pumps is alternated at each start-up.

The piezometric sensor SP1 authorises the start-up of the sludge pumps. When the low level is detected (PB stop level), a delay of 30s (parameterisable variable) is started to ensure the complete emptying of the pumping pit of compartment 1.

3. Emptying of the basin in flood mode

In flooding mode, both compartments are used. The emptying takes place according to two conditions (a) and (b).

a. Compartment 2 level < PEP Low stop level (4.50 mIGN)

- Phase 1: pumping PEU1 / PEU2 and PEU3
    - The level in compartment 1 is measured by probes US1 and SP1.
    - The level in compartment 2 is measured by probes US2 and SP2.
    - The basin is emptied by 2 PEU pumps in compartment C1 (1 + 1) and by the PEU3 pump in compartment C2.

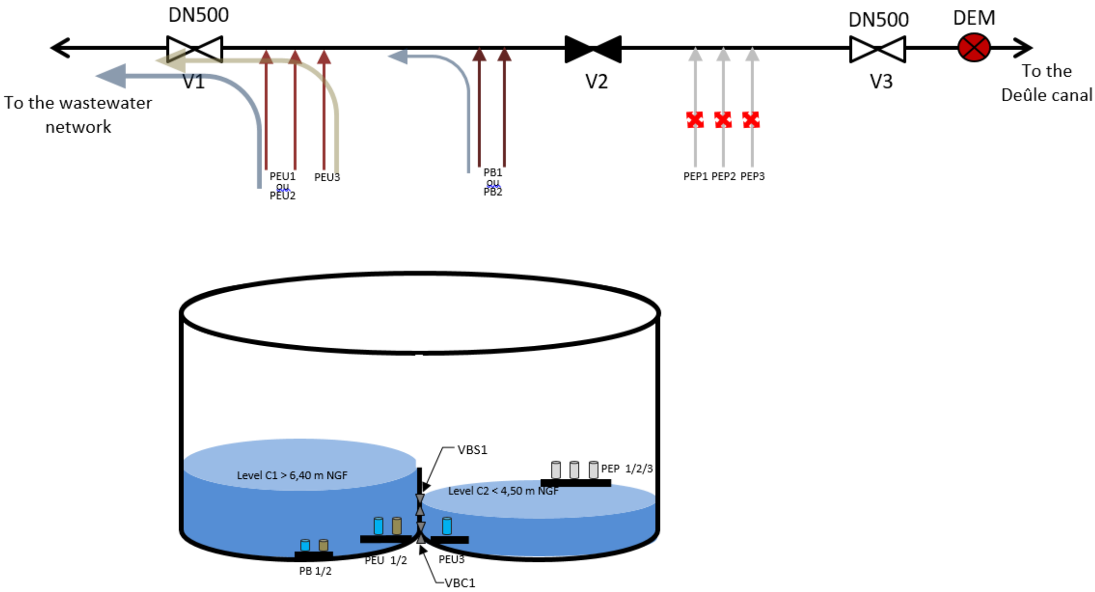


Figure 24 : Flooding mode with Low level - Phase 1 schematic

- Phase 2: Rinse cycle for compartment 2

The rinse cycle of compartment 2 is conditioned by:

  - the end of the emptying of the two compartments.
  - the opening of the low valve VBC1 (communication valve between compartments).

- Phase 3: Rinse cycle for compartment 1

The rinse cycle of compartment 1 is conditioned by:

  - the end of the flushing cycle of compartment 2.
  - the closing of the low valve VBC1.

- Phase 4: Sludge pumps - rinsing water pumping

The flushing water is pumped by the sludge pumps during both flushing phases (1 + 1 as emergency).

b. Level compartment 2 > 6.50 mIGN

1. Emptying of the upper fraction (EP pumps + EU3 pump) ;

2. Emptying of the lower fraction (pumps EU1, EU2 and EU3).

- ➢ Phase 1: pumping of the upper fraction according to one of the scenarios 1, 2 or 3, up to Level C2 < PEP Low stop level (4.50 m NGF)

Three scenarios are possible for the emptying of the upper part of the basin (choice previously defined by the operator) after a delay of 120 minutes (decantation delay; variable that can be set):

  - Scenario 1: pumping with 3 PEP (PEP1, PEP2 and PEP3) – Q: 3 x 150 l/s;
  - Scenario 2: pumping with 2 PEP (1 PEP as emergency) – Q: 2 x 150 l/s;
  - Scenario 3: pumping with 2PEP + PEU3 – Q: 2 x 150 l/s + 60 l/s.

  - The level in compartment 1 is measured by probes US1 and SP1.
  - The level in compartment 2 is measured by the US2 and SP2 probes.

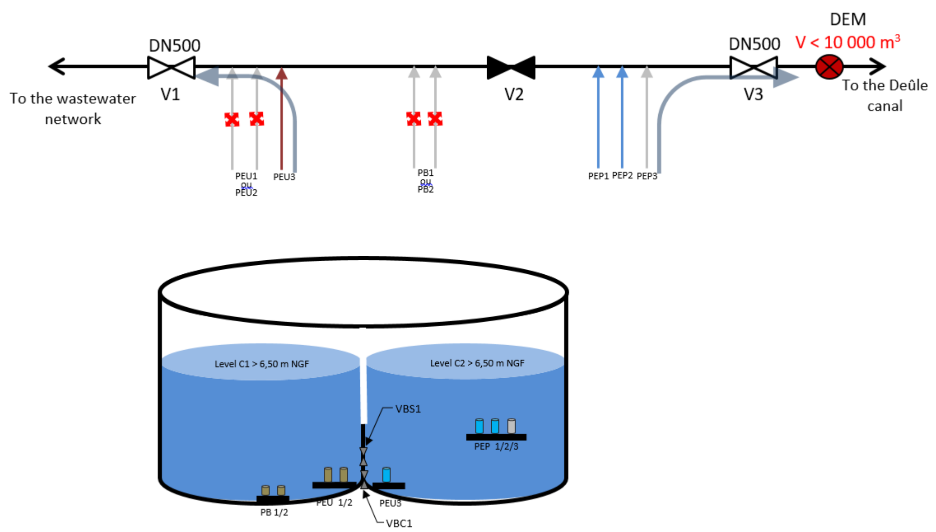


Figure 25 : Flooding mode with High level - Phase 1 schematic

- ➢ Phase 2: Pumping of the lower fraction - C2 level < PEP low stop level (4.50 m NGF)
  - The basin is emptied using 2 PEU pumps in compartment C1 (1 + 1 as emergency) and the PEU3 pump in compartment C2.

- ➢ Phase 3: Rinse cycle for compartment 2

The rinse cycle of compartment 2 is conditioned by:

  - the end of the draining of the two compartments.
  - the opening of the low valve VBC1 (communication valve between compartments).

- Phase 4: Rinse cycle for compartment 1

The rinse cycle of compartment 1 is determined by:

- the end of the flushing cycle in compartment 2.
- the closing of the low valve VBC1.

- Phase 5: Sludge pumps - pumping out rinsing water

The flushing water is pumped by the sludge pumps during both flushing phases (1 + 1 as an emergency).

4. Early basin emptying in flood mode

The early emptying of the basin can be authorised by the operator using a parameter accessible from the MAGELIS (on site) or from the CAURALI supervision (remotely).

Early emptying will be effective as soon as the water level in the compartments exceeds 14.30 m NGF AND the basin is in the filling phase.

In this scenario, it is possible to drain with 1 PEP, 2 PEP or 3PEP, a choice that can be parameterised from the MAGELIS or the CAURALI supervision.

The early draining phase is stopped when; Network level < low threshold in flood mode (16.70 m NGF) OR Basin level < 14 m NGF. In this case, the programme resumes a normal basin emptying scenario.

5. Control of the volume of water discharged into the Deûle canal

No more than 10,000 m3 of water (per 24-hour period) may be discharged into the Deûle canal (VNF conditions).

When a EP pump is put into service, the volume of water discharged into the Deûle is counted using an electromagnetic flow meter. Beyond 10,000 m3, the configuration n°2 of the DN500 valves is put in place, thus allowing the discharge of the EP pumps into the sewage network, provided that the water level in the network allows it.

2.5.3.2 Café des Fleurs pumping station (500 l/s)

The Café des Fleurs pumping station (SR 50) is a pumping station with a capacity of 500 l/s. The station operates on a lift system. It operates with one pump in dry weather and 2 pumps in rainy weather (Figure 26).

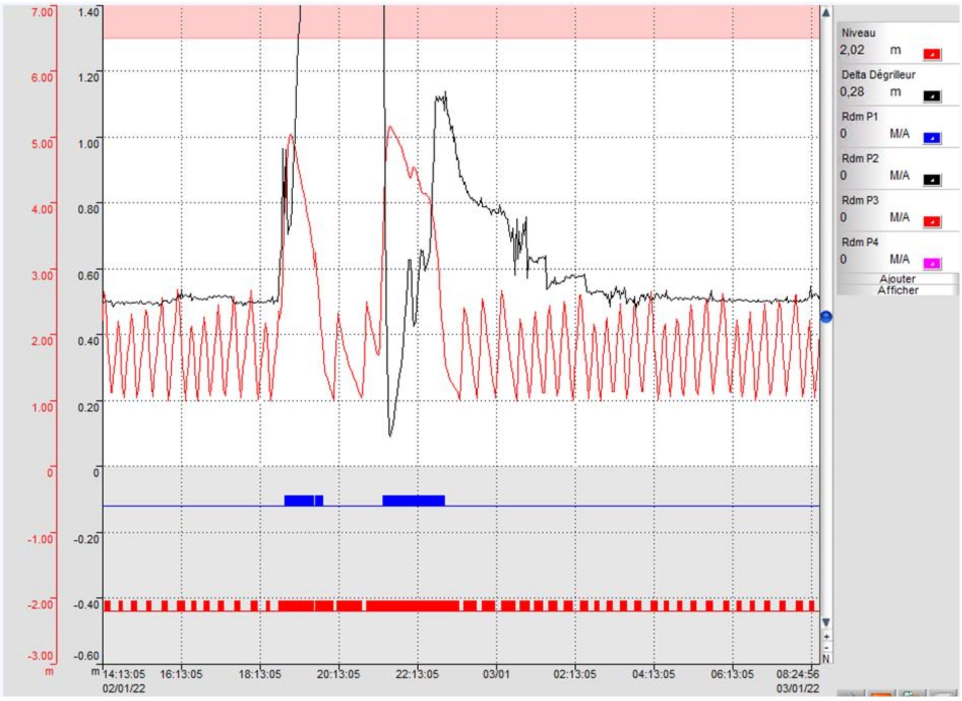


Figure 26 : Example of station operation in dry and rainy weather. Red line: water level in the station. Blue bars: Start/Stop of pump P1. Red bars: Start/Stop of pump P2

2.5.3.3 Café des Fleurs weir 328-001

This is a fixed weir at an altitude of 16.50 m NGF. It is located at the head of the Café des Fleurs pumping station (Figure 27).

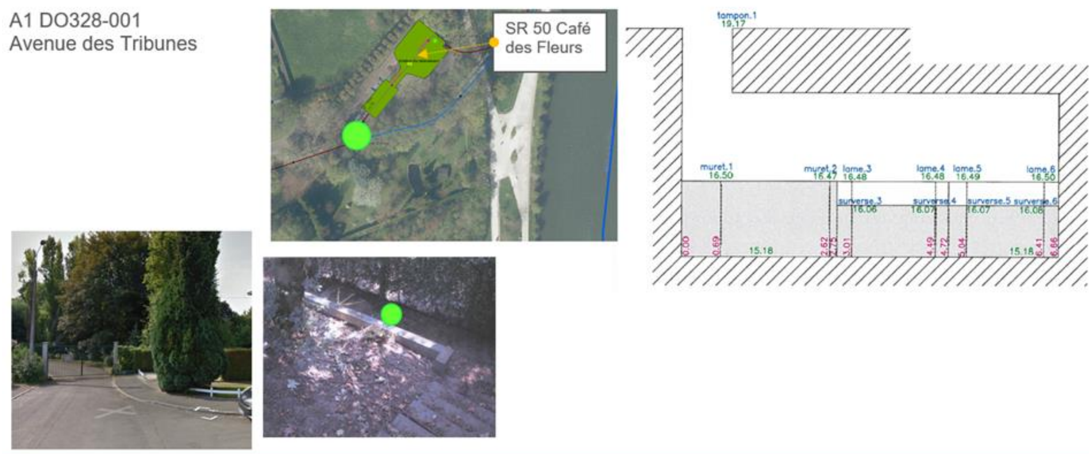


Figure 27 : Illustration of Café des Fleurs weir

2.5.3.4 Ste Hélène Thiers weir - 527-001

This is a CSO with a static weir at an altitude of 15.80 m NGF. It discharges into the Deûle river (Figure 28, Figure 29).

Figure 28 : Illustration of Saint Hélène Thiers weir

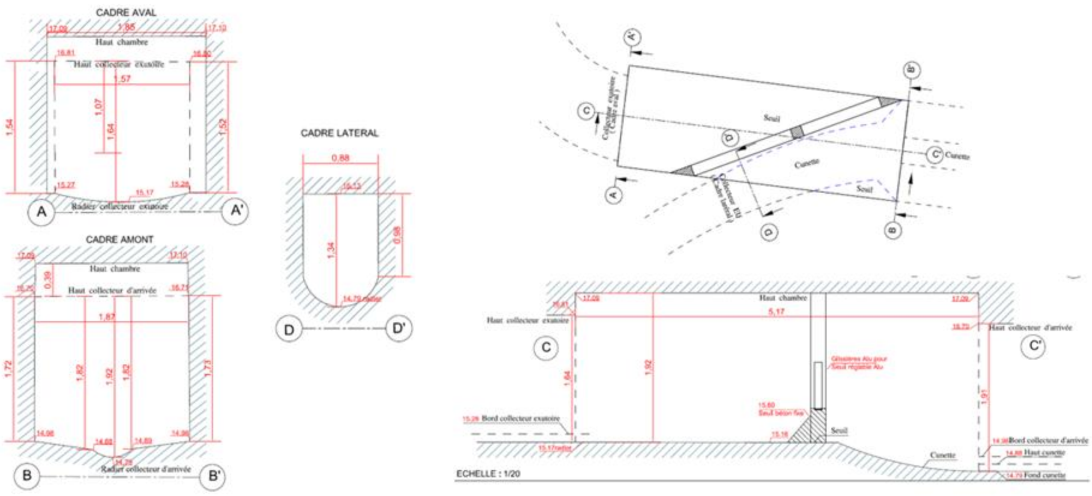


Figure 29 : Design schematics of Saint Hélène Thiers weir

2.5.3.5 Ste Hélène Pasteur weir 527-002

This is a CSO with a static weir at an altitude of 15.65 m NGF. It discharges into the Deûle river (Figure 30, Figure 31).

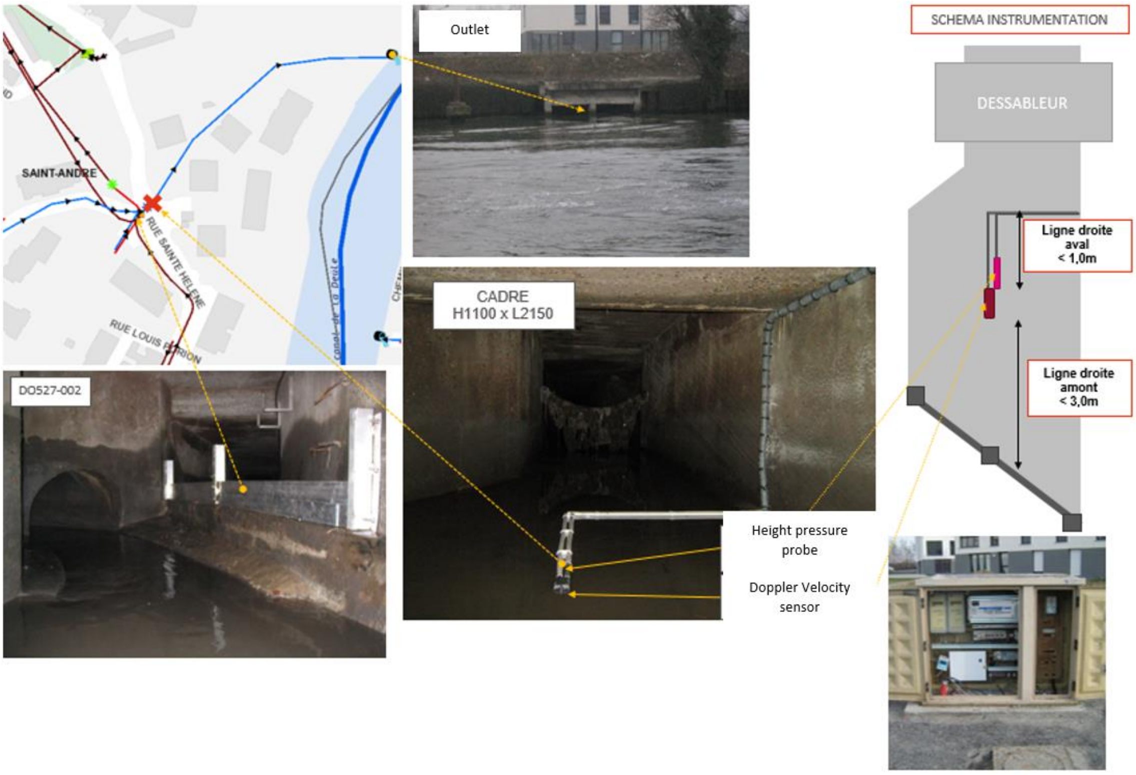


Figure 30 : Illustrations of Saint Hélène Pasteur weir

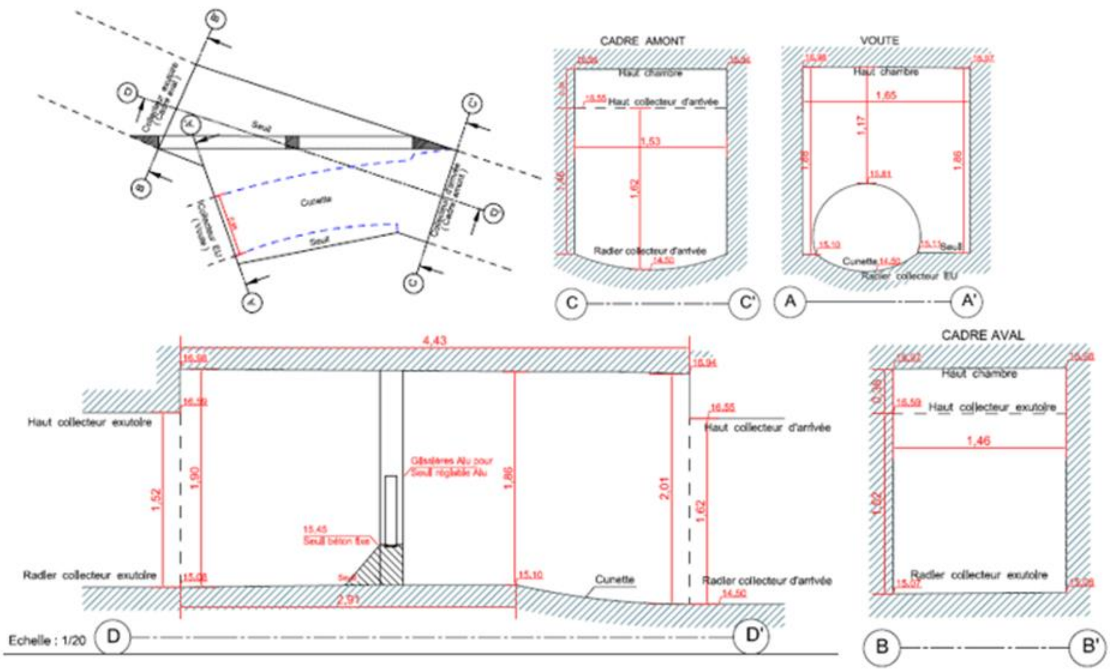


Figure 31 : Design schematics of Saint Hélène Pasteur weir

2.5.3.6 Pont de l'Abbaye pumping station (1 m3/s)

This is a pumping station equipped with 3 pumps. The maximum capacity of the station is 1 m3/s. It allows effluents to be pumped from the left bank of the Deûle canal to the right bank by passing under the Deûle canal (Figure 32).

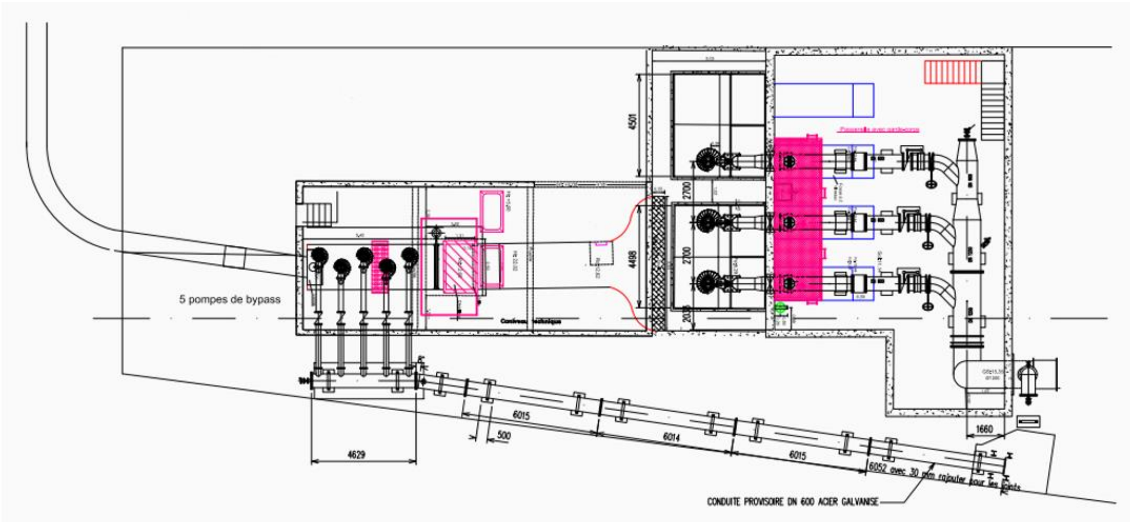


Figure 32 : Pont Abbaye Pumping station – Plan view

2.5.4 Equipments of Bateliers branch

2.5.4.1 Bateliers pumping station (5 m3/s)

The Bateliers pumping station was rebuilt and commissioned in 2015. It consists of two wet wells: one for the eastern sewer system with a capacity of 3 m3/s and one for the western sewer system with a capacity of 2 m3/s (Figure 33, Figure 34). These two wet wells allow a hydraulic disconnection between the western and eastern sewer systems, the western sewer system being located lower than the eastern sewer system. The western system was therefore penalised by the eastern system before this disconnection.

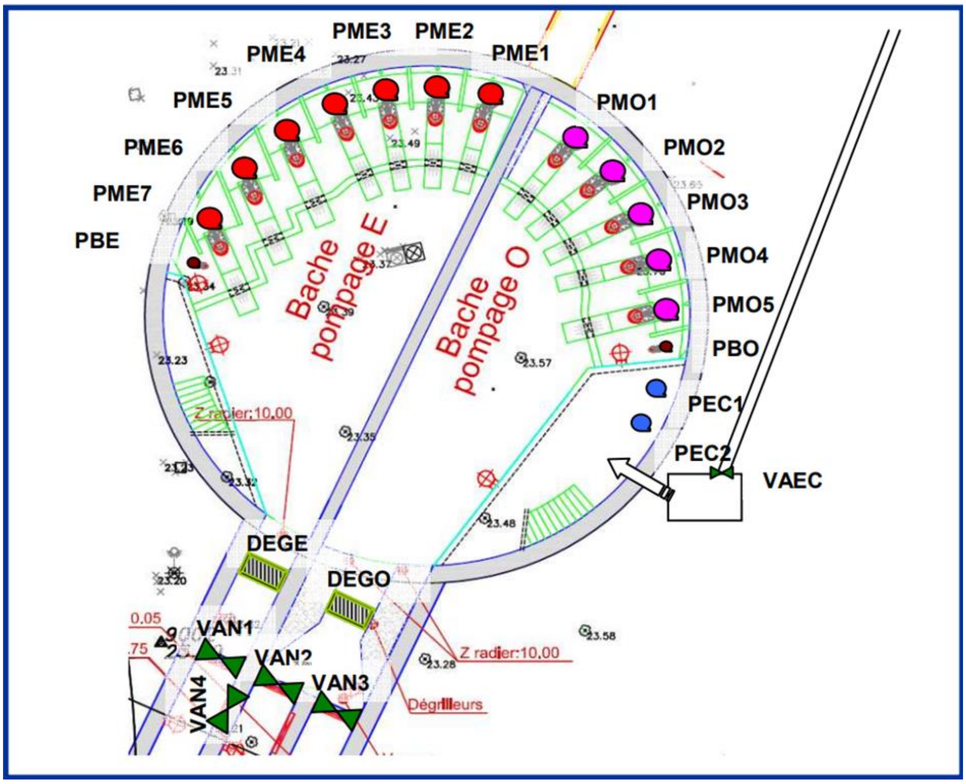


Figure 33 : Plan view of the pumping station

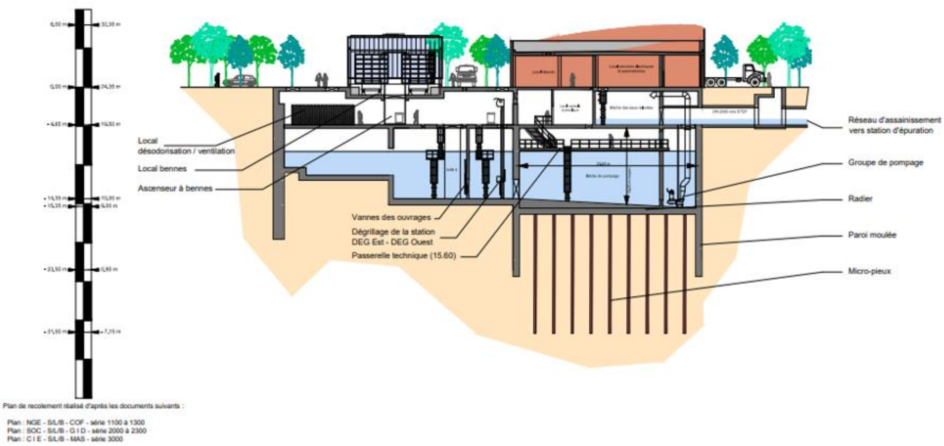


Figure 34 : Connection structure to the WWTP

2.5.4.2 Bateliers basin (20,000 m3)

The Bateliers basin is a 20,000 m3 pollution control basin. In rainy weather, the flow from the Bateliers pumping station increases up to 5 m3/s, then the excess water is stored in the basin up to 20,000 m3. Beyond that, the effluents are discharged into the dead channel of the Deule canal via the Batelier and Maracci weirs. The basin is emptied at a rate of 300 l/s (Figure 35, Figure 36).

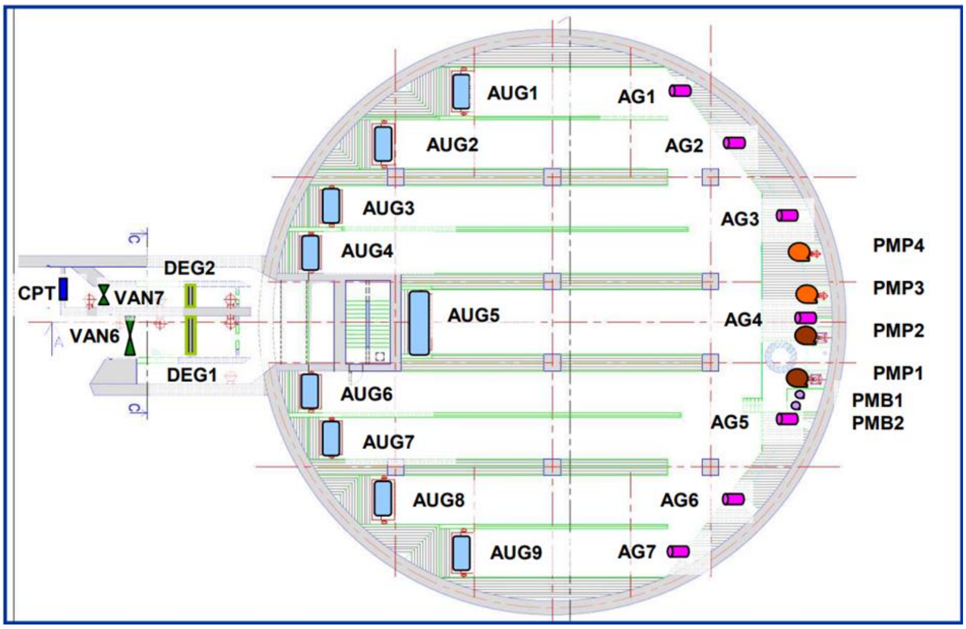


Figure 35 : Plan view of the basin.

Connection structure to the basin

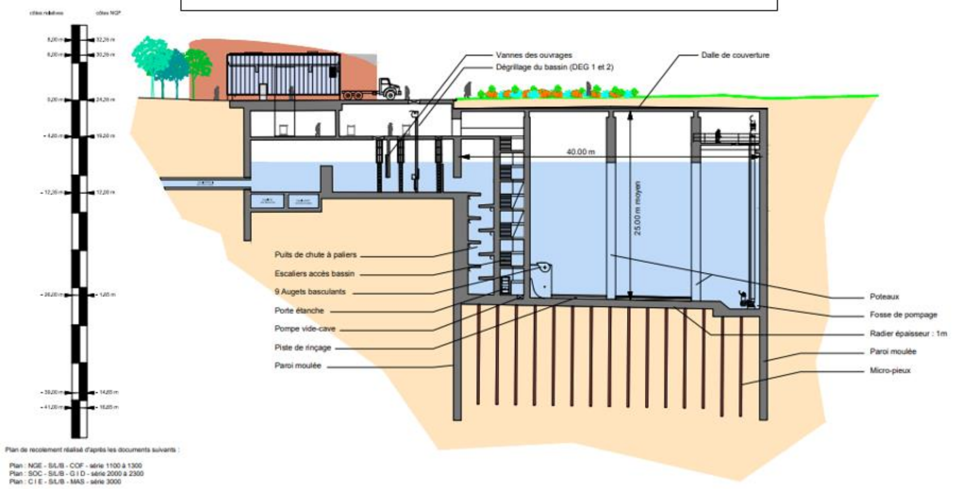


Figure 36 : Connection structure to the basin

2.5.4.3 Weir of the Bateliers 350-001

This is a fixed weir 6 m long at an altitude of 16.20 m NGF. The discharge is made into a dead channel of the Deûle canal. It is the main overflow weir of the agglomeration (Figure 37).

Figure 37 : Illustrations of Bateliers' weir

2.5.4.4 Maracci weir 350-002

This is a static weir 2 m long at 15.30 m NGF (Figure 38).

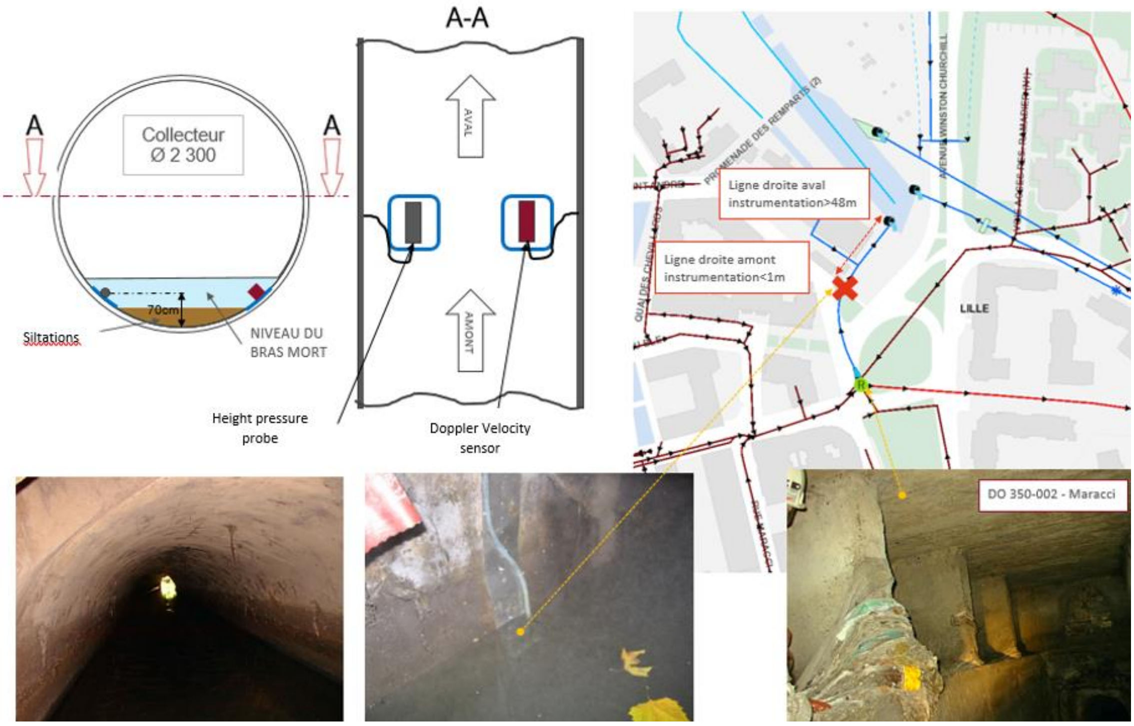


Figure 38 : Illustrations of Maracci's weir

2.6 Assessment of the performance of the agglomeration

2.6.1 Efficiency of the works undertaken

The Lille sewerage agglomeration is an old system. Major upgrading and performance improvement works have been undertaken in recent years to meet the requirements of European and national regulations.

In particular, the following works have been carried out:

- Rebuilding of the Marquette wastewater treatment plant and increase in treatment capacity up to 8.1 m3/s
- Increase in flows transferred to the WWTP (reconstruction of the Bateliers pumping station)
- Creation of pollution control storage basins: Guy Lefort (Lambersart 28,000 m3), Bateliers (Lille, 20,000 m3), Voyettes (Lesquin, 3,500 m3), Bergerie (Quesnoy sur Deûle, 600 m3)
- Raising of storm overflows crests (allowing reduction of extraneous clear water and reduction of discharges)
- Disconnection of stormwater and drainage water ("ECP" pipe (specific extraneous clear water pipe))
- Stormwater disconnection operations

These operations have contributed to reducing the discharge of polluted water into the natural environment and to improving the performance of the sanitation agglomeration both in dry and wet weather (Figure 39).

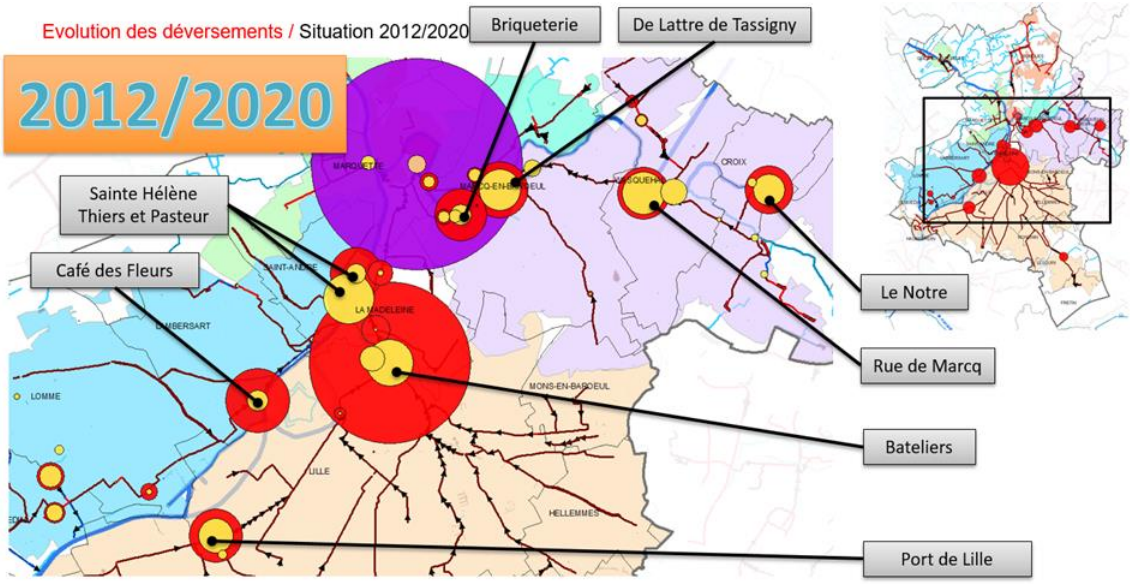


Figure 39 : Evolution of weir overflows - Situation 2012 / 2020

2.6.2 Evolution of the discharge contributions from the Bateliers weir over the years

Before the works, the Bateliers weir accounted for about 50% of the flows discharged in rainy weather. The construction of the Bateliers basin has made it possible to reduce this share to 20% today, while significantly reducing the volumes discharged by the agglomeration during rainy weather (Table 1).

Table 1 : Batelier weir contribution evolutions

	A1			
Name	A1 Global network weir overflow		Bateliers	% /A1 Global
Ref			350-001	
Year	A1 Vol m3	A1 Nb Days of overflow	Overflow Vol m3	
2012	11 383 295	178	5 011 730	44%
2013	10 957 215	174	5 067 257	46%
2014	9 740 953	197	4 141 114	43%
2015	6 533 399	180	2 285 842	35%
2016	7 684 507	178	1 608 234	21%
2017	4 149 788	137	763 164	18%
2018	4 631 593	146	893 078	19%
2019	2 992 046	148	490 272	16%
2020	3 204 666	136	427 038	13%
2021	5 204 851	0	891 126	17%

2.6.3 Evolution of the discharge contributions from the weirs concerned by the LIFE RUBIES project over the years

The 5 weirs studied in the scope of the experimentation currently represent 40% of the flows discharged by the agglomeration during wet weather. The objective of the project is therefore to further reduce the flows discharged through dynamic management of the sewage network by controlling both the hydraulic flows and the quality of both the effluents discharged and the receiving body (Table 2).

Table 2- : All LIFE RUBIES perimeter weir contribution evolutions

	A1							
Name	Bateliers	Maracci	Guy Lefort	Café des Fleurs	Thiers	Pasteur	Sum m3	% (Sum/A1)
Ref	350-001	350-002	328-847	328-001	527-001	527-002		
Year	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3		
2012	5 011 730	1 905	5 494	797 800	360 321	520 245	6 697 494	59%
2013	5 067 257	6 111	0	701 252	441 501	149 144	6 365 265	58%
2014	4 141 114	4 099	0	631 064	489 201	138 841	5 404 319	55%
2015	2 285 842	149 422	10 021	372 513	351 034	69 882	3 238 714	50%
2016	1 608 234	301 453	14 000	482 580	482 922	98 768	2 987 957	39%
2017	763 164	218 263	0	344 951	355 911	16 585	1 698 874	41%
2018	893 078	244 681	10 108	287 464	460 532	67 006	1 962 869	42%
2019	490 272	136 710	0	122 852	424 110	18 382	1 192 325	40%
2020	427 038	122 589	0	92 241	502 826	77 924	1 222 618	38%
2021	891 126	277 620	2 657	249 053	629 460	35 459	2 085 375	40%

2.6.4 Evolution of the regulatory compliance criterion over the years

The regulatory compliance criterion is currently 7.5% on average over 5 years. The legal limit is 5%. Actions remain to be carried out in the agglomeration. They will consist of the construction of a few storage basins, the disconnection of active surfaces to limit rainfall contributions to the sanitation system, and also optimization through dynamic management of the system (Table 3).

Table 3 : Regulatory criterion compliance evolution

	Rain	A1		A2			A3	Regulation	
Name		Global network weir overflow		Global WWTP weir overflow	WWTP security weir	Denis du Péage	WWTP Inflow	Compliance criterion	
Ref						386-006		Annual value	5-year rolling average
Year	Rainfall depth mm	A1 Vol m3	A1 Nbre Spilling Day	WWTP overflow Vol m3 (A2)	A2 overflow Vol m3	Overflow Vol m3	Vol m3 (A3)	A1/(A1+A2+A3)	A1/(A1+A2+A3)
2012	857.2	11 383 295	178	110 305		110 305	45 204 268	20.1%	
2013	795.0	10 957 215	174	147 392	0	147 392	43 046 886	20.2%	
2014	805.2	9 740 953	197	18 882	0	18 882	50 088 028	16.3%	
2015	731.9	6 533 399	180	242 421	79 872	162 549	49 149 908	11.7%	
2016	804.8	7 684 507	178	96 527	25 113	71 414	49 235 081	13.5%	16.3%
2017	683.6	4 149 788	137	21 097	965	20 133	46 890 008	8.1%	14.0%
2018	645.5	4 631 593	146	189 823	36 444	153 379	49 757 770	8.5%	11.6%
2019	641.7	2 992 046	148	35 142	6 722	28 421	46 004 588	6.1%	9.6%
2020	631.4	3 204 666	136	67 653	22 259	45 395	45 425 634	6.6%	8.6%
2021	804.0	5 204 851	0	99 989	12 387	87 603	53 001 546	8.9%	7.6%

2.6.5 Frequency of discharge from weirs concerned by the LIFE RUBIES project

For the weirs concerned by the RUBIES experiment, the discharge frequencies are close to the objective of 20 discharges per year for the Bateliers, Maracci, Guy Lefort and Pasteur weirs. On the other hand, the discharge frequency is still too high for the Café des Fleurs and Thiers weirs (Table 4).

Table 4 : Table 4.CSO discharge frequencies

	A1						
Name	Bateliers	Maracci	Guy Lefort	Café des Fleurs	Thiers	Pasteur	Sum /A1 Global
Ref	350-001	350-002	328-847	328-001	527-001	527-002	
Year	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	
2012	44%	0%	0%	7%	3%	5%	59%
2013	46%	0%	0%	6%	4%	1%	58%
2014	43%	0%	0%	6%	5%	1%	55%
2015	35%	2%	0%	6%	5%	1%	50%
2016	21%	4%	0%	6%	6%	1%	39%
2017	18%	5%	0%	8%	9%	0%	41%
2018	19%	5%	0%	6%	10%	1%	42%
2019	16%	5%	0%	4%	14%	1%	40%
2020	13%	4%	0%	3%	16%	2%	38%
2021	17%	5%	0%	5%	12%	1%	40%

2.6.6 CSO contributions affected by the RUBIES project

The respective contributions of each of the weirs to the overall wet weather discharge are as follows (Table 5).

Table 5 : CSO volume contributions

	A1						
Name	Bateliers	Maracci	Guy Lefort	Café des Fleurs	Thiers	Pasteur	Sum /A1 Global
Ref	350-001	350-002	328-847	328-001	527-001	527-002	
Year	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	Overflow Vol m3	
2012	44%	0%	0%	7%	3%	5%	59%
2013	46%	0%	0%	6%	4%	1%	58%
2014	43%	0%	0%	6%	5%	1%	55%
2015	35%	2%	0%	6%	5%	1%	50%
2016	21%	4%	0%	6%	6%	1%	39%
2017	18%	5%	0%	8%	9%	0%	41%
2018	19%	5%	0%	6%	10%	1%	42%
2019	16%	5%	0%	4%	14%	1%	40%
2020	13%	4%	0%	3%	16%	2%	38%
2021	17%	5%	0%	5%	12%	1%	40%

2.6.7 Rate of use of the basins

2.6.7.1 Bateliers basin

The following table shows the annual number of times the basin is used and the total volume stored. The basin is used about 110 to 130 times a year, which means that it is used almost every time it rains (average of 120 rains a year). The basin is used at its maximum level 20 to 30 times a year. The Bateliers weir is used 20 to 30 times a year depending on the rainfall (Table 6, Figure 40).

Table 6 : Batelier CSO characteristics

Bassin des Bateliers à Lille (B859)

Catchment	**RIVE DROITE DEÛLE**
Basin capacity (m3)	**20 000**

	2021			2020			2019		
	Number of solicitations (days)	Volume (m^3)	%	Number of solicitations (days)	Volume (m^3)	%	Number of solicitations (days)	Volume (m^3)	%
Basin storage (m3)	128	905 413	2.9%	107	777 373	2.9%	111	706 240	2.6%
Number of 100% fills	29		23%	20		19%	17		15%
Number of fills < 50%	91		71%	40		37%	66		59%
Discharged volume (in m3)	32	1 168 746		29	549 628		23	626 982	
Volume transited (SR50) (m3)		30 445 879			26 070 921			26 472 048	
Volume produced by the agglomeration (A3+A2+A1)		58 306 387			48 697 953			49 031 777	
Volume stocked in the basins (B859 + B854 + B847 + B849)		1 586 909	2.7%		1 310 652	2.7%		1 194 547	2.4%
Unstocked volume		56 719 477	97.3%		47 387 301	97.3%		47 837 230	97.6%

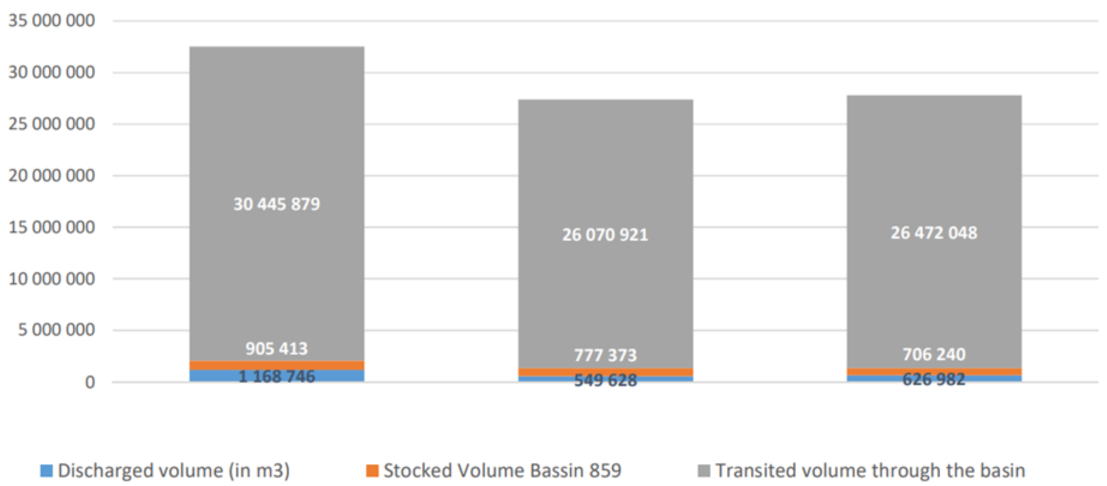


Figure 40 : Bateliers basin – Interannual evolution since 2019

2.6.7.2 Guy Lefort Basin

The following table shows the annual number of times the basin is used and the total volume stocked. The basin is used about 50 times a year, which means that it is used about every second rainfall (120 rainfalls per year on average). The basin is used at its maximum level very rarely, only for very strong storms. The associated weir is also very little used, almost never (Table 7, Figure 41).

Table 7 : Guy Lefort CSO characteristics

Bassin Guy Lefort à Lambersart (B847)

Catchment	RIVE GAUCHE DEÛLE
Basin capacity (m3)	28,000 m3 of which 7,000 in pollution

	2021			2020			2019		
	Number of solicitations (days)	Volume (m^3)	%	Number of solicitations (days)	Volume (m^3)	%	Number of solicitations (days)	Volume (m^3)	%
Basin storage (m3)	52	220 017	5.9%	49	167 312	5.8%	53	171 698	
Number of 100% fills	0		0%	0		0%	0		0%
Number of fills < 50%	124		238%	88		180%	169		319%
Discharged volume (in m3)	1	2 657		0	0		0	0	
Volume transited (SR50) (m3)		3 701 344			2 867 002			NR	
Volume produced by the agglomeration (A3+A2+A1)		58 306 387			48 697 953			49 031 777	
Volume stocked in the basins (B859 + B854 + B847 + B849)		1 586 909	2.7%		1 310 652	2.7%		1 194 547	2.4%
Unstocked volume		56 719 477	97.3%		47 387 301	97.3%		47 837 230	97.6%

Note: Difficulty in emptying the basin as the emptying of the basin is conditioned by the level in the sewage system.

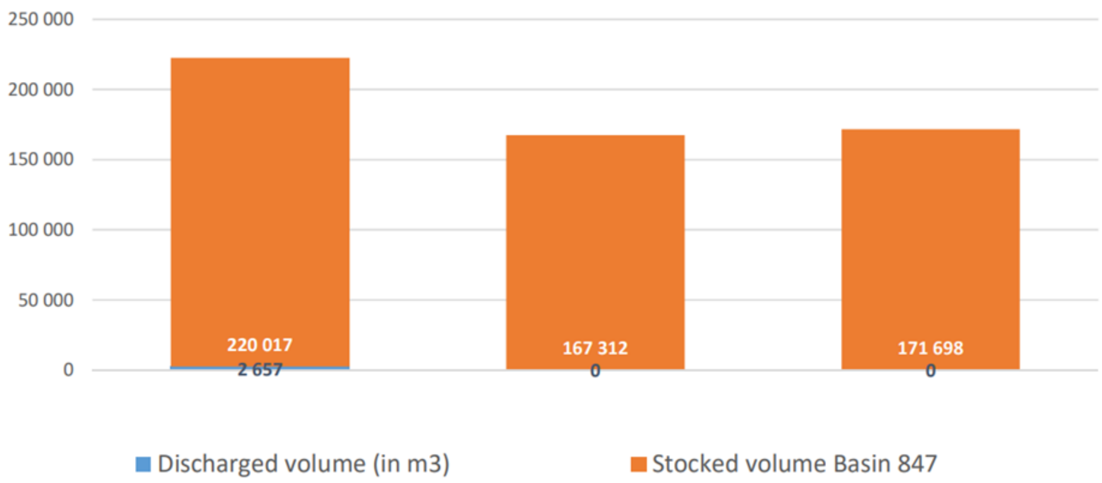


Figure 41 : Guy Lefort basin – Interannual evolution since 2019

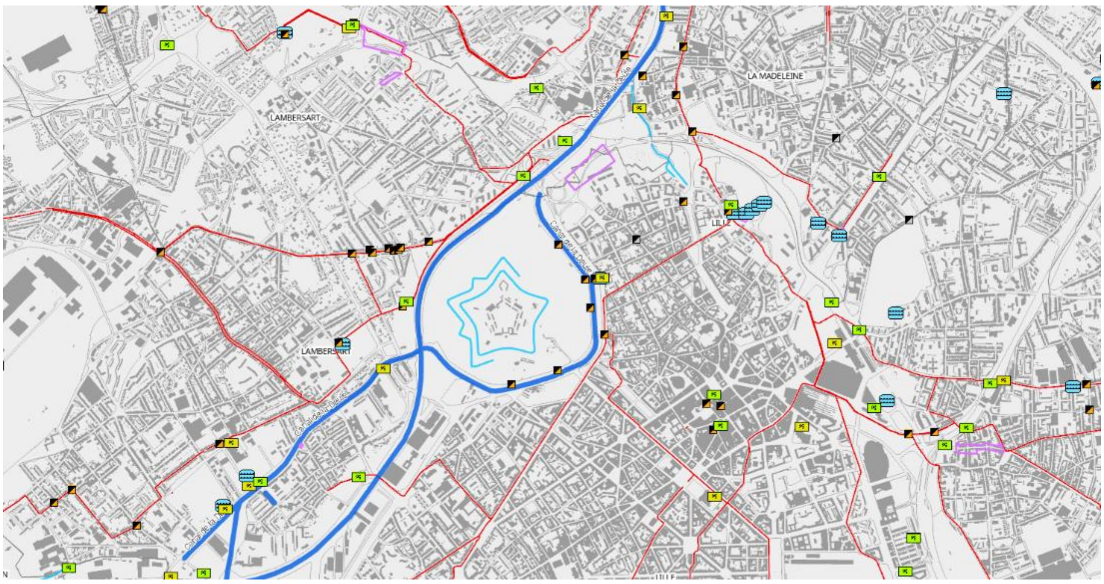
2.7 GIS for dimensions, locations, pumps, valves

To consult, update, distribute and administer its geographic database, the MEL Water and Sanitation Department uses the ARCGIS software suite from ESRI. The geographic information layers making up the sanitation network are stored in an ARCGIS geodatabase, itself stored on the ORACLE SGDB. The editing and updating of the data are mainly done with ARCMAP or ARCGIS PRO. The web diffusion of data is ensured by an ARCGIS-SERVER.

GIS is covering all 35 town of Lille sanitation conurbation. All the entities are divided in several layers:

- 2 Storages
- 60 158 junctions
- 16 rivers
- 1 781 underground assets (hydrocarbon separator, underground chamber…)
- 16 channels
- 290 storm weirs
- 570 pumps and pressurized main (41 km)
- 72 430 gravity fed pipe (1 864 km)
- 3 629 ditches (27 km)
- 629 “Becque” small channel and ditches (88 km)
- 56 measuring stations on the sewage network

GIS views (ARCGIS SERVER) at different zoom scales (Figure 42).



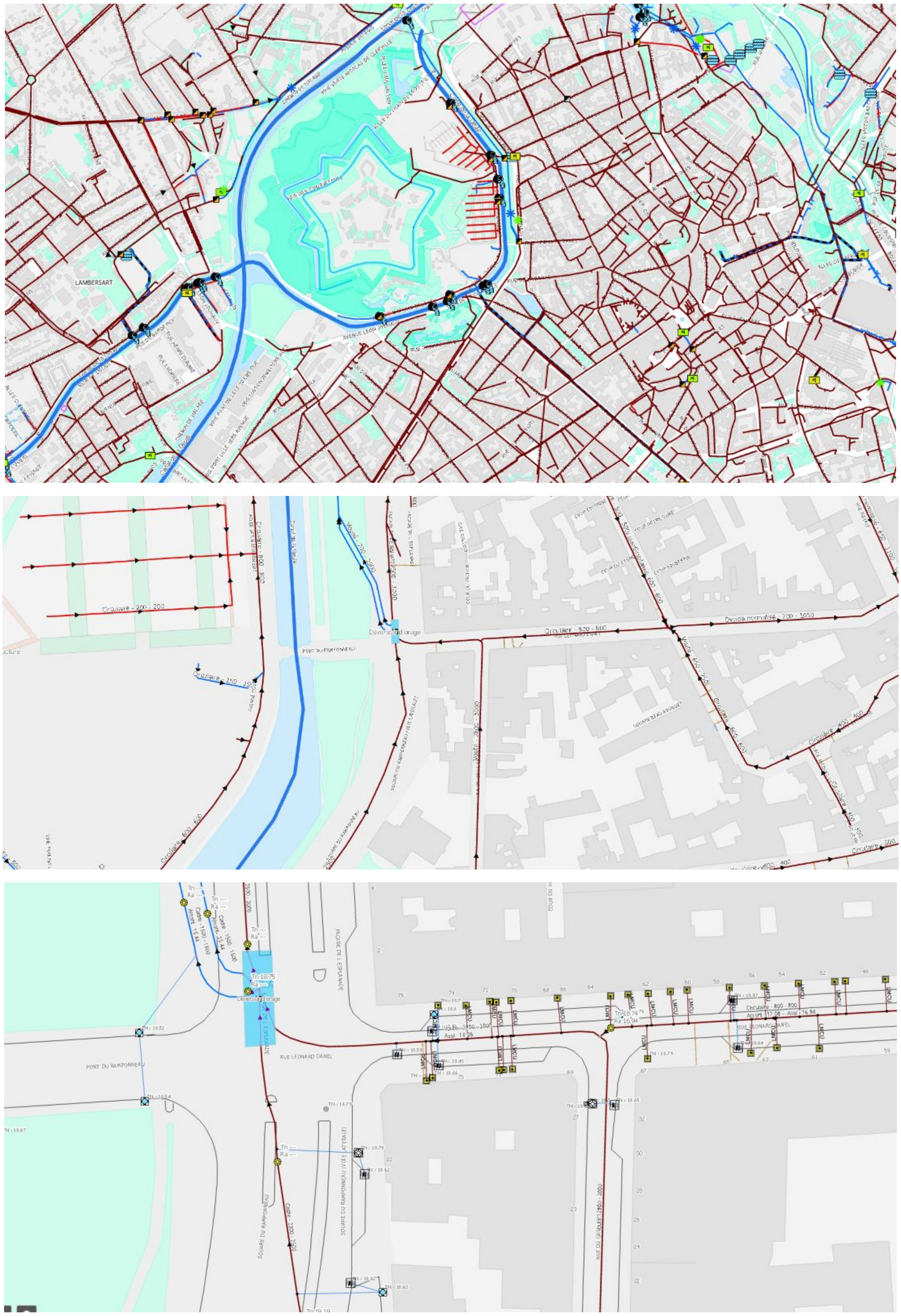


Figure 42 : GIS view and scale illustrations

2.8 Dynamic data

Within the scope of its regulatory obligations, the MEL services ensure a continuous monitoring of the main storm overflows on all its sanitation agglomerations. This monitoring is carried out on approximately 80 storm weirs either from measurements in the sewage network or from data resulting from hydraulic modelling. The measurements in the sewage network are of type height / speed, electromagnetic flowmeter or height / flow law. The data are analyzed daily, compiled and summarized in monthly, annual and interannual reports. They allow to evaluate the regulatory compliance of each wastewater system and to check the efficiency of the actions implemented to limit weir discharges.

MEL's services also ensure a detailed analysis of the operation of its wastewater systems through various diagnostics (functional, permanent, periodic). These diagnoses are mainly based on the monitoring of network measurement points on the main sewers, on pumping stations and storage facilities, on the wastewater treatment system and on rainfall monitoring. Today, more than 200 points are monitored on a daily basis. This monitoring allows:

- to identify and quickly resolve anomalies and malfunctions,
- to count the flows of wastewater and stormwater,
- to estimate the quantities of extraneous clear water, to sectorize the contributions and to propose solutions to reduce these inflows,
- to carry out the permanent and periodic diagnoses of each sewerage system.

The instrumentation of the Lille agglomeration has been deployed since 1997 for the first measurement points. The regulation imposes to measure the flows discharged at the storm weirs of more than 10,000 p.e. (outfall pipe), but the decision was made to instrument the main sewer as well when possible. These points are called characteristic points "PC". They allow to count the flows transited on the main branches. In addition, for internal diagnosis and daily control, "PR" points are used which correspond to measurement points used for the regulation of structures, and "PS" points which are monitoring points without regulatory obligation.

The agglomeration of Lille is covered by 56 measurement points (Figure 43) distributed as follows :

- A1: 23 measuring points of flows discharged by the A1 regulatory storm weirs
- A2: 1 measurement point on the overflow of the wastewater treatment plant
- PC: 10 characteristic points on the sewage network
- PR : 8 measuring points used for the regulation of works
- PS : 15 measuring points used for internal diagnosis and daily control

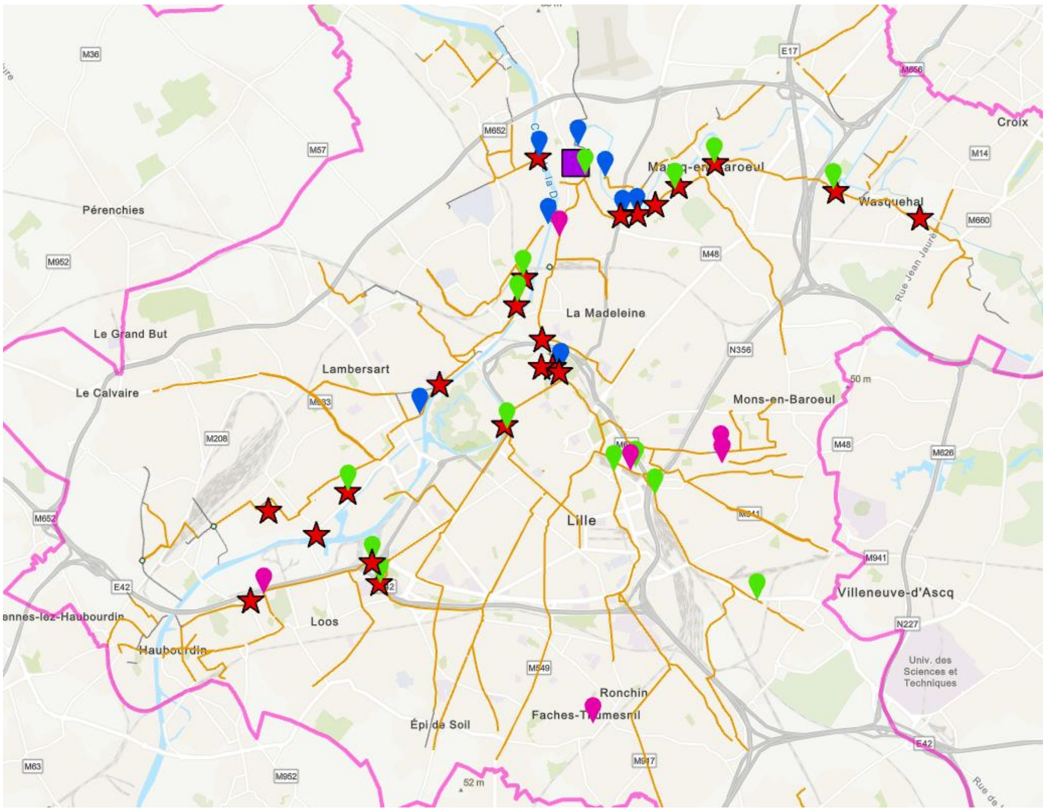


Figure 43 : Map of measurement points in the Lille area

2.9 Existing detailed hydraulics models

A model was built with Mike Urban and then converted by MEL to be used with Infoworks software (Figure 44). The structure of this model is:

- 2372 subcatchments
- 60 storages
- 189 pumps
- 12632 conduits
- 12315 junctions
- 324 weirs
- 65 orifices

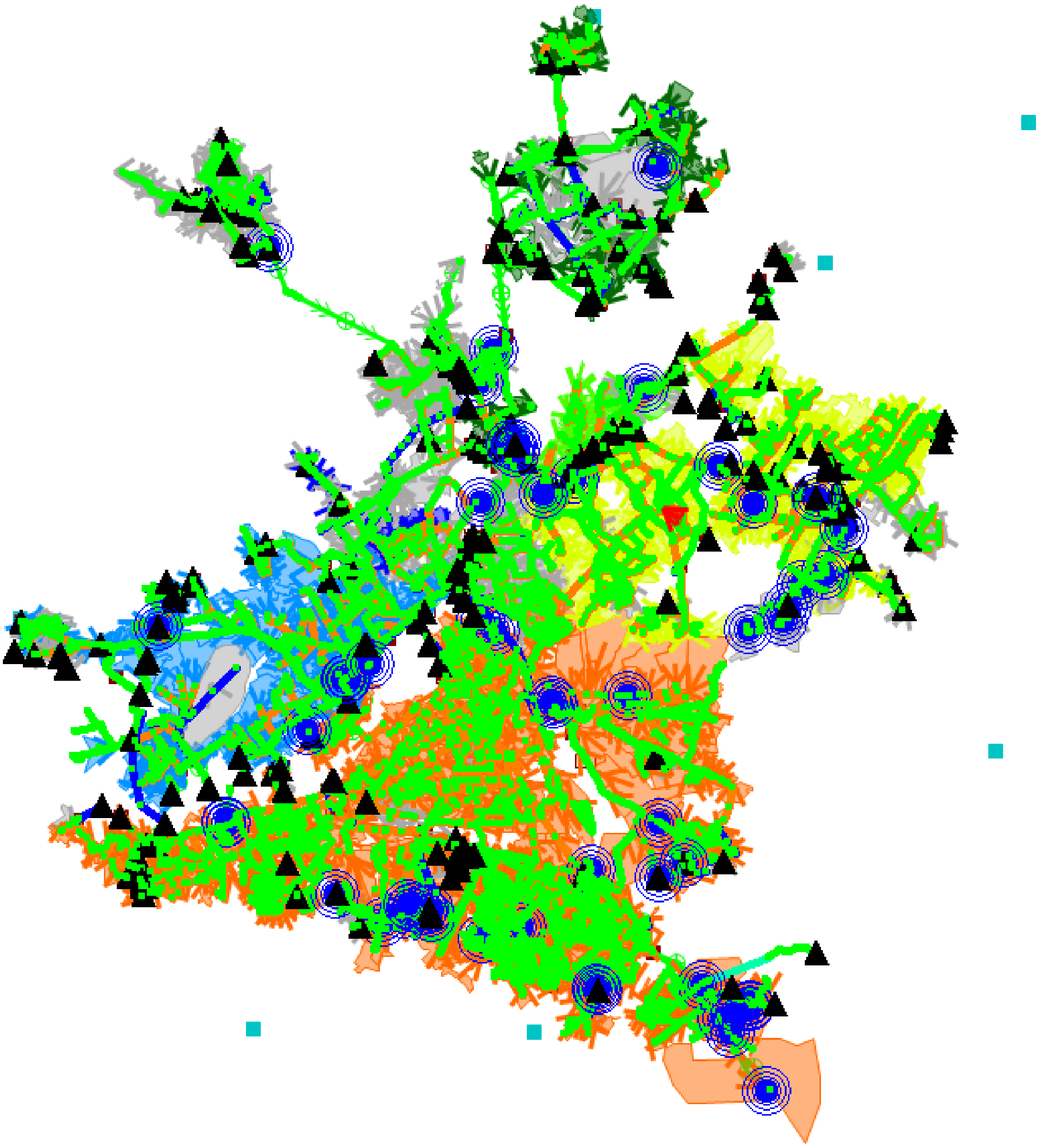


Figure 44 : Plan view of the INFOWORKS model

2.10Current IT Architecture

MEL's services are equipped with several supervision systems allowing real-time communication with the wastewater facilities.

The main supervision system CAURALI (automated control of the Lille sewerage network) ensures the control of 750 facilities (pumping stations, storage basins, measuring points, rain gauges). Each sewerage facility is equipped with a Logic Controller (Schneider), S550 or S4W (Sofrel) or iRIO (napac). The alarms and information detected at the level of the works are sent in real time to 4 Topkapi version 6.1 virtual servers located in a private data center. Two Topkapi applications manage the information feedback with redundancy via several types of communication (MPLS, private APN, PSTN). The supervisors connect to the system via a pool of 4 client stations.

In parallel, each wastewater treatment plant is equipped with a local supervision system that communicates with the main supervision system to provide general operating information (inlet flow, outlet flow, bypass flow). All information is stored in an Oracle database.

The MEL's sewer system and wastewater treatment plant are monitored by separate systems. Some of the data from the treatment plant is sent to CAURALI.

Following figure summarize the overall IT Architecture and situation. AQDV solution will communicate directly to CAURALI servers to get information and transmit instruction (Figure 45).

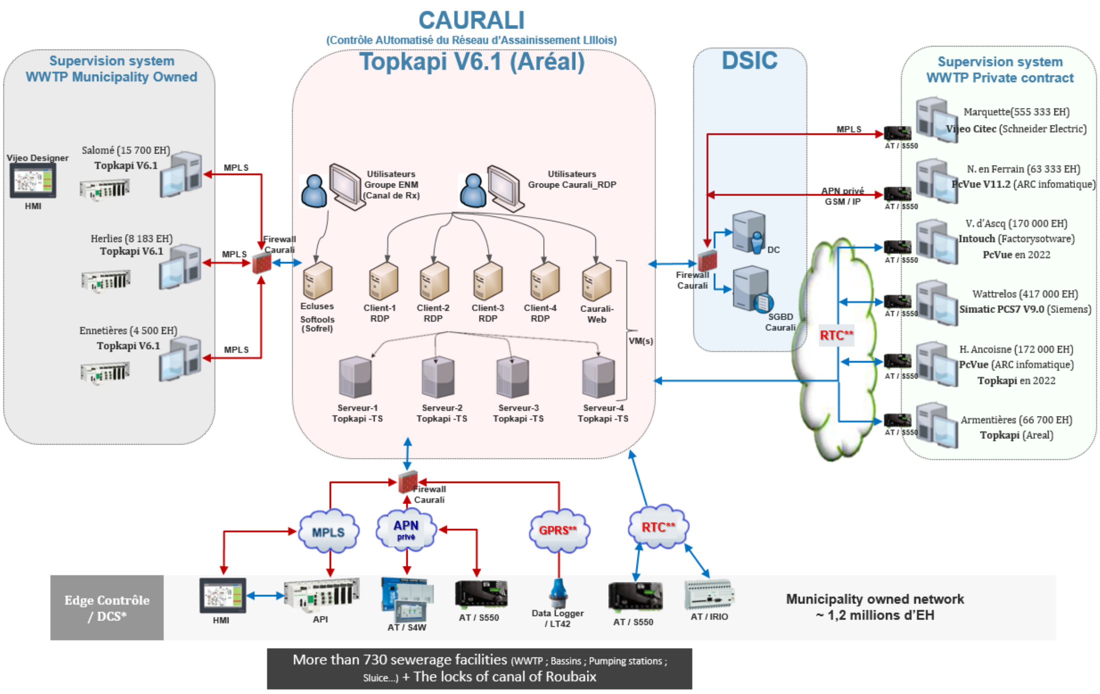


Figure 45 : OT/IT – supervision system of DEA (Water and Sewerage department)

2.11 Control perimeter (What actuators will be controlled)

List of sites with full remote control planned to be included in AQUADVANCED Urban Drainage:

- Bateliers
  - 1 storm water tank
  - 2 pumping stations that take separately the effluents of the East and West branches.
- « Guy Lefort »
  - 1 sector valve

    - 1 storm water tank
    - 3 drain valve
    - 2 sludge pump
    - 3 wastewater pump
    - 3 stormwater pump
- Pumping station « Café des fleurs »
- Pumping statoin « Clos de l'abbaye »

List of sites monitored only planned to be included in AQUADVANCED:

- WWTP Marquette « O Viléo » (upstream and downstream) : Pumping station, upstream screening process, discharged flow
- Sewage network – « Gravitaire 2300 » upstream of WWTP : level monitoring (2 redundant device)
- Overflow « Café des Fleurs » : Level sensor
- Overflow « Thiers » : Level sensor
- Overflow « Pasteur » : Level sensor
- Overflow « Batelier » : Level sensor
- Overflow « Maracci » : Level sensor
- Real time rain gauge (21 spread across 650 km2 of MEL area) 10 localized on the study scope area
- Quality control sensor (to be installed).

3 LIFE RUBIES monitoring strategy

3.1 Quality sensor’s location and installation

3.1.1 For sewer monitoring and control

Effluent flow discharged into the natural environment will be estimated on six sites with turbidity and conductivity sensor. These monitoring stations will allow to calibrate the SWMM-TSS model and monitor CSO discharges pollutant fluxes. One measure will monitor WWTP inflow and the remaining five will be spread across the network:

- Upstream (or downstream) of Thiers/St Hélène/Thiers location
- Upstream (or downstream) of St Hélène/Pasteur location
- Storm overflow « Café des Fleurs »
- Storm overflow – East sewage branch « Batelier »
- Storm overflow – West sewage branch « Maracci »

3.1.1.1 Sainte Hélène/Thiers weir

The downstream sewer (main sewer to WWTP) is equipped with a height-velocity measurement point located downstream the weir's chambre. It is planned to instrument the site in turbidity and conductivity on the upstream sewer line (total flow). The pipe is a 1.9*1.9 m rectangular pipe. On the downstream sewer, there is a restriction of the section after the weir, i.e. the pipe becomes an ovoid T135. It is possible to instrument by probes settled in a tube.

The sampler also fits easily through the manhole. It will be hung at the level of the steps in the access manhole. In dry weather, there is no risk of submersion. The water height is 70 cm. Under storm weather, there is a risk of sewerage surcharge. Eventually, the feasability is validated.

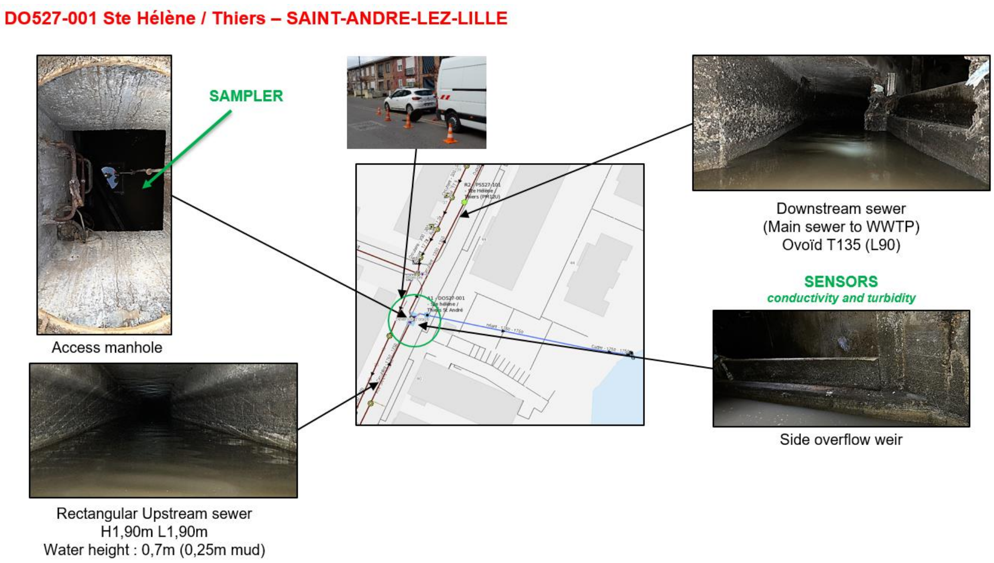


Figure 46 : Sainte Hélène/Thiers monitoring station GIS location and sewer pictures

3.1.1.2 Sainte Hélène/Pasteur weir

There is a monitoring point on the main sewer line, but access is impossible at the moment. A fence prevents access and maintenance of the sensors.

In particular, there is currently a loss of the velocity measurement. The height measurement works nevertheless properly. The access is exiguous at the level of the main sewer pipe in ovoid T135. There is 60 cm of water in dry weather. There is very little space to intervene. The displacement is impossible in the pipe.

The sampler will be installed at the level of the manhole. Access is limited but the possibility of installing the sensors is validated. The sampler once filled (full bottles) will be heavy (about 40 to 50 kg). It can be removed with a winch. Eventually, the feasibility is validated (Figure 47)

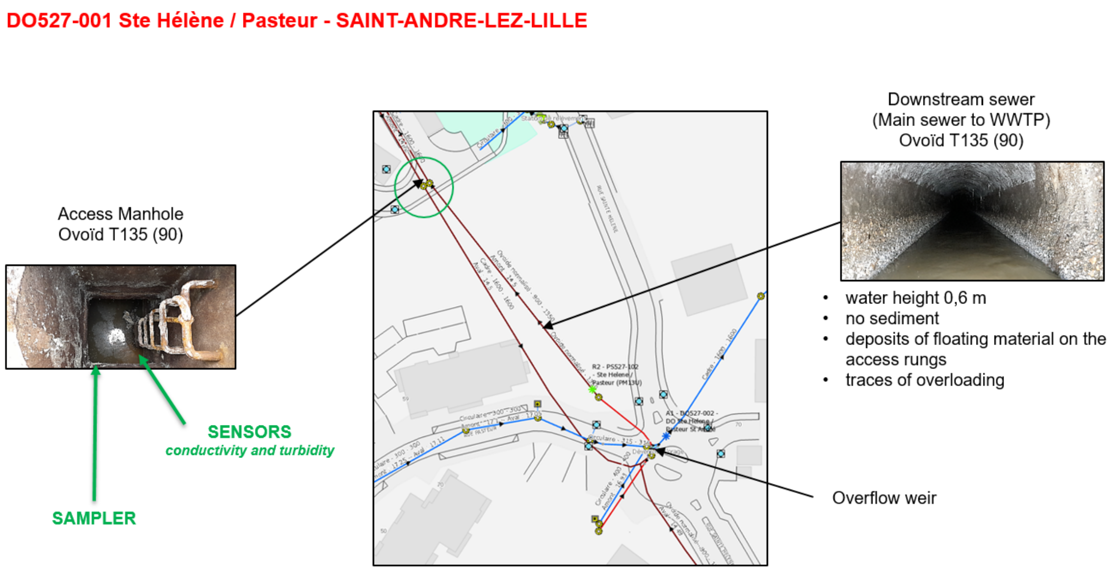


Figure 47 : Sainte Hélène/Pasteur monitoring station GIS location and sewer pictures

3.1.1.3 Café des Fleurs Weir

The weir is accessible through an access manhole. The weir is located in a rather large chamber. The height of the weir is 1.25 m. The main sewer is an ovoid 135 (90). The outfall pipe is an ovoid T270 (180).

The installation of the probes will be done at the level of the weir's crest on the side of the main sewer which is permanently watered (inlet part – main sewer). Specific equipments are required for safe access. Maintenance of the probes is not possible from the surface. Maintenance requires an intervention inside the weir chamber. Eventually, the feasibility is validated (Figure 48).

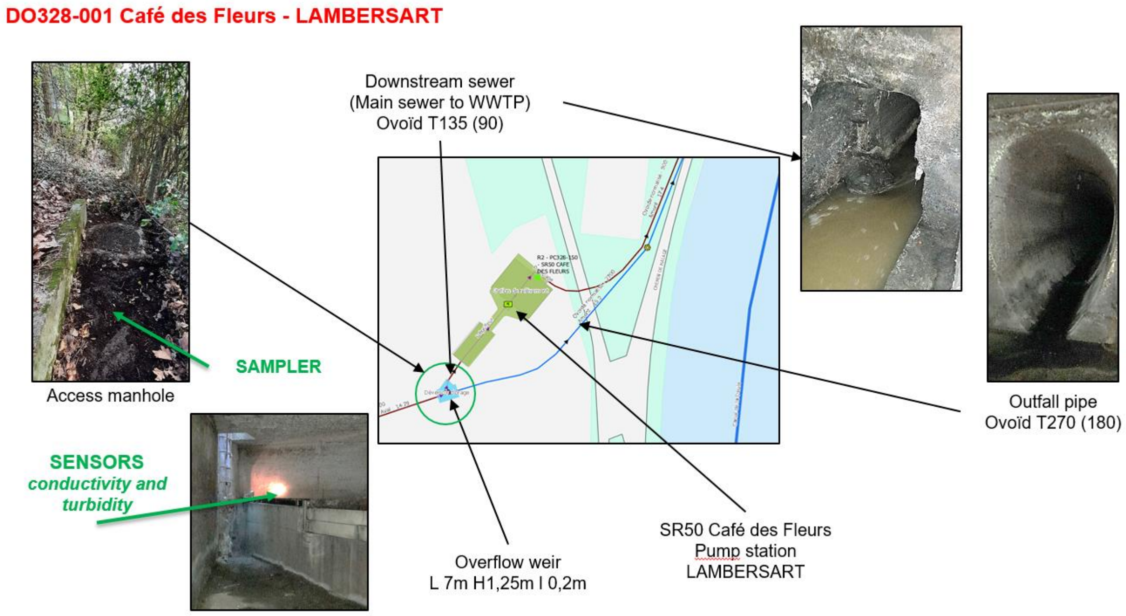


Figure 48 : Café des fleurs monitoring station GIS location and sewer pictures

3.1.1.4 Bateliers weir

There is a manhole that allows access to the overflow weir chamber via manhole steps. The weir chamber is very large (height 3 m). There is a speed height measurement point on the outfall pipe.

It is necessary to equip with conductivity and turbidity sensors the main sewer. A suitable location has been found. The difficulty is the path to the main sewer (7 m walking distance). The sampler can be brought down into the chamber, but the path is difficult. During storm weather, there is a possibility of full surcharge of the chamber. The sampler should be installed in the access manhole at the level of the steps. The descent is compulsory for maintenance.

The instrumentation of an upstream manhole on the main sewer is not possible due to the size of the pipe (5.2 * 3.85 m) and the fact that the manhole is positioned in the middle of the pipe and not on one side. A hinged tube could be considered (fixed on a float arm), but the installation of this type is complicated. The study is to be done. Eventually, the feasibility is validated.

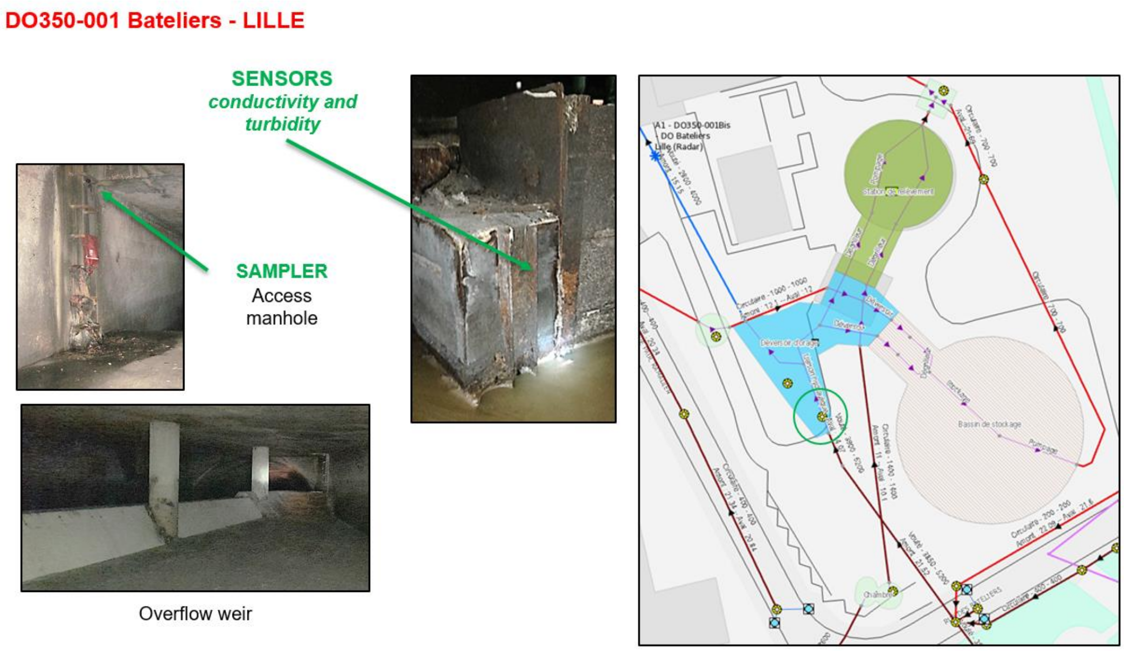


Figure 49 : Bateliers monitoring station GIS location and sewer pictures

3.1.1.5 Maracci weir

The visit was made on two different sites:

- ➢ Site 1: main sewer upstream of the Bateliers site.
- ➢ Site 2: in front of the weir on a manhole on the main sewer.

Site 1:

The visit was made at the level of the main sewer, upstream of the site of the Bateliers. The descent has been made complicated because there are two floors. We arrive on a first grating. In the main sewer the water height is low (7-8 cm), which is a problem to have a good quality measurement. There is a fall and then a departure in the direction of main sewer (circular pipe in Ø500).

The upstream pipe is made of ductile iron, which poses an additional difficulty for the instrumentation. The sampler can be installed outside or on the platform (Figure 50).

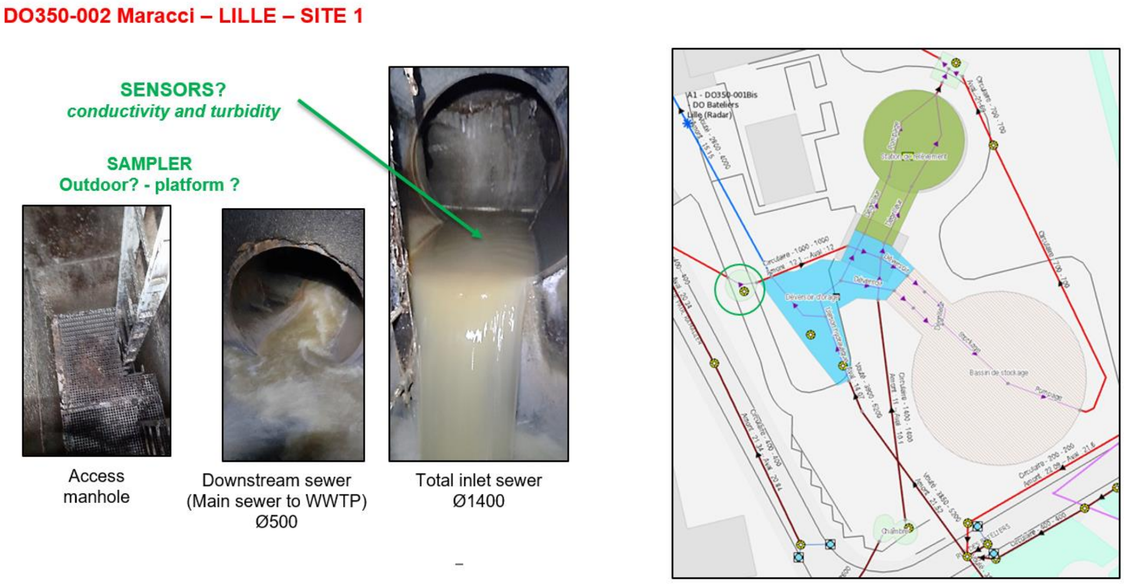


Figure 50 : Maracci's site 1 monitoring station GIS location and sewer pictures

Site 2:

The visit to the weir indicates a complicated intervention and an uncertain feasibility. The access is very exiguous. The sampler can still pass through the manhole. Nevertheless, we wonder about the possibility of installing samplers. We could consider a suspended installation. There is a grease layer at the bottom of the access manhole.

The second site has the advantage of being in line with the measurement site. We should see if we can install a sleeve that would allow us to lower the probes. The feasibility remains to be studied.

It seems that the site 1 is not adapted for the instrumentation. Site 2 is to be preferred but the study should be continued on this site. At this point, further studies need to be carried out (Figure 51).

Figure 51 : Maracci's site 2 monitoring station GIS location and sewer pictures

3.1.2 For river impact assessment

During dry weather measure will be at medium frequency and high frequency in wet weather condition. Three automatic stations with multiparameter probe (O2, pH, T°, turbidity and conductivity) and NH4+ analyzer:

- D1: Reference point upstream
- D2: close view on CSO impact
- D3: wider view on general river quality

Additional manual sampling campaign will take place on these 3 points plus 2 extra on « Canal de Roubaix » upstream and downstream of WWTP (M1, M2) (Figure 52).

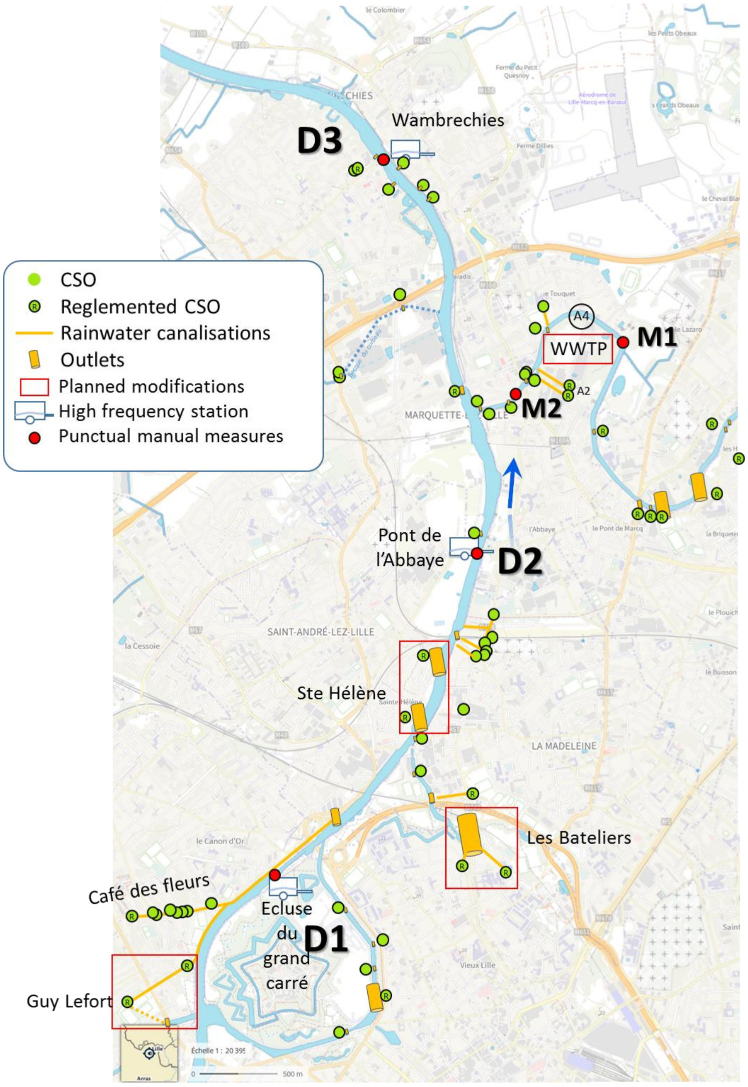


Figure 52 : River monitoring station location

3.2 In sewer quality sensor calibration campaigns

As detailed in deliverable DA1.1, the quality sensor calibration is required to create a mathematic function capable of converting the sensor raw signal into a wastewater quality concentration variable that can be used for control and flux calculation. In order to create this function, water samples will be collected and analyzed while sensor running. The analysis will include: TSS, BOD, COD, TKN, Pt. Then, the relation between sample analysis and raw sensors signal will be built.

The objective is to collect samples both during dry and wet weather conditions so the broadest wastewater quality composition can be captured. In addition, to this objective, it is required to obtain a minimum sample number per site. Thus, the second objective is to collect about 29 wastewater grab samples per site following the methodology detailed in deliverable DA1.1. The figure below describes the methodology to be used for each quality sensor sites (Figure 49).

3.2.1 Sampling protocol for dry weather

24 samples are expected to be collected during two dry weather days at different daytime. A dry weather day requires to have at least three days without rainfall previously the sampling day. It is not necessary that a sampling campaign is performed simultaneously on each monitoring sites.

Small and mobile automatic samplers will be installed as close as possible to the monitoring stations. Samples are taken every hour then, when they are collected, only 12 of them are kept for analysis. It is important to record every datetime of each sample in order to further retrieve the sensor signals at this exact same time. This protocol is repeated twice for each site.

3.2.2 Sampling protocol during wet weather

At least 5 samples are targeted to feed the sensor calibration. In that case, the automatic sampler will be installed the day before a rainfall is forecasted. The automatic sampler will be connected to a level switch and set to trigger the sampling program when the water level rises a level few centimeter above the maximum dray weather day level.

The sampling intervals will be predefined as follow:

- First 5 samples: 3 minutes
- Next 5 samples: 5 minutes
- Next 5 samples: 10 minutes
- Next 5 samples: 20 minutes
- Next 4 samples: 30 minutes

When the operator will collect the bottles, only some of them (minimum 5, but can be more) will be kept for analysis. These bottles will be selected based on the wastewater color aiming at keeping the widest color range.

In the case the automatic samplers cannot be installed in the same manhole as the sensors, a slightly adaptation of the manipulation is needed. It will be necessary that once the samples are in the bottles, the sensors (turbidity and conductivity) are dived into each selected sampled for at least one or two measurement cycles. These datetimes needs to be recorded.

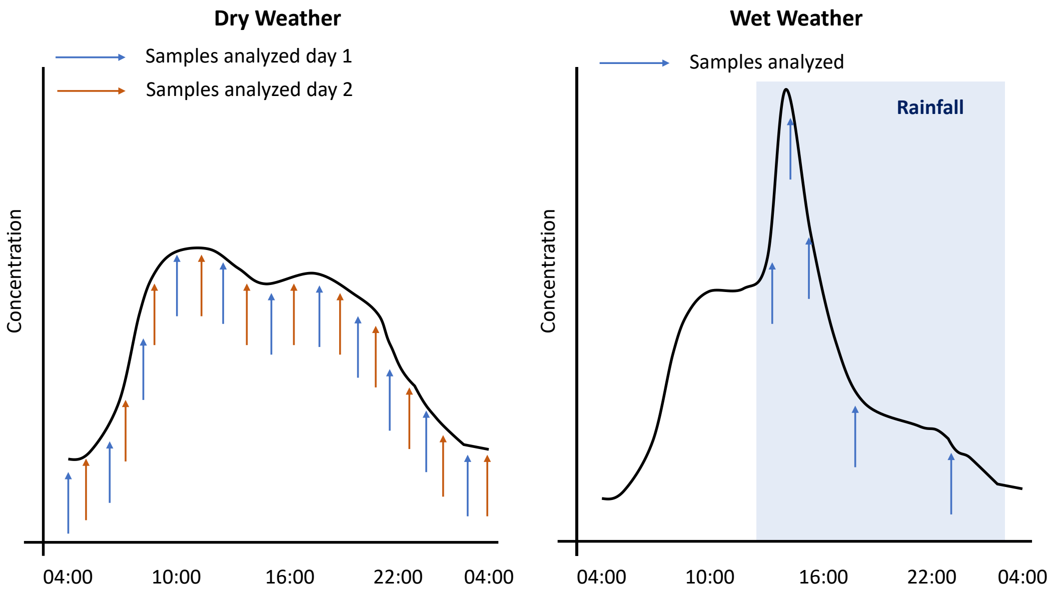


Figure 53 : Sampling strategy for quality sensor in situ calibration

4 Aquadvanced Urban Drainage deployment requirements

AQDV UD is the Suez commercial solution capable of monitoring the whole urban drainage system providing past, current and future vision on the sewer behavior. It will be the basis for LIFE RUBIES solution as it is a well known and experiment solution providing robust features for being able to receive LIFE RUBIES modules and ensuring a safe and efficient deployment.

4.1 LIFE RUBIES IT infrastructure

Following picture summarize the AQDV solution and required general infrastructure (Figure 54).

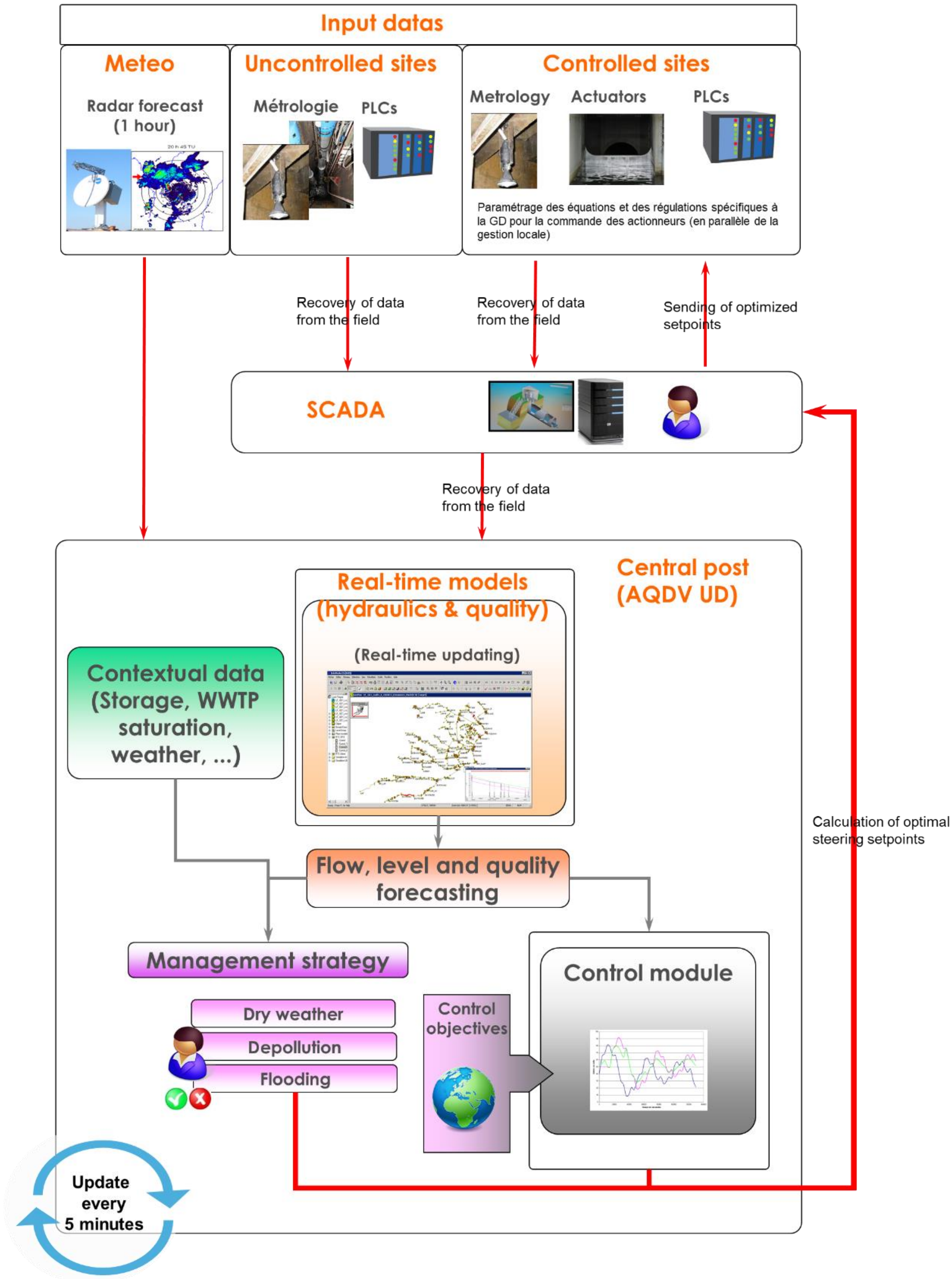


Figure 54 : AQDV UD infrastructure schematic

4.2 Aquadvanced Urban Drainage configuration

The central platform of AQDV UD is built on three main components:

- 1 Database server to record all data and configuration

- 1 “Real-time application” server to run the app
- Different set of client application (HTML5) to configure the system and analyze all the data

The Table 8 summarizes the needed specifications for these two servers. All specifications still need to be approved in the incoming meeting:

Table 8 : AQDV UDF servers’ requirements

	Database server	Application server
CPU	**16 heart**	**16 heart**
RAM	**32 Go**	**32 Go**
OS Hard-Drive	**150 Go**	**150 Go**
Data storage hard drive	**300 Go**	**1 000 Go**

To properly transmit all information from sensors to AQDV, we need to link each of them to one object in AQDV. To do so, an exchange tables system is used: next figure is an extract of one of these table is displayed (Table 9).

Table 9 : Example of a correspondence table of variables between real field sensors and AQDV UD.

BASSIN GUY LEFORT

Variable (mnémonique)	TYPE	Transmission	Commentaires	Contrôle cohérence
MESURES Possibilité pour les niveaux d’avoir l’unité en m simple (retirer «_NGF»)				
B47.C1.NIVEAU_NGF_US1			Hauteur US1 compartiment 1	
B47.C1.M_US1			Défaut US1	
B47.C1.NIVEAU_NGF_SP1			Hauteur Piezo1 compartiment 1	

4.3 Weather data acquisition

The active supervision module of AQDV will compute every five minutes a simulation based on the latest weather, hydraulic and quality data received. Weather data will be provided by MEL:

- From 10 rain gage spread across the study area and directly linked to AQDV
- From Meteo France Radar data for hindcast and forecast (+3h) data on $100km^2$ around MEL with a matrix of $1km^2$ (1km x 1km) (Figure 55).

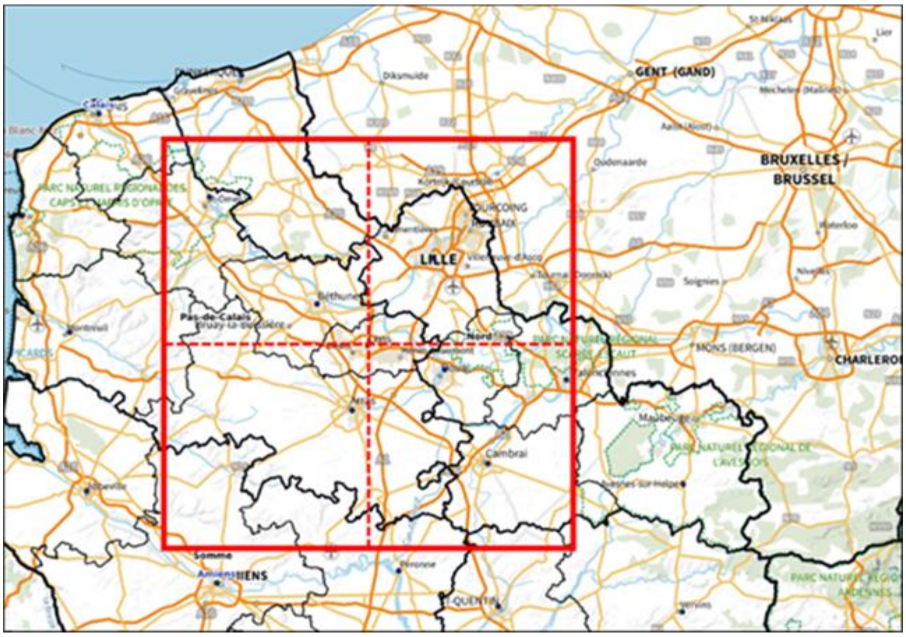


Figure 55 : Radar data area

The range of the radar data has been deliberately shifted to the southwest to anticipate the arrival of the rains. These data will be directly displayed in AQDV Weather view.

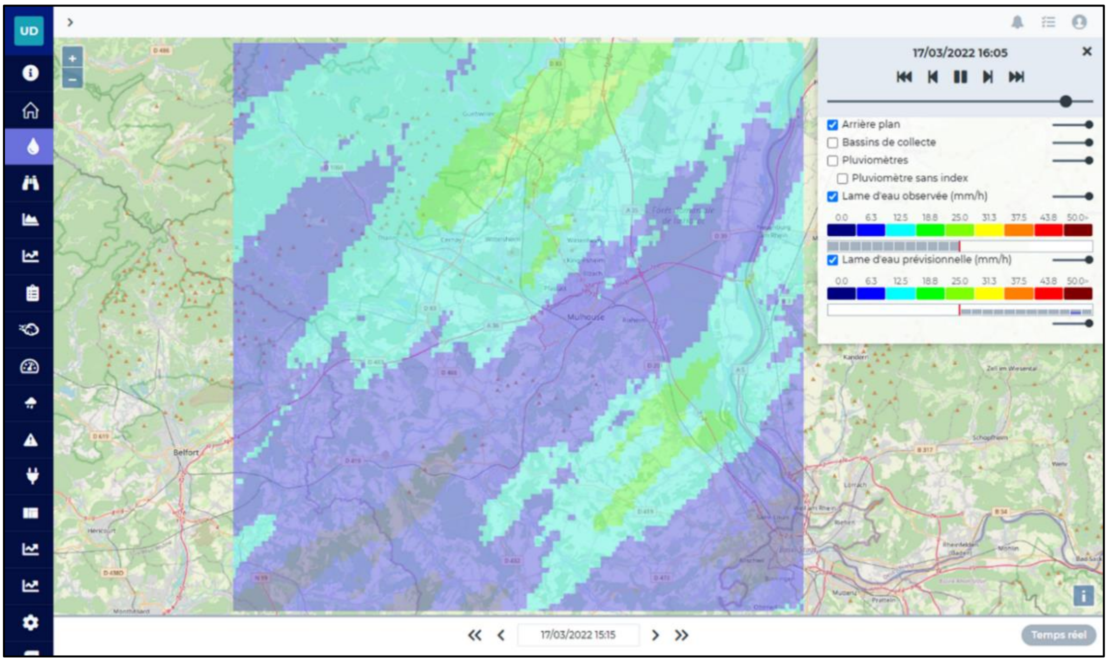


Figure 56 : AQDV UD Weather view screenshot

5 Update/development of models

5.1 Detailed hydraulics model calibration

AQDV solution is based on SWMM as simulation software. Therefore, first step was to translate the Infoworks model to SWMM. All characteristics, patterns, curves, etc. were checked to be sure that they matched previous model and reality (based on GIS and other source).

The provided model is supposed to be already calibrated hydraulically. Second step will be to ensure that the model is a good depiction of the real hydraulic situation by comparing real measures with model results on key point. Depending on these results, a quick calibration on several parameters will be done (active surface for sub catchment, dry weather flow, pattern update). Existing model was not calibrated on quality component, this will be fully treated separately when all sensors will be setup in the incoming month.

5.2 Detailed quality model calibration

To be able to reproduce wastewater quality, the SWMM model will be converted to the SWMM-TSS model format. As explained in deliverable DA1.1, the SWMM-TSS model is an upgraded model library that allows to reproduce the main physical phenomenon that drive the solids in sewers during dry and wet weather.

Once this first step done and once sensors are calibrated thanks to in situ data collected during the sampling campaigns (see section 3.2), these data will be used to calibrate the SWMM-TSS model. The model results will be fitted to various spatio-temporal data leading to a precise model fitting. The data will have different:

- Locations
    - All wastewater quality stations installed for LIFE RUBIES (x5)
    - Entrance and outlet of WWTP
- Frequencies
    - 5 minutes coming from sensors (x5)
    - Daily and yearly, coming from autosurveillance at WWTP entrance and outlet

Different scores will be computed in order to assess the level of fitting reached. These scores will be at least the Nash-Sutcliff criteria and the Root Mean Square Error (RMSE). The calibration phase will aim at optimizing these scores.

5.3 Hydraulics model simplification

To reduce computing time and keep the overall execution loop duration under 5 minutes, hydraulic model was simplified with these generic rules:

- Area that are not upstream of WWTP will be deleted

- Small sub catchment will be merged to reduce the overall number
- Area upstream of north pumping station will be simplified as much as possible (one node one subcatchment)
- All pipes with same characteristics (diameter, material, …) as upstream or downstream pipes will be merged to reduce the number of pipe and calculus
- All pipes with a length inferior to 10 meters will be merged with upstream or downstream pipes with close characteristics (diameter, material, slope…) to reduce continuity error.

5.4 RTC algorithm (MV curve) requirements

The concept of MV curve controller based on the SWMM-TSS model is described in deliverable DA1.1. In order to make the controller working on the real field, it has first to be connected to AQDV UD. The first task will be to make AQDV UD able to run SWMM-TSS and to display results on the web page. Then, AQDV UD will be handling the loop run:

- Simulation for a predefined horizon (example: 3h) every 5 minutes
- Saving hotstart files and results,
- Run the MV Curve controller that is coded in Python
- Send back control rules to be apply in reality to AQDV UD
- AQDV UD to send the control rule to the actuators

The MV curve-based control aims at reducing wastewater pollution spill to the environment rather than volumes. When applying volume-based control, the storage capacity is fulfilled with the first exceeding volume arriving, while when applying pollution-based control, the storage capacity is fulfilled with the most polluted volume. This situation implies that potentially, some early rainfall exceeding volume could be spilled to the environment assuming that the following volume to come are more polluted. As consequences, in case of bad rainfall prediction, there is a risk that the water to come is finally not being true.

6 LIFE RUBIES solution deployment schedule

The deployment schedule of LIFE RUBIES is structured in three main steps ensuring first a safety activation of the LIFE RUBIES solution but also to get the required results for assessing the performances of each module (Figure 53).

Year 1	**Without AQDV UD** Baseline
Year 2	**With AQDV UD hydraulics based** – LIFE RUBIES Hydraulics
Year 3	**With AQDV UD hydraulics based** – LIFE RUBIES Quality

Figure 57 : Macro schedule of LIFE RUBIES demonstration and deployment

A detailed schedule is available in appendix.

6.1 Baseline, without AQDV UD

All basic requirement to deploy AQDV will be done by the end of the first year:

- Assessment of the overall hydraulic and quality situation,
- Scope definition targeted on key point issue,
- Investigation of all existing assets (basin, sensor, supervision) within the GD scope
- Adaptation of network model and integration of real time analysis module
- Metrology:
    - Setup of 5 quality sensor for network
    - Setup of 3 quality sensor for waterbodies
    - Sensor and model calibration

6.2 Offline test on virtual environment

Each site will have its function analyzed and summarized in a sheet to prepare dynamic management.

AQDV first configuration will take place during first semester of 2023. All variables, exchange table and quality algorithm will be integrated in the tool and specific view will be created.

Several strategies will be proposed based on the network and site analysis and will be triggered by numerous variable (weather conditions, WWTP saturation, water level …). These are a couple of general examples of strategies triggers and settings:

- Dry weather mode:
  - Conditions: No rain forecasted on radar and during past hour
  - General settings: Pump at usual settings, storm storage empty, 0 overflow and discharge to river
- Wet weather anticipation:
  - Conditions: Rain forecasted on radar
  - General settings: Pump start level lowered to increase buffer storage capacity, 0 overflow and discharge to river
- Wet weather mode – low intensity:
  - Conditions: rain during past hour
  - General settings: Pump at maximum capacities, gate to storm storage open, 0 overflow and discharge to river
- Wet weather mode – high intensity:
  - Conditions: heavy rain during past hour, storm storage full or WWTP at full capacity
  - General settings: reduced pump flow, discharge to river allowed, 0 overflow
- Flood mode:
  - Conditions: critical high level in network, storage full
  - General settings: maximum discharge to river to avoid overflow in high density area, modulated pump flow and gate setting to divert water to low density area or poor river quality

All these strategies will be tested offline to ensure a smooth transition when the dynamic control will be put online.

6.3 LIFE RUBIES Hydraulics - AQDV UD using hydraulics-based control

Deployment of AQDV for dynamic management will take place during second semester of 2023.

The main goal of the dynamic management based on hydraulics is to solicit the maximum storage capacities before discharging into the natural environment.

For that, the dynamic management is based on 3 main strategies which are:

- Dry weather, allowing to ensure a normal functioning of the equipments, by keeping all the effluents in the network.
- Depollution, which allows the maximum use of the available storage facilities
- Flooding, which is activated when weather and hydraulic conditions are unfavorable in order to protect the population

For instance, for Café des fleurs Pumping station:

- Wet Weather anticipation settings:
  - Start level lowered from 1.6 to 1.0m, only one pump.
  - Test: Dry weather period + small rain event
- Wet weather mode – low intensity settings:
  - Start level lowered from 1.6 to 1.0m, simultaneous pumping
  - Test: Dry weather period + average rain event

After a couple of rain event, some analysis will take place to verify the relevance of each strategy and adjust settings.

6.4 LIFE RUBBIES quality - AQDV UD using quality-based control

After several hydraulics test and once all qualities sensor and measurement campaign done, AQDV will be updated to include quality-based rules in the different strategies. Again, several test and calibration over observed event will be hold. This step is expected to be complete in 2024.

6.5 Potential delays and updated schedule (May 2022)

Several internal and external factor may impact the initial scheduled and delay some action. Following figures represent for each component of the French pilot the new expected timeline:

- Actions in black are done and were not delayed.
- Actions in orange are expected to be delayed without consequence on deliverable date.
- Actions in blue are on track and already began.
- Actions in green are not started yet and still schedule at the initial date.

Few actions were delayed with small or no impact on the overall timeline and none on delivery final deadline.

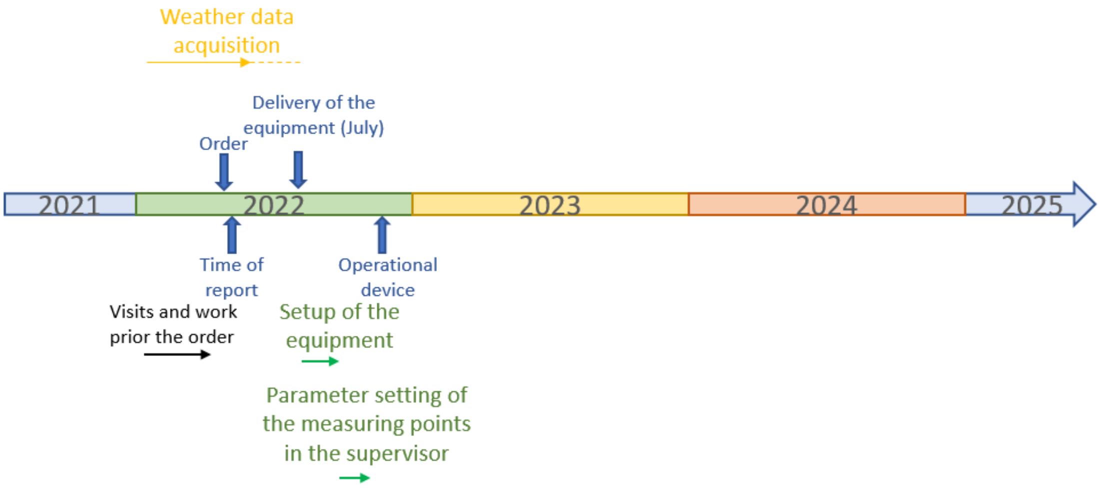


Figure 58 : Coming action and risks of delays for pilot data availability

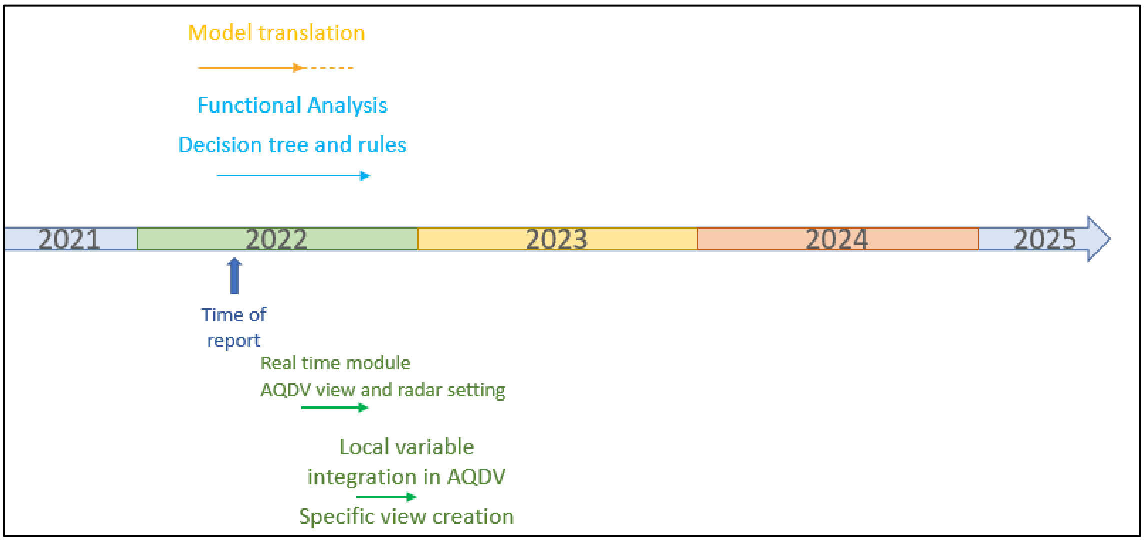


Figure 59 : Coming action and risks of delays for AQDV UD platform deployment

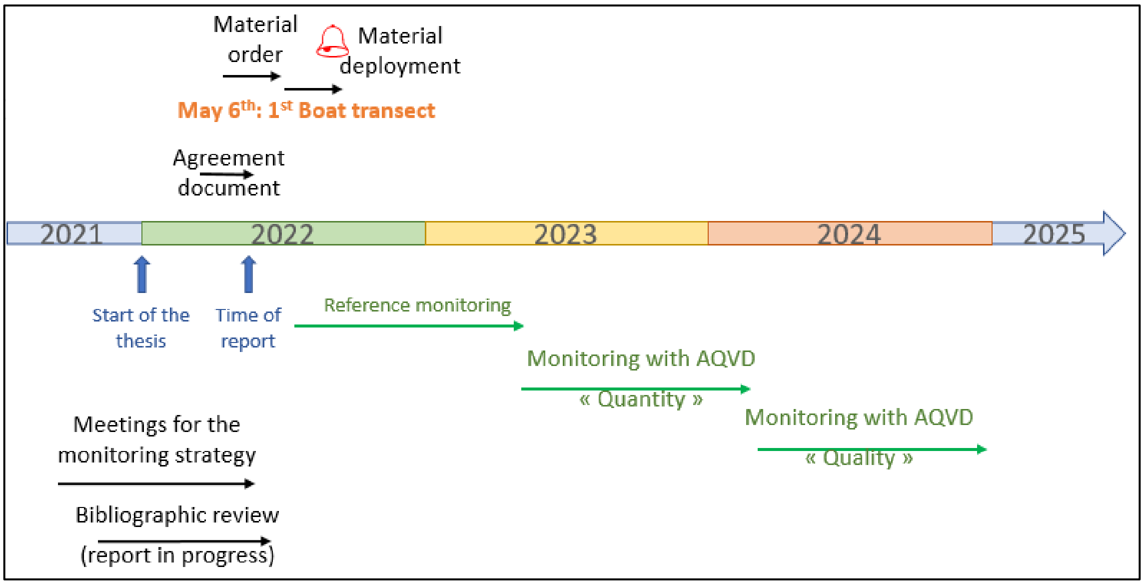


Figure 60 : Coming action and risks of delays for the environmental impact assessment strategy

7 Planification of environmental impact assessment

The environmental impact assessment will be executed in two different and complementary ways. The first approach consists in assessing what the wastewater urban system emits to the environment in terms of wastewater volumes and pollutant fluxes. It is the simplest (even if already very difficult to address) approach as it requires to monitor system emission only. The second approach consists in monitoring the natural body (Deûle river here) and following some indicators and trying to identify the improvement that can be linked to the LIFE RUBIES solution. It is the most difficult approach as the natural body can be influenced by many other phenomena such as: agricultural spillages, natural river hydrogeomorphology, maritime traffic…

7.1 Emission based environmental impact assessment

The first level of environmental impact assessment will be performed from an emission point of view, i.e. using the quality monitoring stations installed at the CSO infrastructures. The sensors' signals will be converted into pollutant concentrations following the methodology detailed in DA1.1 for TSS, COD, BOD, NTK and TP. The concentrations will be converted into fluxes and masses by multiplying the concentrations by the flowrates monitored at the same location. In order to validate and verify this computation, the monitored fluxes will be faced to the model solid transport results.

As the SWMM-TSS model will be calibrated in detail on hydraulics and quality, the fluxes calculation computed at each CSO will be compared to observed fluxes provided by the monitoring stations. Thus, a data validation will be performed by redundancy aiming at providing a high level of result reliability.

This emission based environmental impact assessment will be computed three times, at each project deployment steps (see previous Figure). CSO pollutant fluxes without LIFE RUBIES (step 1), with LIFE RUBIES based on hydraulics (step 2) and with LIFE RUBIES based on quality (step 3).

It is obvious that comparison results from one year to the other will a tedious task as the meteorological condition will be varying importantly, so the CSO fluxes will. Thus, to make results comparable from one year to the other, a specific methodology based on a kind of meteorology based normalization will be developed and applied.

7.2 Imission based environmental impact assessment

The sites of smart monitoring of the networks and the WWTP of Marquette are located between the Citadelle in the south and the confluence Marque-Deûle in the north (Figure 54). 5 fixed stations were chosen for the environmental monitoring. The upstream station called reference (D1) was chosen at the level of the lock of Grand Carré (belonging to Voies Navigables de France, VNF) because it is a protected zone and supplied with electric power for our needs. The downstream station (D3) is located in Wambrechies, in a small protected station of VNF. An intermediate station (D2) has been added to the initial project because it is located downstream close to all the storm water overflows (DO) controlled by AQUADVANCED but upstream from the WWTP and the confluence with the Marque. This point is thus strategic to detect in the very short time possible discharges in the Deûle. This D2 station at Pont de l'Abbaye belongs to the MEL.

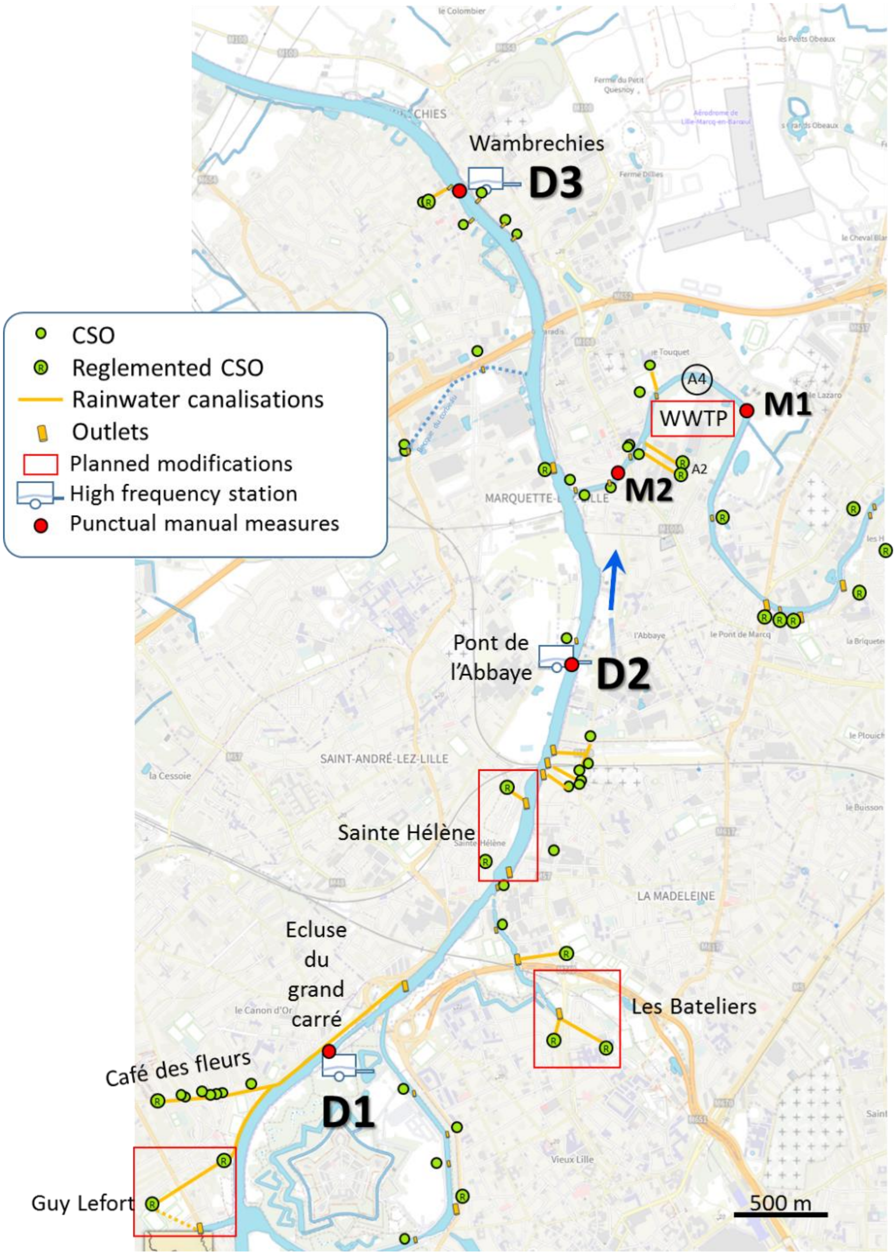


Figure 61 : Study site with the predicted instrumentation locations

One of the difficulties of this study site is the presence of the Marque River, a small contaminated river, into which the treated effluents of the Marquette WWTP are discharged, as well as the effluents treated by the "rainy weather" line or not treated because of malfunction or overflow. As the operation of the WWTP will be optimized and the flows of pollutants arriving at the WWTP will also be modified thanks to the AQUADVANCED system, it was necessary to add two measuring stations on the Marque River, one upstream of the WWTP (M1) and one downstream of the discharges of the WWTP (M2). These two stations will however be equipped differently because no shelter with electrical power is available and budgets are limited.

The overall idea of this environmental monitoring is, on the one hand, to have a sort of baseline of the quality of the watercourse in dry weather and, on the other hand, to target more specifically a certain number of rainy periods, periods when spills will be more likely, with consequent impacts on the quality of the environment. In the initial project, 2022 was to serve as a monitoring year before the implementation of the AQUADVANCED system in terms of quantity. The year 2023 was to be used to evaluate the effectiveness of this system and then in 2024, the evaluation was to focus on the management by considering the quality of wastewater in the networks. However, we recently learned that a large-scale dredging operation was to take place in 2022 on the Deûle canal along our study site (between Don and Le Quesnoy). It is indeed a hard work for VNF to recalibrate the canal within the framework of the Seine-Nord Europe canal to accommodate barges of 3000 tons. Our schedule will remain the same, but the data will have to be processed considering this work.

7.3 High frequency measurements and controlled sampling

Stations D1, D2 and D3 will be instrumented with high frequency (HF) equipments. Each station will have a multiparameter probe (O2, pH, T, turbidity and conductivity) and an analyser for ammonium measurement (Table 10). The probe measurements will be performed every 10 minutes while the analyser measurements will be less frequent (about one per hour) but this frequency can be increased during rainy weather (Table 11). Real-time data to the flow measurements in the DOs would be very useful to control the HF stations and make them automatically switch to "rainy weather" mode as soon as a spill is recorded.

Table 10 : Summary of the types of instrumentation planned for high frequency monitoring.

Station	Multiparameter probe	Ammonium analyser	Automatic refrigerated sampler	Sampler with filters
D1	**Exo 2 (Ysi)**	**Metrohm**	**-**	
D2	**Manta (Eureka)**	**Metrohm**	**Hach Lange**	**Prototype 1**
D3	**Exo 2 (Ysi)**	**Metrohm**	**-**	**Prototype 2**

Table 11 : Summary of the time steps planned for the measurements and samplings in D1, D2 and D3 according to the "dry weather" and "wet weather" periods

	Period (min)	
Instrumentation type	Dry weather	Wet weather
Multiparameter probe	**10**	**10**
Ammonium analyser	**120**	**10**
Automatic refrigerated sampler	**As required**	**As required**
Sampler with filters	**Omptimised sampling (~1/week)**	**Omptimised sampling (~1/h)**

This equipment must be protected. In D1, a shelter will be purchased and deployed with agreement with VNF. In D2, the mobile laboratory of LASIRE will be installed on a site of the MEL but will require an agreement of lodging and some minor installations. In D3, the fixed station of VNF will be used as shelter.

At stations D2 and D3, two prototype non-refrigerated samplers will be installed. Sampling will be triggered when the multiparameter probes measure values that are outside the "steady state". This decision making is driven by an algorithm developed in the thesis of Mr. Jeremy Mougin (Mougin et al., submitted). As the water samples are of the order of 20 mL, ICP-AES and ICP-MS analyses will be performed at LASIRE to obtain a global view of the inorganic composition of the water. In addition to the major elements (K, Na, Ca, Mg, Sr), trace elements will be analyzed: P, Ba, Ce, V, Cr, Mn, Fe, Co, Ni, Cu, Pb, Zn, Pt, Gd, Nd, Dy, B, Rb, U. The contents of several anions will also be measured by anion chromatography: Cl-, SO42-, NO3- and if possible PO43-. Most of these elements are used as tracers of anthropic activities; others, like uranium, are more prospective. Neodymium and dysprosium are used to normalize the possible but probable gadolinium anomaly (Bau et al., 2018). The refrigerated sampler will be present in the mobile laboratory as needed for large volume (1-2 L) unfiltered samples at D2. In particular, it should be used for calibration of passive samplers for drug substances (see section 1.2).

7.4 One-off and integrative measurement campaigns

In addition to the HF instruments, passive samplers (PS) POCIS or Chemcatcher and DGT will be deployed in D1, D2, D3, M1 and M2 during these different campaigns.

These campaigns aim to work simultaneously on the 5 measuring stations, targeting in particular rainy weather. During the project, 1 "dry weather" campaign is planned per year and about 4 for the "rainy weather" campaigns. The information obtained during the "dry weather" campaigns will constitute our baseline. Particular attention will be paid to the "rainy weather" periods. It will be necessary to carry out these follow-ups before and after the deployment of the AQUADVANCED solution. This monitoring must therefore start as soon as possible. The objective in terms of planning is to deploy all the stations by May 2022.

The passive samplers (PS) deployed will be:

- DGT for Diffusive Gradients in Thin-films: tools for in situ collection of "labile" metals (deployments and analyses performed in triplicate). Zinc, copper and lead will be targeted in priority. LASIRE is equipped for trace element analysis.

- Chemcatcher or POCIS for Polar Organic Chemical Integrative Sampler: tool allowing the in situ collection of polar organic micropollutants (deployments and analyses performed in triplicate). Drugs will be targeted in priority (Table 12); discussions are underway with the CHU for the analysis of various substances, as LASIRE is not equipped for this type of analysis. For these PSs in particular, the response is a function of several parameters of the water mass and in particular of the flow velocity of the water. A calibration is thus to be envisaged by arranging PS at the level of station D2 during several days and in parallel, by carrying out a continuous water sampling using the automatic sampler. This experimentation will allow us to calculate the sampling rate of the samplers for each of the considered substances

Table 12 : provisional list of drug substances being considered for environmental monitoring with PS. Abbreviations: PES: Polyether Sulphone; HLB: Hydrophilic Lipophilic Balance; SPE: Solid Phase Extraction; SDB-RPS:Styrenedivinylbenzene-reverse phase sulfonated

	Chemcatcher						POCIS			
Reference	Petrie et al., 2016	Moschet et al., 2015	Vermeirssen et al., 2012	Vermeirssen et al., 2009			Criquet et al., 2017	Morin et al., 2013	Morin et al., 2012	Vermeirssen et al., 2012
Diffusif membrane/Sorbent	PES/HLB	PES/SDB	PES/SDB-RPS	SDB-XC	SDB-RPS	PES/RPS	PES/SPE	PES/HLB Oasis		PES/SDB-RPS
Atenolol	0.034	0.01						0.025		
Azithromycin	0.024								0.06	
Caffeine	0.037		0.039				0.15			0.167
Carbamazepine	0.045	0.1	0.098				0.40	0.188		0.301
Clarithromycin	0.024	0.05							0.668	
Diclofenac	0.044	0.06	0.05	0.22	0.18	0.08	0.17	0.225		0.047
Erythromycin									0.0163	
Methamphetamine										
Odesmethylvenlafaxine										
Sulfamethoxazole	0.058			0.08	0.14	0.09		0.03		
Naproxen		0.07						0.084		
Metformin		0.004								
fluconazole		0.09								
Gabapentin		0.005								
hydrochlorothiazide		0.05								
indomethacin		0.07								
Lamotrigine		0.07								
Levamisole		0.1								
Lévétiracetam		0.02								
Lidocaine		0.09								
mefenamic acid		0.06								
N4-acetyl-		0,03								
O-devenlafaxine		0.009								
Phenazone		0.08								

Spot and manual sampling is also considered to complete the measurements obtained by the PSs during their deployment and removal. Analysis of the elements and species listed in section 1.1 will then be systematically performed at LASIRE.

Note: The "rainy weather" periods are not necessarily obvious to foresee when planing the installation of more consequent instrumentation in the field (PS). It would be important to have, in addition to the flows in the DOs, an initial diagnosis 24-48 hours in advance via the Meteofrance data to prepare, then to have a confirmation a few hours before. The MEL must inquire with Météofrance to know if the LASIRE could have access to the data or if the MEL will have to transfer the "rain" alerts to the LASIRE by email or SMS. Afterwards, the AQUADVANCED system will be able to take over.

7.5 Logitudinal profiles

Within the framework of this study, 5 fixed stations were selected but it seems important to us to carry out several longitudinal profiles on the Deûle to take note of the heterogeneity of the water mass. To do this, we plan to carry out boat trips (with the help of VNF) in dry weather and in rainy weather using a multiparameter probe to map the entire section at a depth of about 50 cm. Indeed, the regular passage of barges is not conducive to water stratification over a depth of a few meters. The section is about 5.6 km long. During these campaigns, if certain parameters evolve significantly, water samples will be taken to measure the same parameters as those of the punctual and integrative campaigns. The planned route, in discussion with VNF (which will graciously provide a barge with pilot) should be as follows: from station D3, upstream along the left bank to the lock (downstream from D1). Then descent towards D3 in zigzag in order to square the whole section of the Deûle studied. It is planned to draw edges with a spacing of approximately 500 m. It would also be interesting to carry out measurements until D1 to apprehend the effect of the lock effect. The number of campaigns is not fixed but we are orienting ourselves towards 2-3 campaigns the first year to include dry and rainy times. This will be repeated the following years if it seems necessary. The first campaign will take place in April-May 2022.

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ANNEXE

		Actions	Livrables	déc-21	janv-22	févr-22	mars-22	avr-22	mai-22	juin-22	juil-22	août-22	sept-22	oct-22	nov-22	déc-22	janv-23	févr-23	mars-23	avr-23	mai-23
				DA1.1		DA1.3					DC1.1	DD1.4	DB1.1 DB4.1 DE1.3								DB4.2
ANNEE 1 (2022): Documents généraux de lancement du projet Mise en place de l'application et de l'acquisition des données Mise en place de la métrologie complémentaire Specs de l'intégration des algos qualité dans AQDV	**Préparation**	Réunion de démarrage																			
		Supports de communication du projet (acec Clément RITTER)	DD1.1 – Logo and templates : 01/12/2021/ Referent : LYRE DD1.2 – Communication Plan: 01/12/2021/ Referent : LYRE DD1.3 – Promotional leaflet : 01/03/2022 / Referent : LYRE		LYRE	LYRE	LYRE														
		Documents administratifs de démarrage	DE1.1 – Project management Manual : 01/01/2022/ Referent : 3S DE1.2 – Guidelines for green procurement and EU Ecolabel products priorisation : 01/01/2022/ Referent : 3S		3S	TERMINE															
	Déploiement AQDV	Mise à disposition des données d'entrée (plans, modèle de base, extrac Topkapi, etc)	DA1.1 – Report defining the integration scope of the solution to be demonstrated - 01/12/2021 - LYRE DA1.3 – Report for French pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE DA1.2 – Report for Spanish pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE DB4.1 – French pilot deployment of instrumentation and AQDV UD environment - 01/09/2022 --> template à mettre sur SHP / Referent : Thibaud DB3.1 : Report on the spanish pilot deployment of instrumentation and AQDV UD environment : 01/09/2022 / Referent : AQUATEC	MEL	MEL	MEL															
		Achat/Installation des serveurs + Mise en place d'accès à distance						MEL	MEL	MEL											
		Fourniture du DAT					3S														
		Ouverture des flux et accès privilégiés 3S								MEL/3S											
		Installation de l'application AQDV									3S	3S									
		Création du synoptique en version 0						3S													
	Modèle Temps réel + Données Radar	Achat des données RADAR et mise à disposition	DB4.1 – French pilot deployment of instrumentation and AQDV UD environment - 01/09/2022 DB3.1 : Report on the spanish pilot deployment of instrumentation and AQDV UD environment : 01/09/2022 / Referent : AQUATEC			MEL	MEL	MEL	MEL	MEL	MEL	MEL					MEL	MEL			
		Connexion aux données données radar et configuration de la vue										3S	3S					3S	3S		
		Mise à disposition du modèle hydraulique existant		MEL																	
		Conversion du modèle ICM to SWMM			3S	3S	3S														
		Intégration du modèle Temps réels										3S	3S								
	Métrologie	Définition de la localisation 5 capteurs qualités réseaux	DA1.3 – Report for French pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE DA1.2 – Report for Spanish pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE		MEL/LYRE/3S	MEL/LYRE/3S	MEL/LYRE/3S														
		Mise en place pérenne des 5 capteurs qualités réseaux	DB4.1 – French pilot deployment of instrumentation and AQDV UD environment - 01/09/2022 DB3.1 – Report on the spanish				MEL	MEL	MEL	MEL	MEL	MEL	MEL								
		Mise à disposition des données qualités réseaux dans CAURALI1											MEL	MEL							
		Calibration/pseudo-étalonnage des sondes qualités								LYRE/MEL	LYRE/MEL	LYRE/MEL	LYRE/MEL	LYRE/MEL							
		Définition de la localisation 3 capteurs qualités Mlieu Naturel	DA1.3 – Report for French pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE DA1.2 – Report for Spanish pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE	ULille	ULille	ULille															
		Mise en place pérenne des 3 capteurs qualités Milieu Naturel	DB4.1 – French pilot deployment of instrumentation and AQDV UD environment - 01/09/2022 DB3.1 : Report on the spanish pilot deployment of instrumentation and AQDV UD environment : 01/09/2022 / Referent : AQUATEC				ULille	ULille	ULille												
		Mise à disposition des prévisions météo par MEL pour Ulille (accès météo + ?) + possibilité de consulter en tps réel certains niveaux liés à des DO via Topkapi ? (une hauteur à St Helene et une hauteur à Batelier) et/ou param d'une alerte SMS/mail sur seuils							MEL												
		Réalisation des campagnes qualité milieu naturel + récup des mesures à partir de l'année 1 (dont profil en long réalisé VNF sur barge qualité)							ULille	ULille	ULille	ULille	ULille								
	Configuration initiale AQDV	Mise à disposition des tables d'échanges sites contrôlés et non contrôlés - variables locales	DB4.2 – French pilot virtual tests - 01/05/2023 DB3.2 – Spanish pilot virtual tests report : 01/05/2023 / Referent : Aquatec					MEL/3S	MEL/3S												
		Intégration des variables dans AQDV - Variables locales											3S	3S							
		Création des vues spécifiques												3S	3S	3S					
	Intégrations algos qualité	Specifications pour préparer les développement des algo qualités --> Atelier à lancer avec LYRE	DB1.1 - Report with LIFE-RUBIES modelling and RTC methodologies description - 01/09/2022 DB2.1 – Report on the integration of LIFE EFFIDRAIN methods modelling and forecasting modules in AQDV - 01/12/2022			LYRE/Ulille/CETA	LYRE CETA	LYRE CETA	LYRE CETA	LYRE CETA	LYRE CETA	LYRE CETA	WAYO/LYRE + WAYO/CETA	WAYO/LYRE + WAYO/CETA	WAYO/LYRE + WAYO/CETA	WAYO/LYRE + WAYO/CETA					
	Synthèse Année 1	DC1.1 – KPI Webtool update and pro gress report of Life performance indicators, including socioeconomic impact : 07/2022 / Referent : 3S => à faire avec des gens qui ont participé à l'offre	DC1.1 - 01/07/2022 - 3S							3S/WAYO/LYRE	3S/WAYO/LYRE										
		DD1.4 - Notice Board --> contenu ?	DD1.4 - 01/08/2022								LYRE	LYRE									
		<u>Progress report --> template ?</u>	DE1.3: Progress Report - 01/09/2022							MEL/LYRE/3S	MEL/LYRE/3S	MEL/LYRE/3S	MEL/LYRE/3S								

		Actions	Livrables	déc-21	janv-22	févr-22	mars-22	avr-22	mai-22	juin-22	juil-22	août-22	sept-22	oct-22	nov-22	déc-22	janv-23	févr-23	mars-23	avr-23	mai-23	juin-23	juil-23	août-23	sept-23	oct-23	nov-23	déc-23
				DA1.1		DA1.3					DC1.1	DD1.4	DB1.1 DB4.1 DE1.3								DB4.2							DE1.4
ANNEE 2 (2023) : Mise en pace du pilotage hydraulique V0 Intégration des algorithmes pour le pilotage par la qualité	**Déploiement Gestion Dynamique par l'hydraulique**	Intégration de la qualité dans AQDV : Algos LYRE + Algos Cetaqua/CSIC à intégrer dans AQDV (MPC Curve)	DB2.2 – Report defining software and communication architecture for IT infrastructure deployment - 01/02/2023														WAYO/AQUATEC	WAYO/AQUATEC	WAYO/AQUATEC	WAYO/AQUATEC								
		Rédaction des Anayse Fonctionnelle (sur les sites du périmètre contrôlé) et préparation GD :					3S	3S	3S	3S	3S	3S	3S	3S	3S	3S	3S											
		Création des schémas d'instrumentation GD - BO Bateliers + BO Guy Lefort + PR Abbaye	DA1.3 – Report for French pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE				3S	3S	3S	3S	3S																	
		Proposition V0 des arbres de décisions et des concepts de pilotage	DA1.2 – Report for Spanish pilot configuration definition, requirements and preparation - 01/02/2022 - LYRE								3S																	
		Validation V0 des arbres de décisions et des concepts de pilotage	DB4.1 – French pilot deployment of instrumentation and AQDV UD environment - 01/09/2022									3S																
		Intégration du module pilotage V0 dans AQDV										3S	3S															
		Configuration des ouvrages GD	DB3.1 : Report on the spanish pilot deployment of									3S	3S															
		Implémentation de la Gestion Dynamique dans les sites locaux :												MEL	MEL	MEL	MEL	MEL										
		Programmation dans la supervision												MEL	MEL	MEL	MEL	MEL										
		Adaptation des automates de la couche GD	DB4.2 – French pilot virtual tests - 01/05/2023											MEL	MEL	MEL	MEL	MEL										
		Tests de contrôle cohérence (échanges des variables)	DB3.2 – Spanish pilot virtual tests report : 01/05/2023 / Referent : Aquatec																MEL/3S	MEL/3S								
		Tests unitaires																		MEL/3S	MEL/3S							
		Mise en observation : Essais Temps sec / Temps de pluie																				MEL/3S	MEL/3S	MEL/3S	MEL/3S	MEL/3S		
	KPI + Cahiers de recette	DC1.2: KPI Webtool update and Mid-term reportof Life Performance Indicators, including socioeconomic impact	DC1.2 - 01/12/2023																			3S/WAYO/LYRE	3S/WAYO/LYRE	3S/WAYO/LYRE	3S/WAYO/LYRE	3S/WAYO/LYRE	3S/WAYO/LYRE	3S/WAYO/LYRE
		Manuels utilisateur + cahiers de recette	DB7.1: Technical guide on the application of LIFE ???? RUBIES solution- 01/11/2023																									
		Mid-term Report	**DE1.4: Mid-term Report - 01/12/2023**																									
ANNEE 3 (2024) : Observation + optimisation du pilotage par la qualité		Poursuite de l'observation : Essais Temps sec / Temps de pluie + optim pilotage qualité																										
		Analyse de marché / Referent : LYRE	*DB6.1: Market Analysis : 01/06/2024 / Referent : LYRE*																									
		DB7.2: Feasibility study for each of the two selected sites : 01/09/2024 / Referent : 3S	*DB7.2: Feasibility study for each of the two selected sites : 01/09/2024 / Referent : 3S*																									
		DB6.2: Commercialisation Plan : 01/11/2024 / Referent : 3S	DB6.2: Commercialisation Plan : 01/11/2024 / Referent : 3S																									
ANNEE 4 (2025) : Synthèse des résultats		Recette finale	DB4.3 – French pilot operational tests - 01/01/2025																									
		Bilan GD (Rapport) - synthèse des résultats	DB3.3 – Spanish pilot																									
		DB5.1: Technical, environmental, economic and social assessments of the LIFE RUBIES project results : 01/01/2025 / Referent : CSIC																										
		DB7.3: Replication and Transfer Plan : 01/01/2025 / Referent : 3S																										
		DB6.3: Business Plan : 01/03/2025 / Referent : 3S																										
		DC1.3: Final KPI Webtool update and Report of Life Performance Indicators, including socioeconomic impact and receiving water bodies assessment : 01/03/2025 / Referent : 3S																										
		DD1-5 - Layman's report : 01/03/2025 / Referent : LYRE																										
		DE2.1 After LIFE Plan: Exploitation Plan of LIFE RUBIES : 31/03/2025 / Referent : 3S																										
		DE2.2 After LIFE Plan: Communication Plan of LIFE RUBIES : 31/03/2025 / Referent : 3S																										
		DE1.5: Final Report : 30/06/2025 / Referent : 3S																										