

# PHREEQc in process control

## Operational implementation of PHREEQc in the process control of a surface water treatment

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water van waarde

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# Water Laboratory North

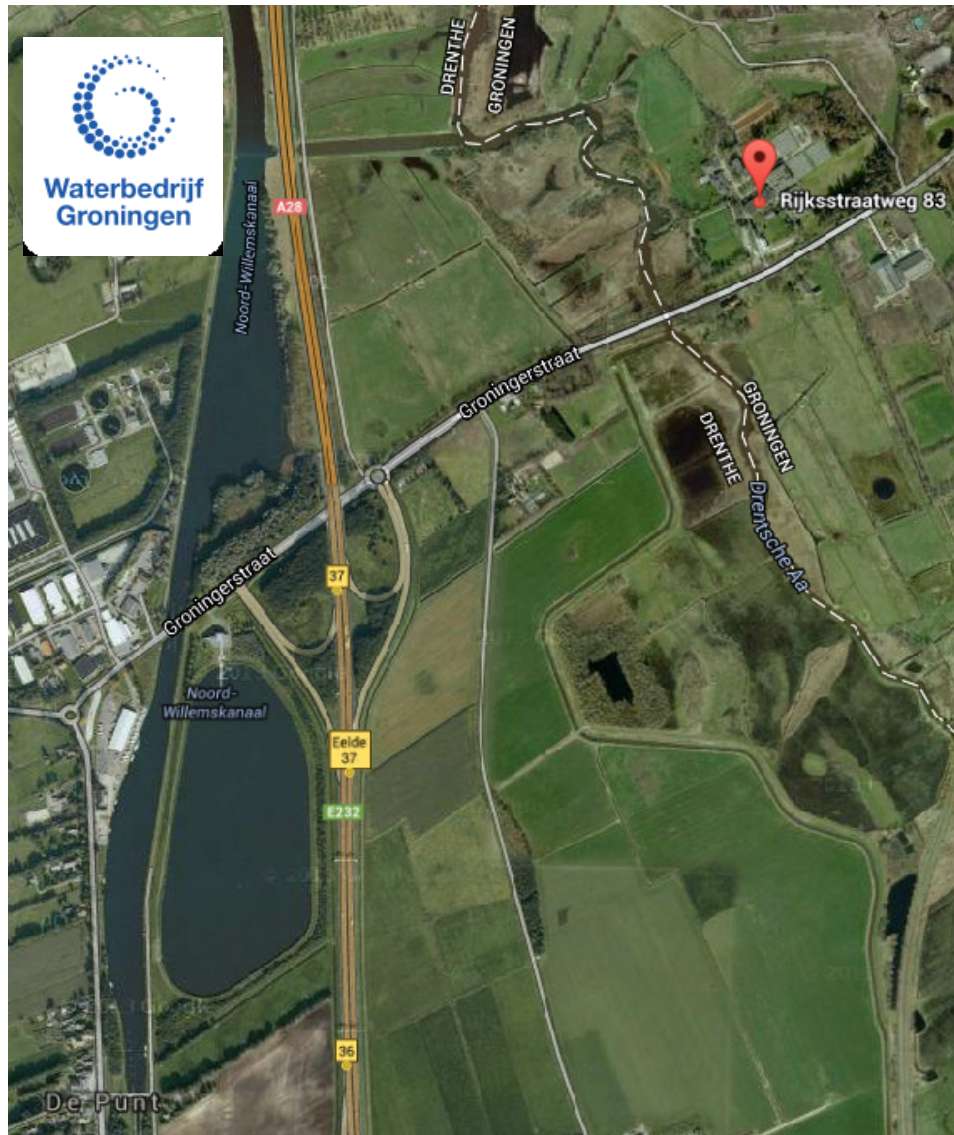


Center for water quality and water technology

Analyses of all types of water and advises on water treatment

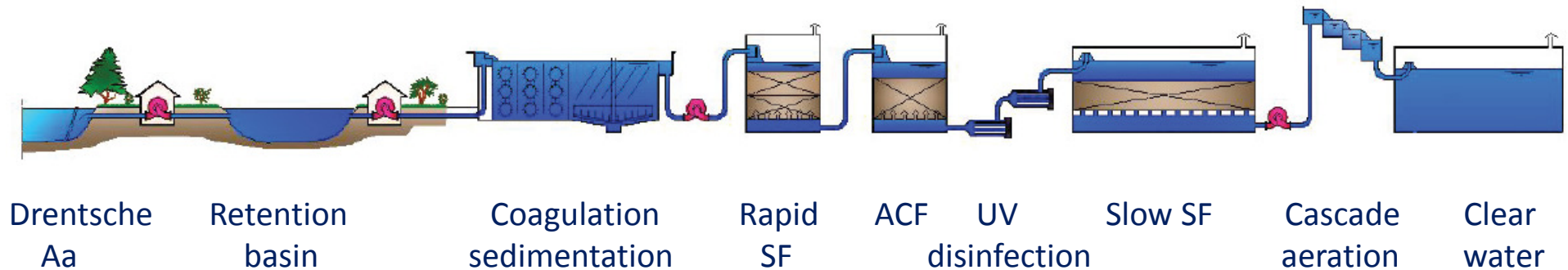
Monitoring and improving water quality by chemical, biological and technological research and consultancy

# Surface water treatment plant De Punt

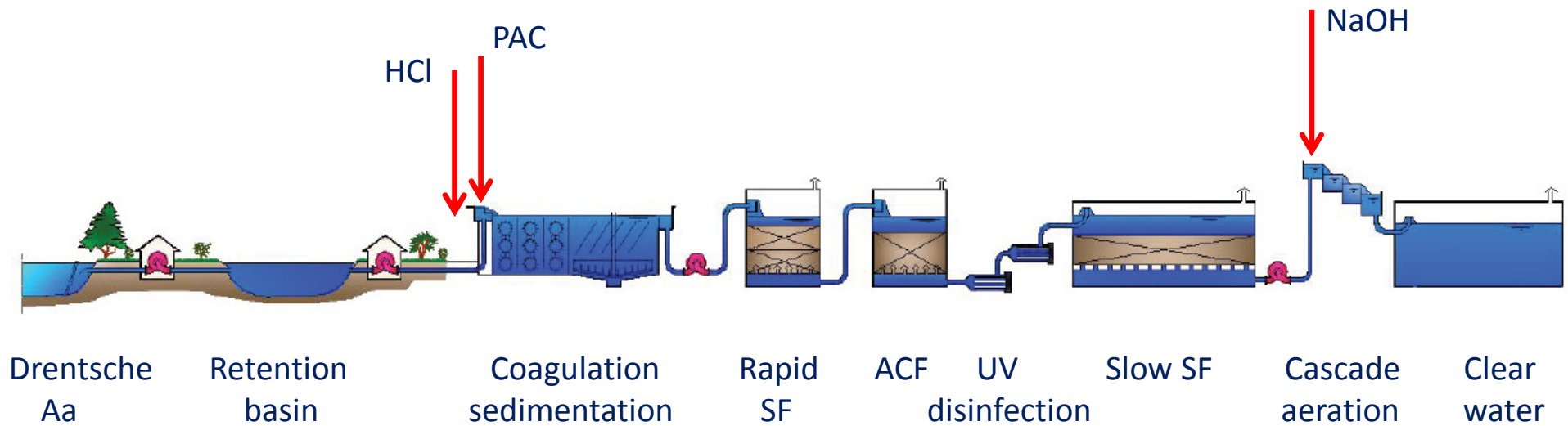


- 2012 renovated
- 7.1 Mm<sup>3</sup>/y
- + 4.0 Mm<sup>3</sup>/y ground water
- Design cap 840 m<sup>3</sup>/h

# Surface water treatment plant De Punt



# Surface water treatment plant De Punt



# Cascade aeration

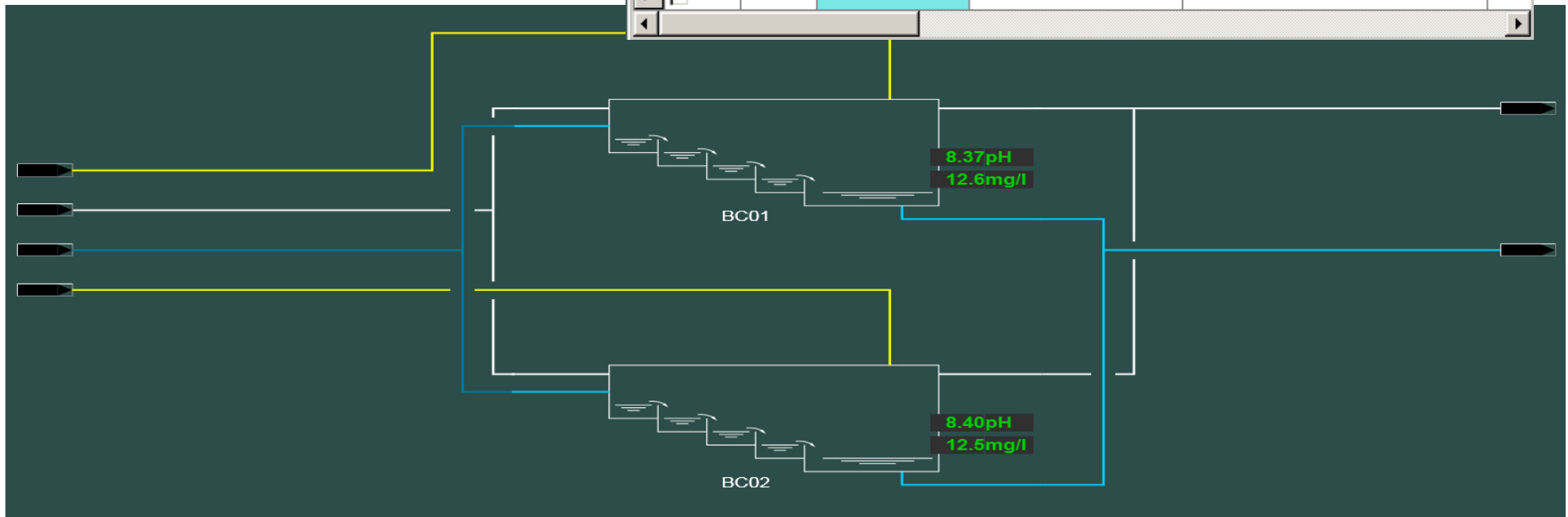
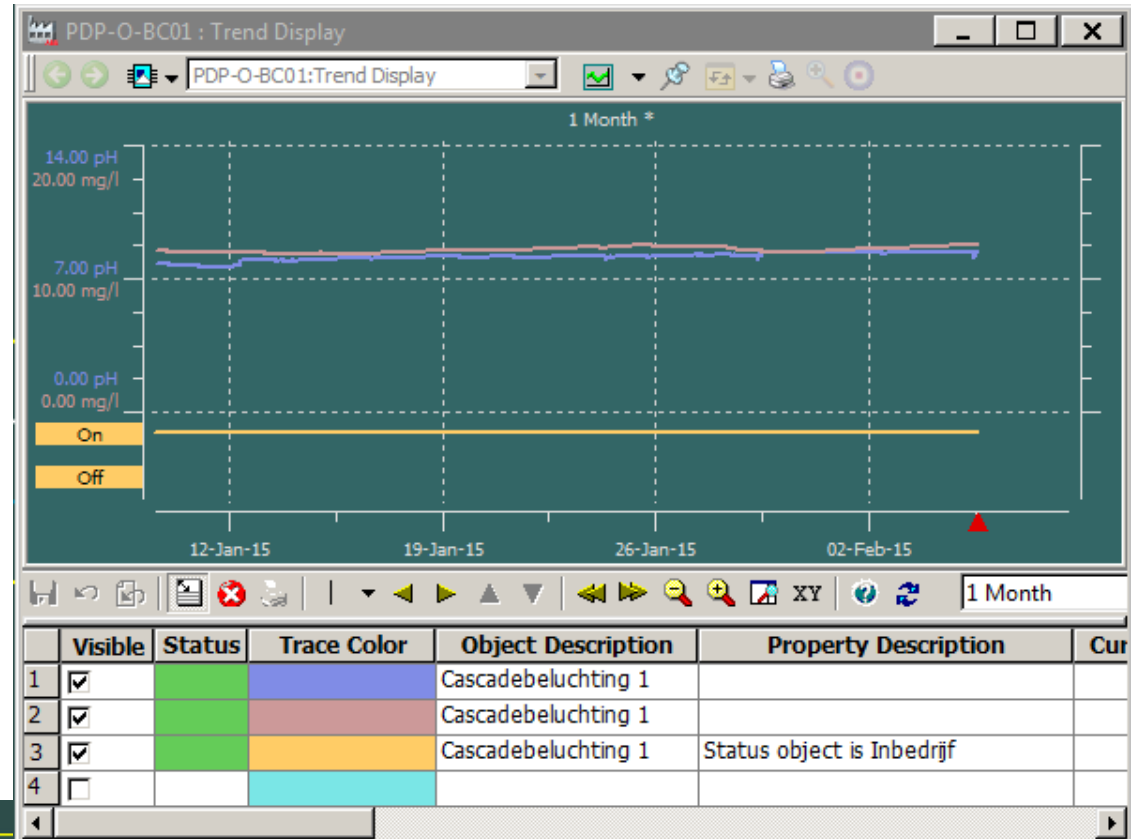
- Increasing the pH
- Controlling the saturation-index (by dosing NaOH)
- Increasing amount of oxygen ( $O_2$ )



# Saturation index

- Degree of over- or undersaturation of calcium carbonate
- $$SI = \log \left( \frac{[Ca^{2+}][CO_3^{2-}]}{K_s} \right) = pH - pH_s$$
- $SI > 0$ : limestone precipitation
- $SI < 0$ : limestone aggressive

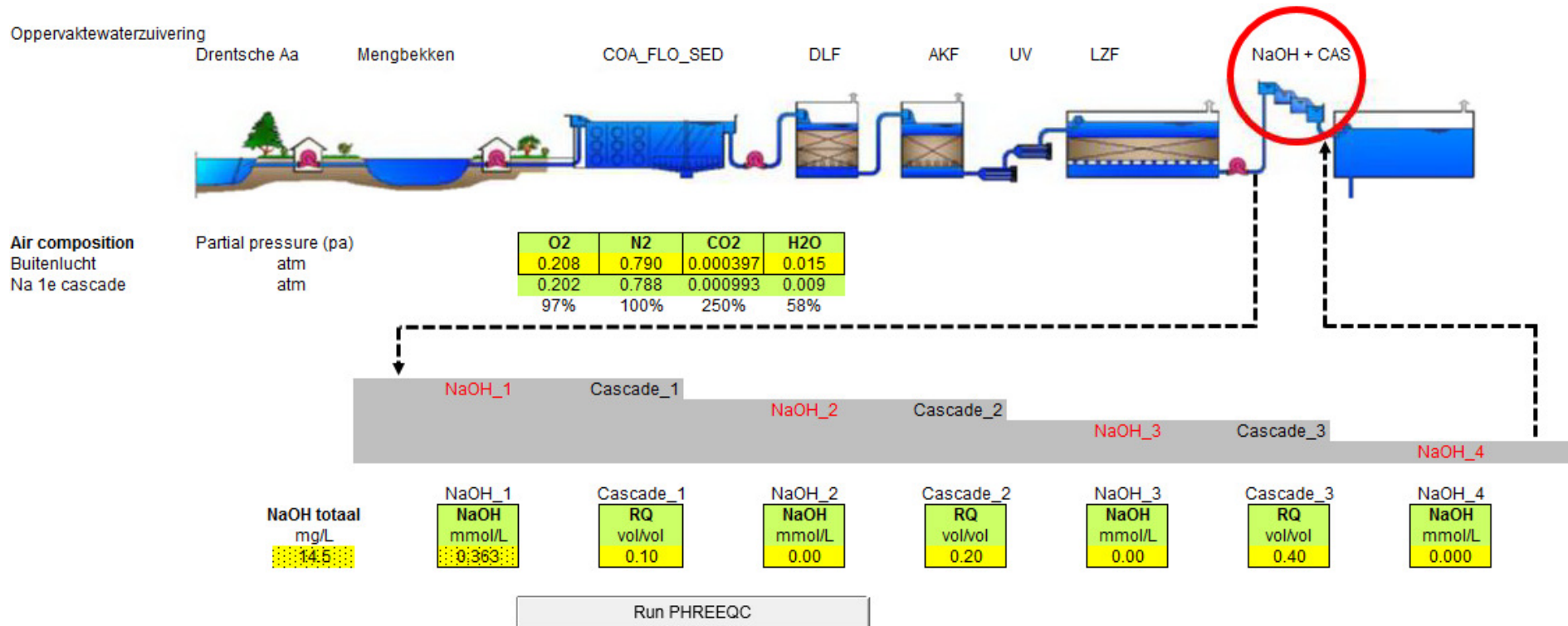
# pH control





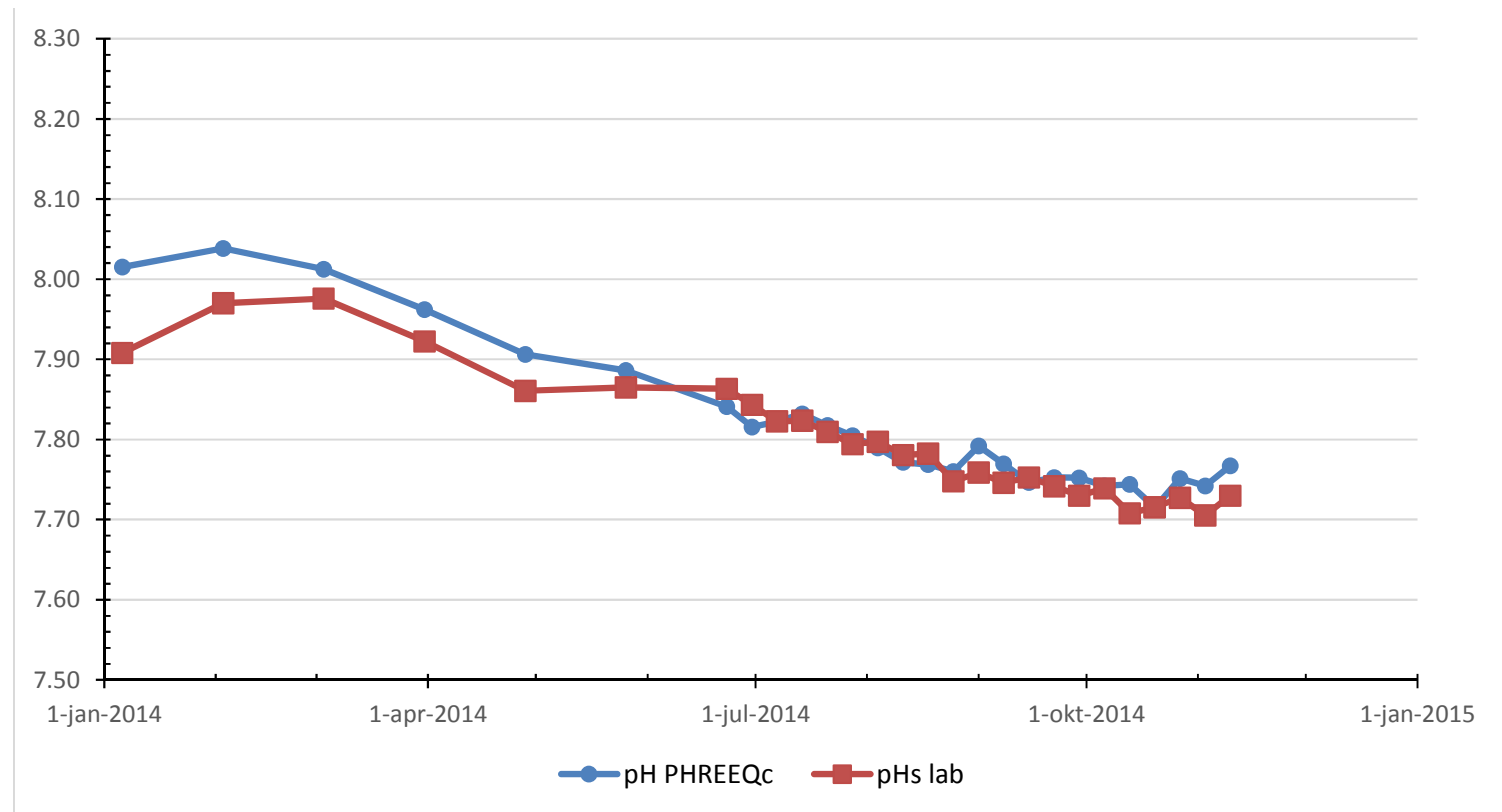
# Calculation of pHs with PHREEQC

Input is the raw water, dosing of the chemicals, water flow



# Calculation of pHs with PHREEQc

- Historical water quality analysis
- Calibration and validation of the model



# Results modelling

- Water quality fluctuates with seasonal influence, but week-to-week limited
- pHs well predicted, but NaOH concentration not accurately

Next step: implementation of the model in operational process control

# Power Generation Information Manager (PGIM)

The screenshot displays the PGIM Navigator application. On the left, the 'Functional Structure' tree shows a hierarchy of folders including 'Calculations', 'Events', 'PGIMcursus', 'Rapporten', and 'Drinkwater'. The 'Drinkwater' folder is expanded, showing sub-folders like 'Distributie', 'DPSen', 'NK Noorddijk', 'NK Ruischerbrug', 'Productie', 'PS De Groeve', 'PS De Punt', 'BS', 'CF', 'Drukregeling', 'Export2Energq', 'FA', 'Filtratie', 'FL', 'FV', 'JAAR\_Waterbalans', 'JR\_Reinwater', 'LZF', 'Meetproef WLN', 'MND\_ChemicalenVerbruik', 'Phreeqc', 'RF', 'RR', 'TRND\_Troebelheid GW', 'TRND\_Troebelheid meetproef', 'TRND\_Troebelheid OW', 'TRND\_Troebelheid spoelwater', 'WF', 'WR', 'WU', 'PS Nietap', 'PS Onnen', 'PS Sellingen', 'WLN rapporten', 'Work\_ABB', and 'JR\_1Tag'.

The main window displays a table of signals with the following columns: Signal (), Source (WSRV...), Description (), Last value (), Dimension (), Status (), Lower scale-val..., and Upper scale. The table lists 4116 signals, including various status and value measurements for different components like 'Multiplexer sneelfilters 4,5,6', 'Cascadebeluchting 1', 'Coagulatie sedimentatie straat 1', and 'rapMR01bedrijfuren'.

Signal ()	Source (WSRV...)	Description ()	Last value ()	Dimension ()	Status ()	Lower scale-val...	Upper scale
✓ PDP-O-AS1.Status.MW_Sample8.Value	WSRV-PGM-0...	Multiplexer sneelfilters 4,5,6	0.000		0	0.000	1
✓ PDP-O-BC01.Status.BaseStatus.InBedrijf	WSRV-PGM-0...	Cascadebeluchting 1	1.000		0	0.000	
✓ PDP-O-BC01.Status.NiveauMeting.Value	WSRV-PGM-0...	Cascadebeluchting 1	0.000		256	0.000	1
✓ PDP-O-BC01.Status.pHMeting.Value	WSRV-PGM-0...	Cascadebeluchting 1	7.847	pH	0	0.000	
✓ PDP-O-BC01.Status.ZuurstofMeting.Value	WSRV-PGM-0...	Cascadebeluchting 1	9.321	mg/l	0	0.000	
✓ PDP-O-BC02.Status.BaseStatus.InBedrijf	WSRV-PGM-0...	Cascadebeluchting 2	1.000		0	0.000	
✓ PDP-O-BC02.Status.NiveauMeting.Value	WSRV-PGM-0...	Cascadebeluchting 2	0.000		256	0.000	1
✓ PDP-O-BC02.Status.pHMeting.Value	WSRV-PGM-0...	Cascadebeluchting 2	7.803	pH	0	0.000	
✓ PDP-O-BC02.Status.ZuurstofMeting.Value	WSRV-PGM-0...	Cascadebeluchting 2	9.354	mg/l	0	0.000	
✓ PDP-O-CBL0-Keuze.Status.VoorkeurA	WSRV-PGM-0...	Toerbeurt blowers	0.000		0	0.000	
✓ PDP-O-CBL0-Keuze.Status.VoorkeurB	WSRV-PGM-0...	Toerbeurt blowers	1.000		0	0.000	
✓ PDP-O-CF01.Status.logMR01toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	7.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR02toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	2.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR03toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	5.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR04toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	4.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR05toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	4.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR06toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR07toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	4.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR08toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR09toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR10toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR11toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR12toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	3.000	rpm	0	0.000	
✓ PDP-O-CF01.Status.logMR13toeren.Value	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	49.805	%	0	0.000	1
✓ PDP-O-CF01.Status.rapMR01bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17970.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR02bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17975.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR03bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17974.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR04bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17969.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR05bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17974.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR06bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17974.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR07bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17969.000		0	-100.000	1
✓ PDP-O-CF01.Status.rapMR08bedrijfuren	WSRV-PGM-0...	Coagulatie sedimentatie straat 1	17923.000		0	-100.000	1

Below the table, there is a summary row: 4116 signals.

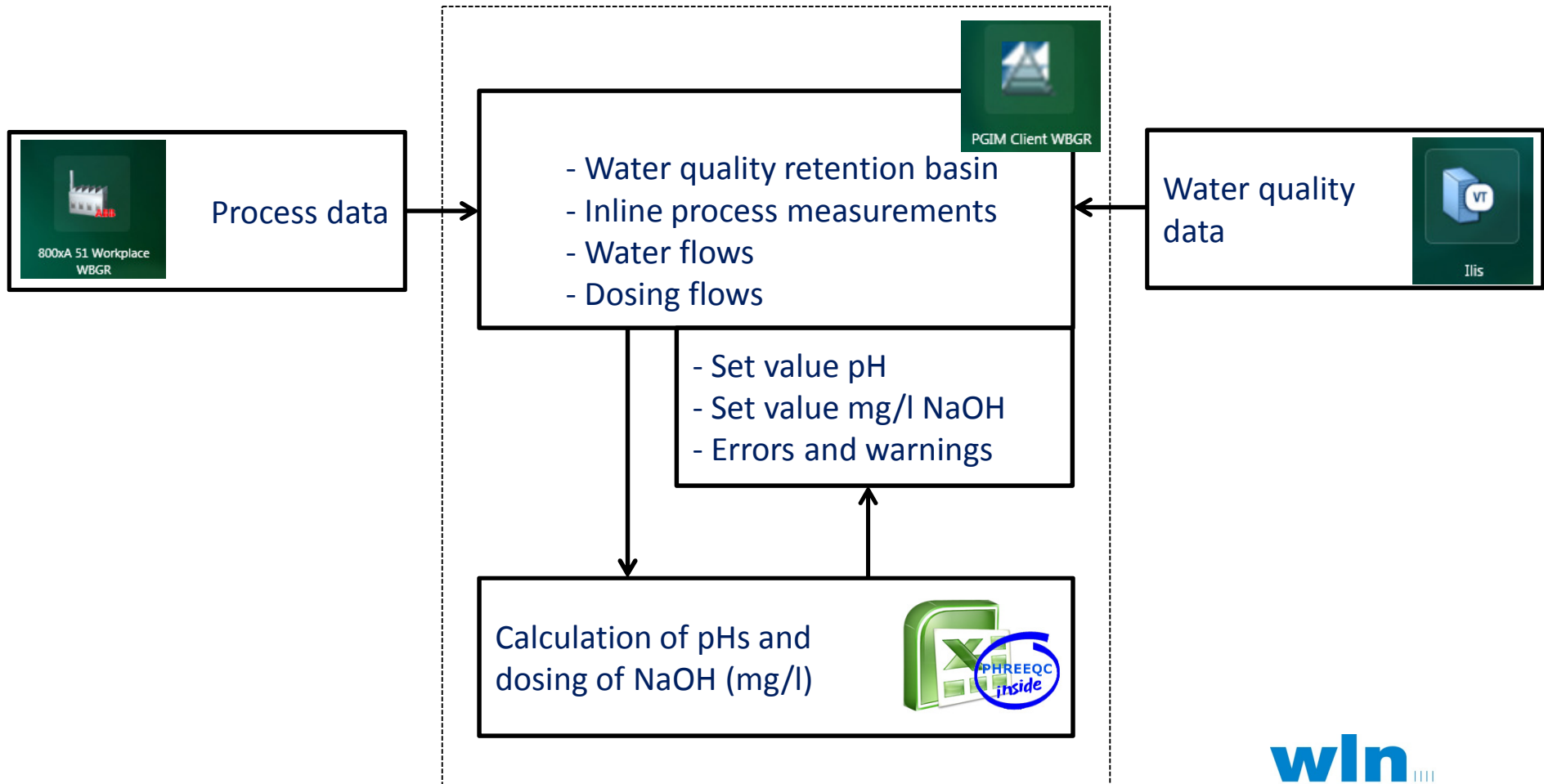
The bottom section of the interface shows the 'Aspect Name' field with the path: \\srv-pgm-002\wbgr\Rapporten\Drinkwater\PS De Punt\Phreeqc\Stimela\_DePunt\_OppZuivering\_bewerk\_BSwi.xmls and an 'Open Aspect' button.

# Laboratory Information Management System (LIMS)

```

1504407 PS De Punt [OW]; Effluent mengbekken (afh. zuurdoser
Monsterpunt ppuo0200gl Datum 02-02-2015 11.15 Opm 1 Sta
27 Parameters Ruw Afgerond Eenheid
<Enter>=(De) Selecteer 9 Zuurgraadverschil (lab/veld - 0.01 0.01 pH
----- 10 Zuurgraad 7.77 7.8 pH
Monster 11 * Zuurgraad gemeten bij (tempe 20.5 20.5 graden C
Monsterpunt ppuo0200 12 Electrisch geleidend vermogen 29.4 29.4 mS/m
Datum >0101201 13 * EGV gemeten bij (autom. comp 20.1 20.1 graden C
Kenmerk 14 Waterstofcarbonaat 105.58 110 mg/l
Methode 15 Waterstofcarbonaat (in mmol) 1.73081967 1.73 mmol/l
16 Tijdelijke hardheid 0.86540984 0.865 mmol/l
17 Ammonium 0.06942857 0.07 mg/l
18 Ammonium (mg N) 0.054 0.05 mg N/l
19 Nitriet 0.092 0.092 mg/l
20 Nitriet (mg N) 0.028 0.028 mg N/l
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1502358 ppuo0200gl PS De Punt [OW]; Effluent meng 19-01-2015 9.35 51
1502359 ppuo0200gl PS De Punt [OW]; Effluent meng 26-01-2015 12.20 51
1503662 ppuo0200gl PS De Punt [OW]; Effluent meng 26-01-2015 12.20 51
1503663 ppuo0200gl PS De Punt [OW]; Effluent meng 26-01-2015 12.20 51
1504407 ppuo0200gl PS De Punt [OW]; Effluent meng 02-02-2015 11.15 5
1504408 ppuo0200gl PS De Punt [OW]; Effluent meng 02-02-2015 11.15 31
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^E=FILE ^N=DATUMS F9=OPM. F7=RAPPORT ^T=WO ^U=PARAM.OVZ. ^V=INFO Tab=DETAIL
F4=Afbreken ^W=Help F8=Nw Selectie F1=Nieuw F2=Verw. PgDn=Pag.Neer
  
```

# Dataflow



# Operational implementation

- Dashboard for the operators with input for the NaOH dosing
- Errors and warnings if calculated value is not within expected value
- Use model to evaluate entire treatment process
- Learning module for the operators

# Questions??

