

## Sensor data [#2]

This document describes the content of the “Sensor data” folder.

Different types of sensors are installed in the Bellinge urban drainage system, and VCS Denmark is in the process of changing SCADA system these years, which is why two data sources are provided with different format. The two SCADA systems are System2000 (Frontmatec, 2021) and iFix (GE Digital, 2021), which are overall similar but different in some ways. System2000 data provides output in local time (UTC+01 DST), with some indication of daylight-saving time in recent years, but not from 2009 – 2015. It collects and stores data every 1 min, unless otherwise stated. iFix-data (the new system) is also in local time (UTC+01 DST) but there is no indication of what times are Daylight Saving Time (DST). Data is collected every 1 min unless otherwise stated, but to save space data is stored only if the value difference is more than 1 cm for level sensors. There is an indication of data quality, but it is not known exactly what gives a stamp of poor data quality. The time stamp on the measurement is given when the data point reaches a PLC (Programmable Logic Controller), which is why some data points are not in continuous time, even if the measurement is intended to be continuous. However, these are minor errors.

In addition to the permanent sensor recordings collected in SCADA system, data from temporary mobile sensors are also collected. Data is collected every 2 min in order to save battery and is also here stored in local time (UTC+01 DST).

The water level sensor measure the depth to a given point, called the 0-point and is the zero-value of the sensor, see Figure 9 in (Pedersen et al., 2021). To make it comparable to model data and also other references, this depth is converted to a level according to the 0-point value. Note that the sensor is unable to measure depth below the 0-point level. The 0-point may have changed during the years, and there is no log-file with changes in SCADA settings in System2000.

Data is provided from different types of sensors, including level-meters, flow-meters, pumps with sensors of pumping information and position of the gate. The permanent level-meters are radar-based or transducers, and the temporary level-meters are ultrasonic sensors. The location of the different sensors can be seen in (Pedersen et al., 2021) and information about the available data can be seen in Table 1.

The python scripts provided in this dataset (see the “Scripts” folder) are designed to handle the different data sources and ensure that a consistent format is provided. Awareness should be on using cleaned data which are placed in pumping stations or flow meters, as the scripts in folder 9 Scripts are not optimized for these types of timeseries.

Regarding the rule-based control settings in system controlling the gates, pumps etc., it is not possible to extract a log-file of changes in that from System2000. An uncertainty due to this must be assessed when working with the data.

Table 1: Overview of the different sensors in the area. The 0-point relates to Error! Reference source not found..

Location	Type	Source	Filename	Device	Unit	Span	Start date	Stop date	Model node	0-point
G80F13P	Level pump sump	System2000	data-pPF13PNIVPS.txt	Transducer	Cm	0-400 cm	01-08-2010	04-09-2018	G80F13P	33.10
	Power 1	System2000	data-pPF13PSTFP1.txt		A		01-08-2010	04-09-2018	G80F13Pp1	
	Power 2	System2000	data-pPF13PSTFP2.txt		A		01-08-2010	04-09-2018	G80F13Pp1	
	Level pump sump	iFix	SVTP01.G80F13P-D1-W1-BL1_M5-PV-SMO.rpt		m		05-09-2018		G80F13P	
	Power 1	iFix	SVTP01.G80F13P-D1-W1-BE1_M5-PV-SMO.rpt		A		05-09-2018		G80F13Pp1	
	Power 2	iFix	SVTP01.G80F13P-D1-W1-BE2_M5-PV-SMO.rpt		A		05-09-2018		G80F13Pp1	
G80F66Y	Level inlet 1	iFix	SVTP01.G80F66Y-D1-W1-BL1_M5-PV-SMO.rpt	Radar	m		24-10-2019		G80F66Y	34.23
	Level inlet 2	iFix	SVTP01.G80F66Y-D1-W1-BL2_M5-PV-SMO.rpt	Radar	m		24-10-2019		G80F66Y	34.23
G80F11B	Level basin 1	iFix	SVTP01.G80F11B-D1-W1-BL1_M5-PV-SMO.rpt	Radar	m		24-10-2019		G80F11B	34.91
	Level basin 2	iFix	SVTP01.G80F11B-D1-W1-BL2_M5-PV-SMO.rpt	Radar	m		24-10-2019		G80F11B	34.91
G71F05R	Level inlet	System2000	data-pG71F05R-D1-W1-BL2_M2-PV-SMO.txt	Radar	cm	0-200 cm	01-08-2010		G72K020	18.39
	Level basin	System2000	data-pG71F05R-D1-W1-BL3_M2-PV-SMO.txt	Radar	cm	0-500 cm	01-08-2010		G71F05R_sky1	14.14
	Position throttle <sup>1</sup>	System2000	data-pG71F05R-D1-W2-BG3_M2-PV-SMO.txt		cm	0-300 cm	01-08-2010		G71F05R_skylo1	13.84
G71F04R	Level inlet 1	System2000	data-pG71F04R-D1-W1-BL3_M2-PV-SMO.txt	Radar	cm	0-300 cm	01-08-2010		G71F090	17.09 <sup>2</sup>
	Level inlet 2	System2000	data-pG71F04R-D1-W1-BL4_M2-PV-SMO.txt	Radar	cm	0-300 cm	01-08-2010		G71F090	17.05 <sup>2</sup>
G71F06R	Level inlet	System2000	data-pG71F06R-D1-W1-BL2_M2-PV-SMO.txt	Radar	cm	0-300 cm	01-08-2010		G71F06R	16.72
G71F68Y	Level pump sump	System2000	data-pG71F68Y-D1-W2-BL1_M2-PV-SMO.txt	Radar	cm	0-800 cm	01-08-2010		G71F68Y	11.17
	Flow pump	System2000	data-pG71F68Y-D1-W2-BF1_M5-PV-SMO.txt		m3/h		01-08-2010		G71F68Yp1	
	Power 1	System2000	data-pG71F68Y-D1-W2-BE1_1_M0.txt		A		06-03-2017		G71F68Yp1	
	Power 2	System2000	data-pG71F68Y-D1-W2-BE2_1_M0.txt		A		06-03-2017		G71F68Yp1	
G73F010		Danova	G73F010.tsv	Ultrasonic	m		25-06-2019		G73F010	22.589
G72F040		Danova	G72F040.tsv	Ultrasonic	m		08-01-2020	23-03-2020	G72F040	19.28
EM	Air-temperature		Folder – temperature		Celsius		01-01-2009			

<sup>1</sup>Position in 60 means throttle is open. Lower value is closing the throttle

<sup>2</sup> G71F04R Level inlet 1 and G71F04R Level inlet 2 changed in nov. 2019 to an 0-point of 17.11 and 17.06 respectively.



This documentation is part of the compilation of files related to Pedersen, Agneth Nedegaard; Pedersen, Jonas Wied; Vigueras-Rodriguez, Antonio; Brink-Kjaer, Annette; Borup, Morten; Mikkelsen, Peter Steen (2021); Dataset for Bellinge: An urban drainage case study. Technical University of Denmark. Collection.  
<https://doi.org/10.11583/DTU.c.5029124>

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## Known “failures”

Date	Sensor	Comment
11-05-2015	G71F04R Level 1 G71F04R Level 2 G71F06R Level Inlet G71F68Y Level pump sump G71F68Y Flow	G71F06R was cast as described in (Pedersen et al., 2021)
27-09-2018 – 04-10-2018	G71F04R Level 1 G71F04R Level 2 G71F06R Level Inlet G71F68Y Level pump sump G71F68Y Flow	The throttle pipe between G71F04R and G7106R was changed to $\varnothing 277$ . Before that it was two short pipes of diameter $\varnothing 200$ mm
Until 11-02-2020	G80F11B Level basin 1 G80F11B Level basin 2	The sensor was placed too low, therefore max level cannot be measured. The sensor was adjusted in height after this date
23-07-2020 – 28-07-2020	G71F04R Level 1 G71F04R Level 2 G71F06R Level Inlet G71F68Y Level pump sump G71F68Y Flow	The throttle pipe between sensor G71F04R and G71F06R was blocked. This means that water entered the volume pipe.
06-01-2020 – 19-11-2020 (app.)	G71F04R Level 1 G71F04R Level 2	The scaling of the signal was manually changed to 0-2m instead of 0-2.9m. This was manually edited in the script by multiplying the depth with 1.45 in this period
03-05-2021 – 04-06-2021	G71F05R Position throttle	The throttle was set out of operation, as there was a renovation of some pipes in the area. The throttle was constant open if wastewater was led to the volume pipe.

## References

- Frontmatec: System2000, [online] Available from: <https://www.frontmatec.com/en/software-automation/competencies/scada>, 2021.
- GE Digital: iFix, [online] Available from: <https://www.ge.com/digital/applications/hmi-scada/ifix>, 2021.
- Pedersen, A. N., Pedersen, J. W., Viguera-Rodriguez, A., Brink-Kjær, A., Borup, M. and Mikkelsen, P. S.: The Bellinge data set: Open data and models for community-wide urban drainage systems research, Earth Syst. Sci. Data, doi:10.5194/essd-2021-8, 2021.