Workpackage 2
Process monitoring and performance control

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DEMOWARE Kick-off Meeting, Manresa, 12-13 March 2014

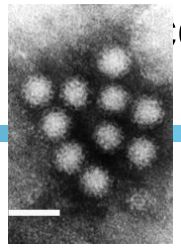
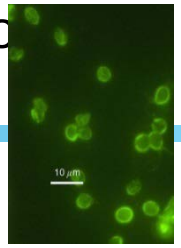
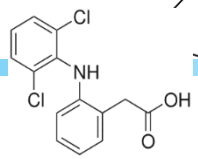
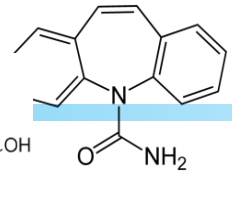
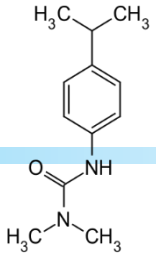
SEVENTH FRAMEWORK PROGRAMME

Outline

- Overview
  - WP Objectives & scope
  - Tasks (partner involvement and timing)
  - MS / DL
- Work planned and approaches

WP2 Objectives

- to identify critical contaminants in water reuse schemes
- to demonstrate and test advanced monitoring and control options for microbial and chemical contaminants fate
- to test advanced technologies to control the integrity of treatment barriers
- to provide end-user specific recommendations on process monitoring and performance control of water reuse schemes

microbial contamination

chemical contamination

Task 2.1

Task 2.2

Water quality characterisation

Health risks

Treatment process performance & control

Task 2.3

Membrane integrity

Distribution networks

Task 2.4

Operational risk reduction

Task 2.5

Task 2.6

Guideline for proces monitoring & perforamance control

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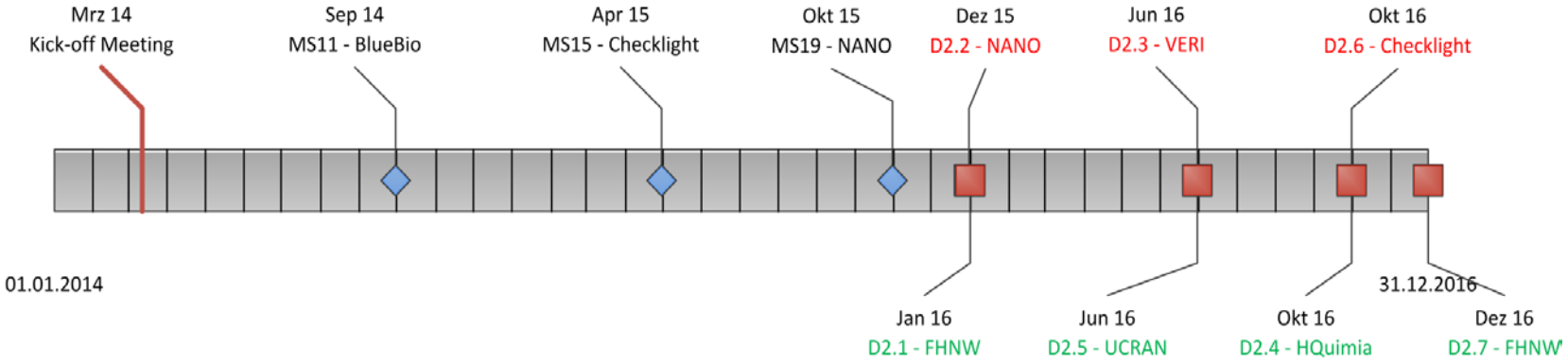
Tasks overview and partners involvement

	CTM	FHNW	UCRAN	IRSA	IRTA	Fiordelisi	Checkligh t	BlueBio	NANO	DCI	MEK	TWUL	VERI	IWVA	HQuimia
Task 2.1 Monitoring and control of microbiological parameters (M1-M30)															
Subtask 21.1 New techniques to assess disinfection processes (M1-M30)			**X**	X				X				X			
Subtask 21.2 Verifying the fate of microbial contaminants in agricultural irrigation schemes (M6-M30)				**X**		X									
Task 2.2 Monitoring and control of chemical contaminants (M3-M34)															
Subtask 22.1 Establishing & improving chemical fingerprinting (M3-M30)													X		
Subtask 22.2 Effect-based assays for chemical contaminants detection (M3-M34)							**X**				X			(X)	
Subtask 22.3 Target compound fate (M9-M24)		**X**												X	
Task 2.3 Approaches for membrane integrity testing (M1-M30)															
Subtask 23.1 Survey of technologies and techniques to monitor membrane integrity (M1-M6)	X	**X**								X	X				
Subtask 23.2 New concepts for membrane integrity testing (M3-M30)	X	X							X	**X**					X
Task 2.4 Application of electrochemical sensors for optimised distribution network operation (M1-M30)															
Subtask 24.1 Reduction of clogging in agricultural irrigation networks (M1-M24)	X				**X**										
Subtask 24.2 Adjustable maintenance strategies in distribution networks for urban applications (M6-M30)	X														**X**
Task 2.5 Operational risk reduction and control through failure management (M18-M30)	X	X													**X**
Task 2.6 Guideline developments for process monitoring and performance control (M24-M36)	X	**X**	X	X	X	X	X	X	X	X	X	X	X	X	X

Milestones and Deliverables

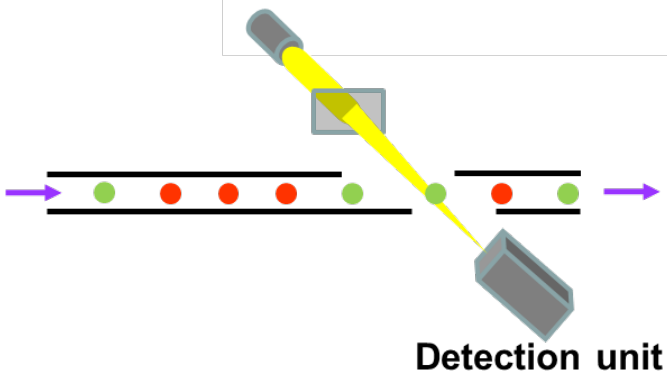


No	Title	Lead partner	Due month
D2.1	Best practice recommendation on integrity monitoring	2	24
D2.2	Report on membrane integrity testing protocol	16	24
D2.3	Data mining procedure and frame of reference for the evaluation of the micro-pollutants levels in environmental samples	21	30
D2.4	Good practice summary for biofilm mitigation in networks	27	34
D2.5	Report on the applicability of FCM and qPCR methods to assess and control microbial contamination	3	30
D2.6	Report on bioassay-monitor on-site testing	12	34
D2.7	Guidelines for process monitoring and performance control of water recycling schemes	2	36

Task 2.1 Monitoring and control of microbiological parameters

- Subtask 21.1 New techniques to assess disinfection processes (M1-M30)
- Subtask 21.2 Verifying the fate of microbial contaminants in agricultural irrigation schemes (M6-30)
- Associated deliverable(s)
  - D2.5 Report on the applicability of FCM and qPCR methods to assess and control microbial contamination

Flow cytometry for rapid assessment of treatment efficiency



Location: Old Ford Water Recycling Plant, London

Industry partner: Thames Water

Academic partner: Cranfield University

Diagnostic technology: Flow cytometry

Context: wastewater treatment to non-potable water for irrigation, toilet flushing,

- Objectives
  - Monitor treatment train and determine microbiological treatment efficiency
  - Modify CT values in final disinfection step and monitor effect on water microbiology
  - Determine robust species receiving least damage during treatment
  - Microbiological mapping of network distributing treated reused water.

Objective and deliverables

- molecular monitoring of disinfection efficiency
- identification and quantification of specific indicator organisms, which are resilient to disinfection step.
- develop a method to monitor the disinfectant efficiency by quantification of the chosen viable indicator organisms.

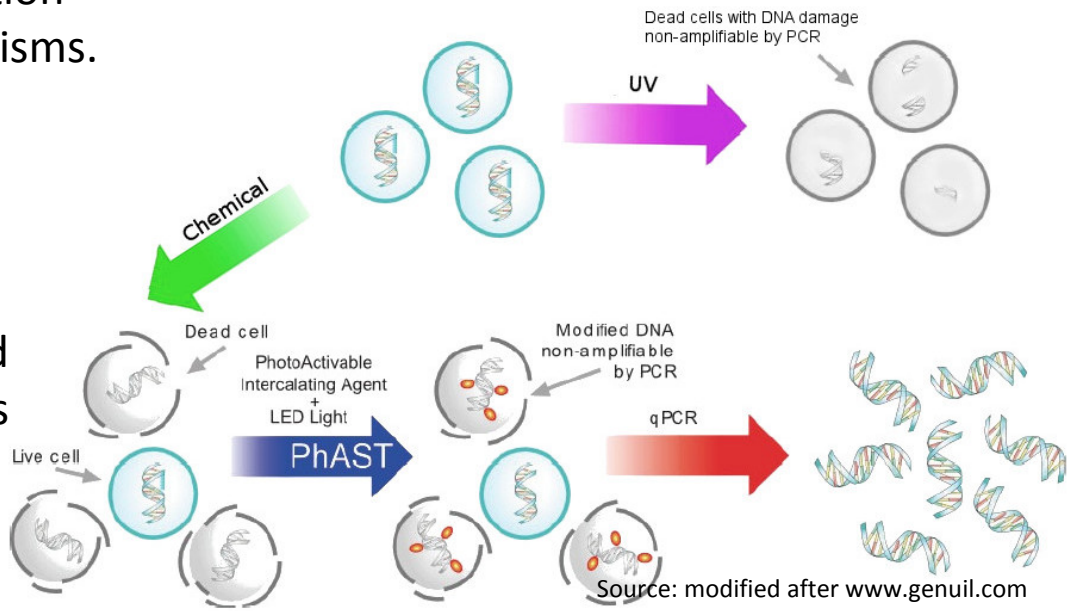
Technological approach

- distinction of viable and 'dead' bacteria
- method involving nucleic acid-binding dyes to exclude damaged cells from subsequent DNA extraction and qPCR

→ calibrate an indicator system for quick assessment of disinfection success.

Context and outlook

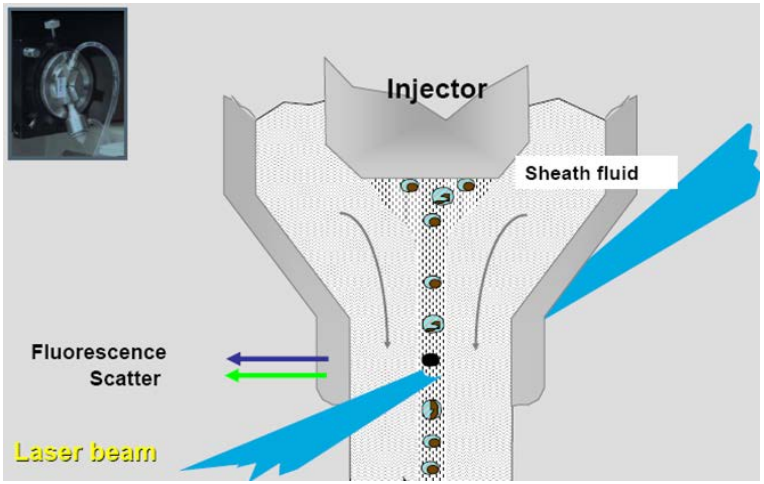
- test at sites using chemical disinfection
- establish appropriate sampling and sample preparation methodologies
- first population comparison of the treated and untreated waters.



Source: modified after www.genuil.com

Microbial monitoring at the demo site «Capitanata» using flow cytometry

Partners: IRSA-CNR, Fiordelisi s.r.l.
Demo site: Capitanata (Italy)

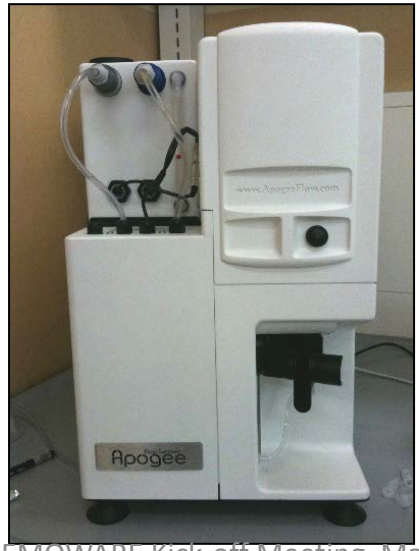


Context: treated agro-industrial wastewater used for irrigation of own crops (closed loop).

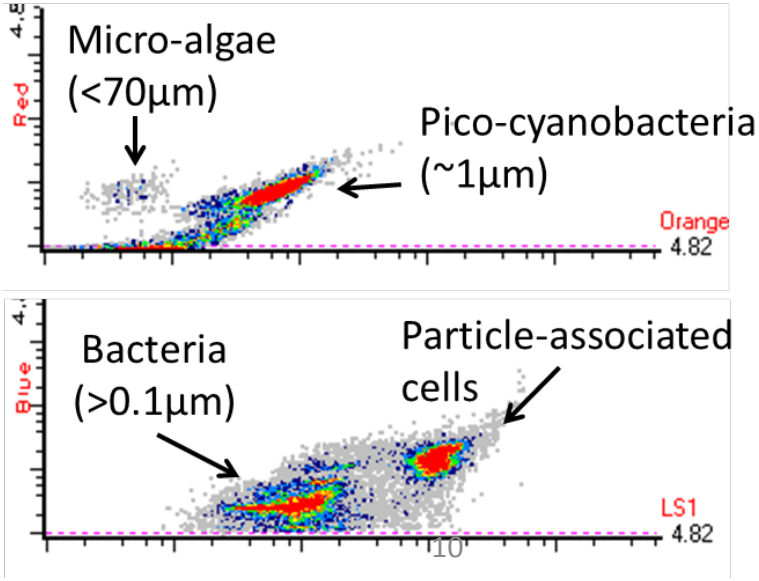
Objectives:

- Monitor reclaimed water at different treatment levels (secondary, tertiary);
- Compare FCM to other tools (ST2.1.2);

Flow cytometry for multiparametric detection of single particles and cells in a liquid suspension. Fluorescence and morphology descriptors

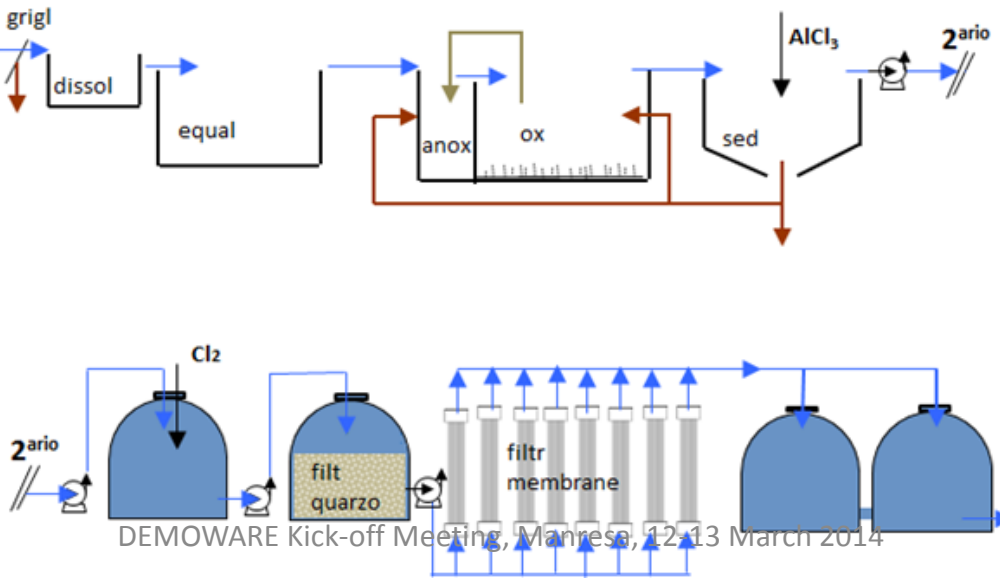


Apogee A50-micro
www.apogeeflow.com
- Bench top machine
- Portable (<30Kg)
- Stable laser alignment
- Wide cell size range (diameter 0.1-70 µm)
- Fast acquisition (up to 1000 evts/sec)



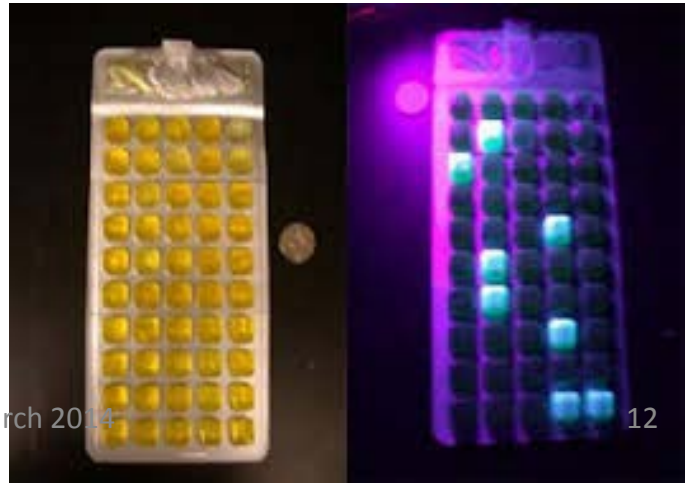
Evaluate agro-industrial wastewater reuse for irrigation

- Investigating water reuse for irrigation as a tool for water savings and resource optimization at Capitanata site
- **Available water sources**
  - Wastewater treatment secondary effluent;
  - Tertiary treatment effluent;
  - Well water (control).



Subtask 21.2 Verifying the fate of microbial contaminants in agricultural irrigation schemes (M6-30)

- Regular microbial screening of *E. coli* (IRSA) and Salmonella (contract to Univ. Foggia) on:
  - the different water sources used for irrigation,
  - soil before and after irrigation,
  - edible parts of crops.
  - Different methods for *E. coli* determination will be compared (plate counts, Colilert)



Task 2.2 Monitoring and control of chemical contaminants

- Subtask 22.1 Establishing and improving chemical fingerprinting to better characterize chemical contamination (M3-M30)
- Subtask 22.2 Effect-based assays for chemical contaminants detection (M3–M34
- Associated deliverables
  - D2.3 Data mining procedure and frame of reference for the evaluation of the micro-pollutants levels in environmental samples
  - D2.6 Report on bioassay-monitor on-site testing

Task 2.2 Monitoring and control of chemical contaminants

- Subtask 22.1 Establishing and improving chemical fingerprinting to better characterize chemical contamination (M3-M30) => WHY ?

Classical methodology

List of known molecules

↓

Targeted analysis
(often specific for each type of molecule)

- Quantitative results for known molecules
- Are we sure to have all the chemical contaminants ?

Innovative Approach

Unknown contents of molecules

↓

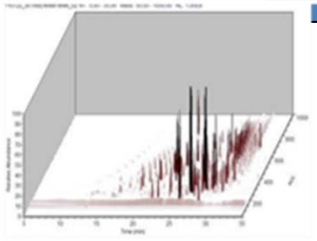
Untargeted analysis
(large screening of polar and non polar molecules)

- Chemical footprint of samples
- Identification of markers (related to specific activities)
- Qualitative approach
- Need to be automated

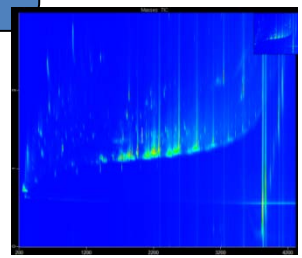
Task 2.2 Monitoring and control of chemical contaminants

- Subtask 22.1 Establishing and improving chemical fingerprinting to better characterise chemical contamination (M3-M30) => HOW ?

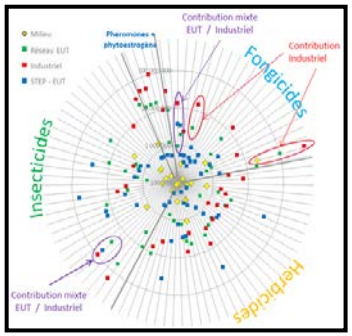
LC-HRMS
Identification of polar to medium polar compounds



GCxGC-TOFMS
Detection of non-polar to medium polar compounds



Chemical Footprint of a sample



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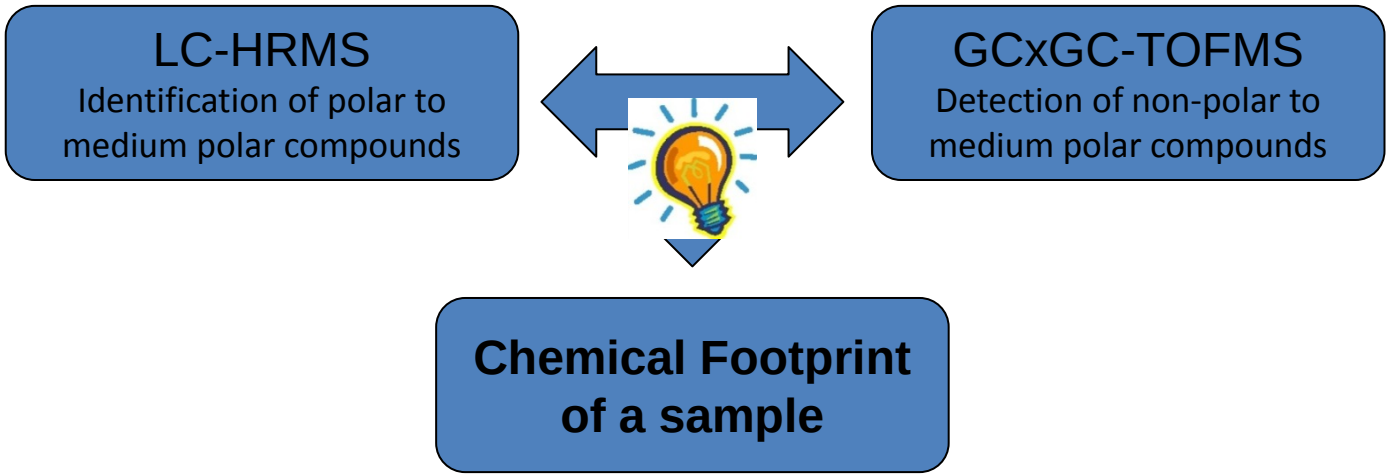
Task 2.2 Monitoring and control of chemical contaminants

- Subtask 22.1 Establishing and improving chemical fingerprinting to better characterise chemical contamination (M3-M30) => WHAT ?



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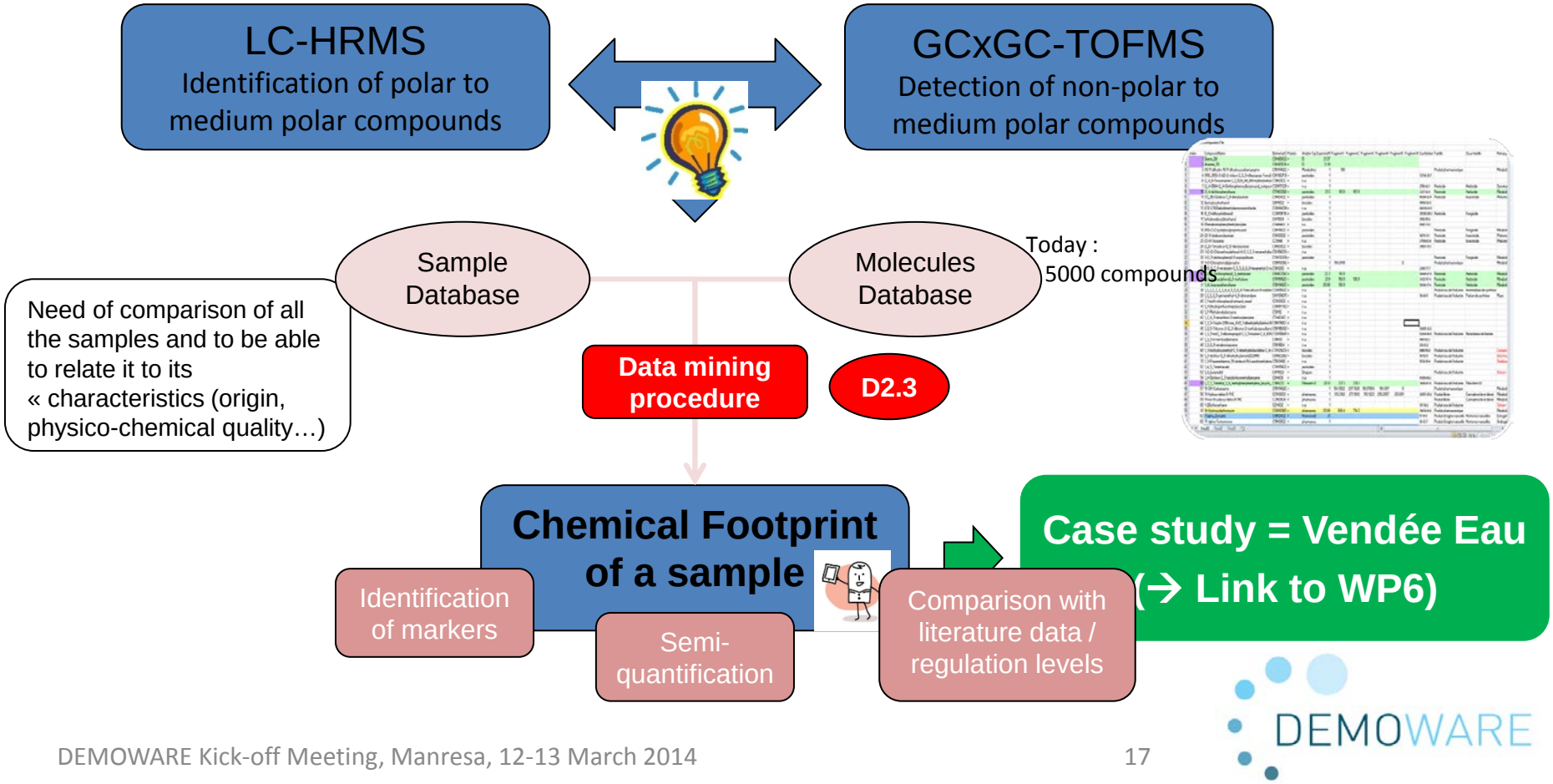

Subtask 22.2 Effect-based assays for chemical contaminants detection (M3–M34)

biomonitech

- Objective:
  - Provide means to rapidly detect chemical contaminants in reclaimed effluent
- Concept and tasks
  - Non-pathogenic luminous marine bacteria used as sensors (bioluminescence)
  - Proprietary reagents sensitize the bacteria to a broad range of chemical contaminants, and stabilize their operating conditions
  - Indication of toxicity without the need to depend on reference water
  - assess the various toxicity levels throughout the purification processes (mainly in Shafdan)
  - develop two automatic units (BMT-200), each at the end point of the two planned treatment processes in Shafdan site
  - testing in another DEMOWARE site

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Task 2.3 Approaches for membrane integrity testing

- Subtask 23.1 Survey of technologies and techniques to monitor membrane integrity (UF, NF, RO) (M1-M6)
- Subtask 23.2 New concepts for membrane integrity testing (M3-M30)
- Associated deliverable(s)
  - D2.1 Best practice recommendation on integrity monitoring
    - based on review and DEMOWARE findings
  - D2.2 Report on membrane integrity testing protocol
    - how to apply in water reuse schemes

Subtask 23.1 Survey of technologies and techniques to monitor membrane integrity

- Literature survey
  - what is common practice
  - identification of limitations (size, location of failure, time response)
- Expert interviews
  - distribute responsibilities for technologies among partners (UF, NF, RO)
- Next steps
  - Report structure
  - questionnaire proposal

Subtask 23.2 New concepts for membrane integrity testing

UF Membranes:

- New approach in DOW™ Ultrafiltration fiber integrity testing
- adding nano-particles (manufactured by NanoSight) in the feed water
- to be tested in Sabadell & Tarragona sites in Spain
- compare against pressure decay test.
- development of fiber integrity monitoring strategies

RO Membranes

- New approach in DOW™ FilmTec Reverse Osmosis membranes
- Salt Passage and indicator for convective transport of multivalent ions, such as MgSO4,
- to be tested in Sabadell & Tarragona sites
- compare against conventional vacuum test..

Task 2.4 Application of electrochemical sensors for optimised distribution network operation

- Subtask 24.1 Reduction of clogging in **agricultural irrigation** networks (M1-M24) – IRTA, CTM
- Subtask 24.2 Adjustable maintenance strategies in distribution networks for **urban applications** (M6-M30), Hquima, CTM
- Associated deliverable(s)
  - D2.4 Good practice summary for biofilm mitigation in networks

Subtask 24.1 Reduction of clogging in agricultural irrigation networks M1-M24

- Site: Torre Marimon (Catalonia)
- Objective:
  - To demonstrate the feasibility of an electrochemical sensor to be applied as a non-invasive technology to observe biofilm formation and derive appropriate maintenance measures.
- Treatment technology
  - Secondary effluent + disinfection
  - CO_2 injection to reduce clogging (pH drop, pressure increase)
- Approach
  - set of different operational conditions
  - determine chemical and biological water quality
  - monitor biofilm growth.

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Subtask 24.2 Adjustable maintenance strategies in distribution networks for urban applications

- Objective:
  - To derive a correlation between reclaimed water quality and observed biofilm formation to allow for systematic biofilm mitigation.
- Site: Sabadell
- Treatment technology
  - MBR + disinfection based on UV irradiation and hypochlorite dosing
- Approach
  - operate a segmented pipe system (different materials)
  - characterise reclaimed water quality
  - observe biofilm formation (sensor, protein determination, qPCR) at different operation regimes

Task 2.5 Operational risk reduction and control through failure management (M18-30)

- Site: Sabadell (Catalonia)
- Treatment technology:
  - MBR + disinfection based on UV irradiation and hypochlorite dosing
- Objective
  - To test the methods and findings from the previous tasks for the development of a risk and failure management plan for each specific step of water reuse schemes.

1. install and operate experimental network segments to evaluate possible failures of the disinfection steps within the WWTP
2. Monitor the effects on the microbiological water quality
3. Development of specific risk and failure management plan

Associated Deliverable

- D2.7 Guidelines for process monitoring and performance control of water recycling schemes

Task 2.6 Guideline developments for process monitoring and performance control

- conclude recommendations for improved monitoring and operational control based on results of Tasks 2.1-2.5
- compile know-how
  - gathered in the Project
  - available from the operators of the demonstration sites
  - from international literature

  for different critical steps of a water reuse schemes
  - from the source (industry control in sewer)
  - treatment (reliability of disinfection steps)
  - distribution networks and irrigation system (biofilm control
- to support operators of water reuse scheme in implementing Water Reuse Safety Plan (risk assessment and management).

→ D2.7 Guidelines for process monitoring and performance control of water recycling schemes