DESSIN

DEMONSTRATE ECOSYSTEM SERVICES ENABLING INNOVATION IN THE WATER SECTOR

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D34.2 A demonstrated intelligent software-hardware platform for monitoring and control of small packaged plants for urban sewer mining

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The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 619039

Title of the Report

D34.2: A demonstrated intelligent software-hardware platform for monitoring and control of small packaged plants for urban sewer mining

SUMMARY

Deliverable D34.2 contains the results of Task 34.3 of DESSIN Project which is related to Athens Demonstration: Sewer Mining for Urban Reuse enabled by Advanced Monitoring Infrastructure. As the actual deliverable is of a nature that can not be submitted electronically to the EC services, it is accompanied by this report which summarizes the results of T34.3 “Implement the monitoring and supervisory system”. It focuses on the implementation of the intelligent software-hardware platform for monitoring and control of small packaged plants for urban sewer Mining. It documents the implementation detais for of the SW and HW platform for collecting, processing and visualizing field sensors installed at the packaged plant in KEREFYT, the Sanitary Engineering Research and Development Center of EYDAP. The front-end and back-end implementation aspects are described including the adoptation of OGC standarts, the data models and encodings used, the cloud based User Interface, the web technologies and web services implemented. The platform presented has been integrated and tested at KEREFYT and is fully functional and operational.

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TELINT	Lazaros Karagiannidis (NTUA) Michalis Vrettopoulos (NTUA) Nikos Gkonos (TELINT) Effie Makri (TELINT)
CONTRIBUTING AUTHOR(S)	
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Christos Makropoulos David Schwesig	NTUA IWW
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List of Acronyms and Abbreviations

ICT	Information and Communication Technology
OGC	Open Geospatial Consortium
SOS	Sensor Observation Service
SES	Sensor Event Service
sensorML	Sensor Model Language
O&M	Observations and Measurements
XML	Extensible Markup Language
UI	User Interface
HTTP	Hypertext Transfer Protocol
REST	Representational State Transfer
WS	Web Service
KVP	Key-Value Pair
API	Application Programming Interface
SOAP	Simple Object Access Protocol
EPR	End Point Reference
JSON	JavaScript Object Notation

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Executive summary

Deliverable D34.2 reports the outcomes of the activities of Task 34.3 “Implement the monitoring and supervisory system” of DESSIN Project which is related to Athens Demonstration: Sewer Mining for Urban Reuse enabled by Advanced Monitoring Infrastructure. Although the deliverable type is “Other” it was decided not to limit the report in describing only the platform but to focus additionally on the following items:

- SW and HW implementation
- Front-end and Back-end implementation aspects
- Sensor Data Representation Layer Implementation
- Web platform implementation
- Web platform functionality

1 Introduction

1.1 Objectives

The objective of the software-hardware platform for monitoring and control of small packaged plants for urban sewer mining is to integrate data collection tools, sensing elements and monitoring and configuration tools into a common platform. The platform is based on the ICT platform for distributed sewer mining technology presented in D22.2 aiming at implementing an interoperable sensor data layer, exploiting a suitable communication solution, and integrating a monitoring web platform for local and remote control.

Additional emphasis was given in addressing interoperability, flexibility, extendibility and usability issues of the platform in order to enhance its seamless integration and adaptability with existing legacy systems as well as to facilitate its acceptance and adoption by the stakeholder community.

2 Software Implementation

As already presented in deliverable D22.2, the functional software platform architecture, which is the baseline for the implementation of the platform is depicted in Figure 1 .

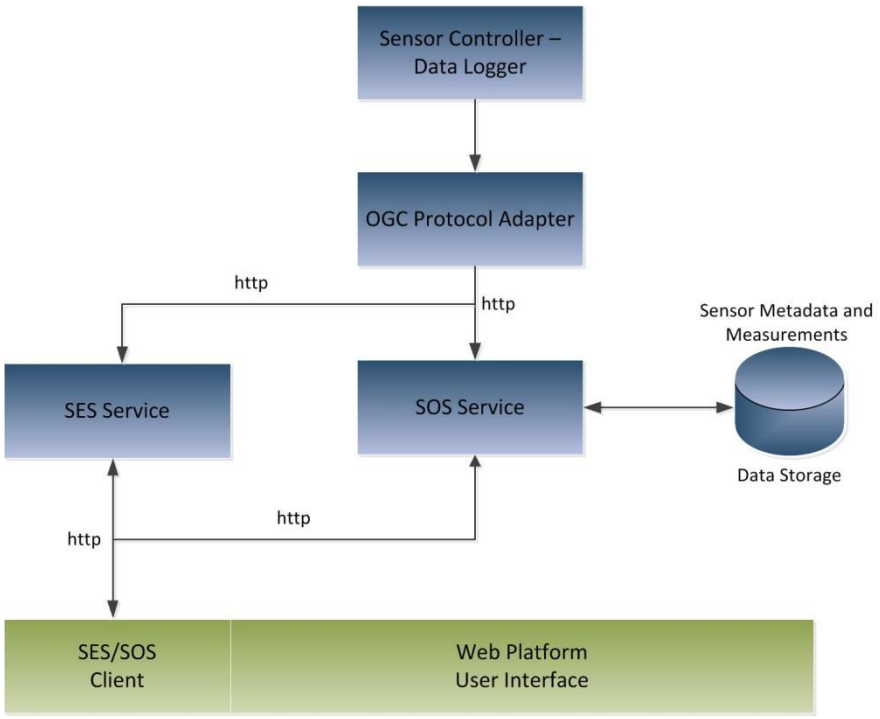

Figure 1: SW Architecture

The functional blocks of the SW architecture are summarized below:

- Open Geospatial Consortium (OGC) protocol adapter
- Sensor Event Service (SES)
- Sensor Observation Service (SOS)
- Data Storage
- SES/SOS Client
- Web Platform User Interface

In the following sections the implementation of the SW components are described, both the back-end and the front-end. Special focus will be given on the incorporation of the OGC standards, as well as business logic, the data flow sequence and the web platform and User Interface of the implemented solution. While in D22.2 the basic components and the prototype of the platform was presented, the following sections present the implementation details of the fully integrated and real-time platform.

2.1 OGC Protocol Adapter

OGC Protocol Adapter is responsible for the communication with the Data Logger/Sensor Controller through the serial MODBUS Protocol and retrieves the raw measurement data for each available sensor on the system.

Once the adapter retrieves the sensor data from the Data logger it translates the measurements to the Observation & Measurement (O&M) [1] standard and sends it to the SOS service. SOS is a standard web service interface for requesting, filtering, and retrieving observations and sensor system information.

The adapter implements a filtering rule mechanism based on minimum and maximum measurement thresholds. When the measurements are below minimum or exceed the maximum threshold, an alert can be generated, which is sent to the SES service. SES is a standard web service interface for publishing and subscribing to alerts from sensors. The thresholds have been defined by the operators of the packaged plant.

The following paragraphs describe the Modbus and the OGC interface of the implemented adapter.

2.1.1 Modbus Interface

The OGC Protocol adapter communicates with the sensor controller through the Modbus Serial Protocol. For the communication of the adapter with the Modbus protocol, the jamod library [2] of Java programming language was used. The parameters required for the Modbus Protocol are listed in Table 1.

Table 1: Modbus Configuration Parameters

Parameters Name	Default Values
Parity	NONE
Address	/dev/ttyUSB0
Stop Bit	1
Baud Rate	19200
Data Bit	8

Modbus supports bit or word data transfers. In RS-485 based Modbus networks, the Address Field in the telegram frame is used to address a single device in the network. The Sensor Controller Telegram is a Modbus register map that holds the configured list of devices, their measurements and measurement types and the functions supported. This registers will be used to send the respective message fields to the OGC adapter. It lists the sensor devices, their measurement types and indicates the reference registers in the Modbus message field in order for the adapter to discover and read each particular sensor data. Hach's Sensor Controller Telegram (Table 2) is configured based on the available sensors connected to the controller.

Table 2: Sensor Controller Telegram

Sensor Device	Reference	Measurement	Type
PhD sc Membrane	0	PH	Float
PhD sc Membrane	2	Temperature	Float
Conductivity 34xx sc Prod RO	4	Conductivity	Float
LDO 2	6	DO	Float
LDO 2	8	Temperature	Float
Solitax sc 1594970	10	MLSS	Float
Solitax sc 1595089	12	Turbidity	Float
Anise	14	Ammonium	Float
Anise	16	Nitrate	Float
Anise	18	Potassium	Float
Anise	20	Chloride	Float
Anise	22	Temperature	Float
Nise	24	Nitrate	Float
Nise	26	Chloride	Float
Nise	28	Temperature	Float
Conductivity 3789-2 sc V2 Cond	30	Conductivity	Float
Conductivity 3789-2 sc V2 Cond	32	Temperature	Float
Conductivity 34xx sc COND PROD UF	34	Conductivity	Float
Conductivity 34xx sc COND PROD UF	36	Temperature	Float
pH sc PH RO	38	PH	Float
pH sc PH RO	40	Temperature	Float

The Modbus Protocol has a variety of functions (connect, read, write) that enables the adapter to communicate with the Sensor Controller. The Modbus functions that have been implemented at the adapter are two: The connect function and read functions. The following Table 3 describes the functions on the adapter:

Table 3: Adapter Modbus Functions

Function Name	Function Description
ConnectToDataLogger	This function is responsible for the connection between the datalogger and the Raspberry Pi[1]
GetMeasurements	This function is responsible to read the measurements from the datalogger at the given references from the telegram.

[1] The Raspberry-Pi low cost device serves the needs for the implementation of IoT applications

It is worth noting here that all the data that is handled via the ModBus (bits, registers) must be located in the device application memory. The data references need to be linked with physical addresses. This mapping of the ModBus registers is stored in the device in the form of a Telegram. As the mapping between the ModBus data model and the device application is vendor specific, the term "Telegram" are used by vendors to describe how the ModBus data has been organized into physical addresses.

2.1.2 OGC Interface

The adapter is responsible to translate the raw measurements collected form the sensor controller to the OGC standards (Sensor Model Language, SensorML) [3], O&M) and then forward them to SOS service module. In addition, the adapter detects possible alerts according to the filtering rules for minimum and maximum measurements values based on configured thresholds. When an alert is detected the adapter translates it to SES XML and forwards it to SES service module. The functions of the OGC interface are presented in Table 4.

Table 4: Functions of OGC Interface

Function Name	Function Description
PostNotifications	Responsible for creating an HTTP POST request to "ses/rest/messages" resource in order to send notification message on SES module.
PostMeasurements	Responsible for creating an HTTP post request "sos/rest/observations" resource in order to send observation's data to SOS module.
PostSensor	Responsible for creating an HTTP POST request to "sos/rest/sensors" resource in order to send sensor's metadata to SOS module.
UpdateSensor	Responsible for creating an HTTP POST request to "sos/rest/sensors/{sensorID}" resource in order to send sensor's updated metadata to SOS module.
EncodeSensor	Creates an xml object compliant with OGC SOS 2.0 standard containing the metadata of a sensor.
EncodeObservation	Creates an xml object compliant with OGC SOS 2.0 standard containing the data of an observation.
EncodeNotification	Creates an xml object compliant with SES discussion paper.

2.2 SOS service

The Sensor Observation Service (SOS) [4] handles the sensor metadata through a range of services/functions. The following SOS services are related to an action relevant to metatdata (e.g. insertion, retrieval, update, deletion), and are implement in the context of the DESSIN SOS Service:

- POST sos/rest/sensors (Insertion of sensor metadata)
- GET sos/rest/sensors/id (Retrieve specific sensor metadata)
- PUT sos/rest/sensors/id (Update specific sensor metadata)
- DELET sos/rest/sensors/id (Delete specific sensor metadata)

For example, if one has to access the metadata of a sensor, then the HTTP GET method needs to be called through the path http://147.102.5.15:8080/sos-dessin/service/rest/sensors/DL0_S0 of the SOS website for the DESSIN. An XML with all the available metadata of the sensor in SensorML format will be returned.

Annex II provides an example of such an XML, highlighting in RED text the most important metadata fields.

The SOS Module is an aggregator service module that allows any authorized client to access (read/write) live sensor data, historical data as well as sensor metadata through a web service call. It is, in other words, a web service that allows querying from / inserting to the database of real time or time-series sensor observations. Data can be selected based on time range, sensor type, geographical and network topology. The SOS Core Extension Functions are shown in Table 5.

Table 5: SOS-Core Extension Functions

Function Name	Function Description
GetCapabilities	Returns a self-description of the service.
GetObservation	Returns the pure sensor data encoded in Observations & Measurements 2.0 (O&M).
DescribeSensor	Returns information about a certain sensor, encoded in a Sensor Model Language 1.0.1 (SensorML) instance document.

The SOS Transactional Extension Functions are presented in Table 6.

Table 6: SOS-Transactional Extension Functions

Function Name	Function Description
InsertSensor	Publishes new sensors.
UpdateSensorDescription	Updates the description of a registered sensor.
DeleteSensor	Deletes a sensor.
InsertObservation	Publishes observations for registered sensors

The SOS Enhanced Extension Functions are depicted in Table 7.

Table 7: SOS-Enhanced Extension Functions

Function Name	Function Description
GetFeatureOfInterest	Returns the GML 3.2.1 encoded representation of the feature that is the target of the observation.
GetObservaitonById	Returns the pure sensor data encoded in Observations & Measurements 2.0 (O&M) for a specific observation identifier.

The 52°North Sensor Web [5] framework provides the implementations for the SOS and SES services. Moreover, it offers discovery of sensors by implementation of Sensor Instance Registry (SIR) and an intermediary layer, called the Sensor Bus, to which sensor resources and SWE services can be adapted to establish communication. In DESSIN project 52°North's SOS RESTful Extension [6] was implemented, which provides access to and manipulation of SOS resources (i.e., observations, capabilities, offerings, sensors, and features) in a RESTful way, that uses plain HTTP methods (GET, DELETE, POST, PUT) to interact with those resources, beyond the standard Key-Value Pair (KVP) and Simple Object Access Protocol (SOAP) bindings.

The mapping of the Core Extension and Transactional Extension Functions to the SOS REST API is presented in Table 8 and Table 9.

Table 8: SOS-REST Core Extension Functions

Core Extension Functions	SOS REST API
GetCapabilities	GET /sos/rest/capabilities
GetObservation	GET /sos/rest/observations{?procedures, temporalfilter, spatialfilter, responseFormat}
DescribeSensor	GET /sos/rest/sensors/{id}

Table 9: SOS-REST Transactional Extension Functions

Transactional Extension Functions	SOS REST API
InsertSensor	POST /sos/rest/sensors
UpdateSensorDescription	PUT /sos/rest/sensors/{id}
DeleteSensor	DELETE /sos/rest/sensors/{id}
InsertObservation	POST /sos/rest/observations

2.3 SES service

Sensor Event Service (SES) [7] Module provides a publish/subscribe based access to alerts within the sensor network. It is a means of notification for all the events that happen. Since it is a publish-subscribe service, it creates different topics so the consumer does not have to receive unwanted alerts.

SES has three sub-services according to the OGC discussion paper:

- Information Broker
- Subscription Manager and
- Publisher Registration Manager

The SES Broker Functions are listed in Table 10.

Table 10: SES-Broker Functions

Function Name	Function Description
GetCapabilities	Returns a self-description of the service.
DescribeSensor	Returns a description of a specific sensor
ListStoredFilters	Returns a list of the available stored filters
DescribeStoredFilters	Returns a description of a specific filter that is stored
Notify	Sends an event message-notification to the information subscriber-consumer
Subscribe	Establishes a subscription to a certain publication
RegisterPublisher	Registers the Publisher to a topic

The SES Subscription Manager Functions are listed in Table 11.

Table 11: SES-Subscription Manager Functions

Function Name	Function Description
Destroy	Deletes the subscription
SetTerminationTime	Sets a termination time for the subscription
PauseSubscription	Pauses a subscription
ResumeSubscription	Resumes a subscription

The Publisher Registration Manager Functions are listed in Table 12.

Table 12: SES-Publisher Registration Manager Functions

Function Name	Function Description
Destroy	Deletes the publisher
SetTerminationTime	Sets the termination time of the registration
RenewRegistration	Refreshes the registration of the publisher

2.3.1 SES Functions

The 52°North's SES implementation doesn't include a RESTFUL binding. Hence, the following RESTFUL bindings were implemented according to SES discussion paper and our needs, as presented in Table 13.

Table 13: SES-Rest API

SES REST API	Function Description
GetCapabilities	GET /rest/capabilities
RegisterPublisher	POST /rest/registrations
GetSensors	GET /rest/registrations
DescribeSensor	GET /rest/registrations/{publisherId}
DestroyRegistration	DELETE /rest/registrations/{publisherId}
SetTerminationTimePublisher	PUT /rest/registrations/{publisherId}/termination_time
Subscribe	POST /rest/subscriptions
Unsubscribe	DELETE /rest/subscriptions/{subscriberId}
SetTerminationTimeSubscriber	PUT /rest/subscriptions/{subscriberId}/termination_time
Notify	POST /rest/messages
ListStoredFilters	GET /rest/filters
DescribeStoredFilters	GET /rest/filters/{storedFilterId}

2.3.2 SES Interfaces to DB

The 52° North SES service module uses the WS Resources specification [8]. The SES uses the interfaces to manage the lifetime and state of resources. A WS-Resource is the composition of a resource and a Web Service through which the resource can be accessed. A WS-Resource is further defined as follows:

- A reference to a WS-Resource is represented by an End Point Reference (EPR), or more precisely an XML element whose type is, or is derived (by extension), from the complexType named EndpointReferenceType defined by the [WS-Addressing] specification. Such EPRs MUST reference exactly one WS-Resource.
- The set of properties of the resource MUST be expressed using an XML Infoset described by XML schema. The WS-Resource MUST support accessing resource properties through message exchanges defined by the WS-Resource Properties specification [WS-ResourceProperties].
- A WS-Resource MAY support the message exchanges defined by the WS-Resource Lifetime specification [WS-ResourceLifetime].

2.4 Sensor Data Representation Layer

2.4.1 SensorML

The following table (Table 14) contains the most important data model attributes of the xml of a sensor sent to SOS service module.

Table 14: SensorML Data Model Attributes Description

Data model Attribute	Attribute Description
IdentifierList	Contains a list of identifiers element that describe the sensor ID, the long name and the short name
ParametersList	Contains a list of parameters elements that describe the location name of the sensor, the minimum and maximum thresholds of the sensor

2.4.2 O&M

The following table (Table 15) contains the most important data model attributes of xml of an observation sent to SOS service module.

Table 15: O&M Data Model Attributes Description

Data model Attribute	Attribute Description
procedure	Describe the procedure id of the sensor
timePosition	Timestamp of the observation
result	Describes the unit of measurement and the value of the measurement

2.4.3 SES notification

The following table (Table 16) contains the most important data model attributes of xml of a notification sent to SES service module.

Table 16: SES Notification Data Model Attributes Description

Data model Attribute	Attribute Description
Topic	Topic name that the notification will be send to SES service module
Sensor	Sensor ID
AlarmType	Definition of the alarm
TimeOfAlarm	Timestamp of the alarm
ReasonForAlarm	A message that describes why an alarm occurred

2.5 SOS/SES client

The SOS/SES Client is a Data Fusion Engine (using JavaEE and SpringMVC technologies running on Apache Tomcat 7.0 Server) which communicates with the SOS/SES services and is able to parse the OGC XML messages by using the message decoder. The outcome of the decryption is a JSON (or XML) object which is sent to the DESSIN Web Engine (Dashboard) requested by the operator (Figure 2).

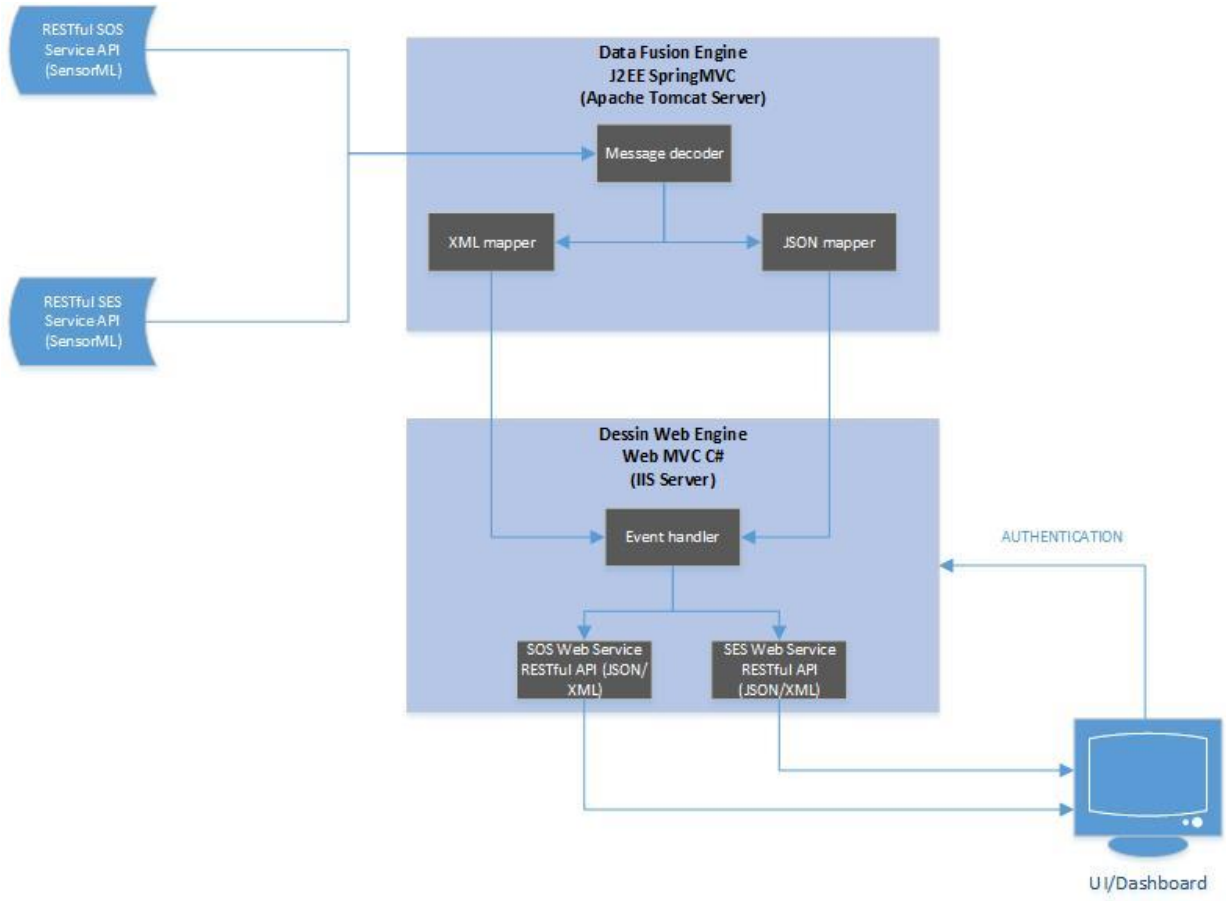

Figure 2: SOS/SES Client Engine Functional Diagram

Table 17 presented below, describes the most important functions of the Data Fusion Engine.

Table 17: Data Fusion Engine Functions

Function Name	Function Description
getAPIRequestByHref	An HTTP request for specific sensor. Returns a sensroML type inputstream.
parseSensorMlFromSOS	It is the main decoding function for SOS. It receives sensorML format data and returns a Sensor Object (JSON and XML).
ServerSocketImpl	Starts a server socket for the SES communication.
decodeAlarm	It receives a SES input and returns a decoded Alarm Object (JSON and XML)
parseSES	It adds the decoded message to the AlarmList

The most important fields of the Sensor object are depicted in Table 18.

Table 18: Sensor Object Description

Attribute	Description
name	Name of the sensor.
location	The location of the sensor on the installation site.
Uom	Unit of measurement.
Min	Minimum value of measurements allowed.
Max	Maximum value of measurements allowed.

Table 19 contains the most important attributes of the SES Alarm/Event object.

Table 19: Alarm/Event Object Description

Attribute	Description
name	Name of the sensor.
alarmType	Definition of alarm.
timeOfAlarm	Time of the alarm/event happened.
reasonForAlarm	Explanation of the reason that alarm/event happened.

2.6 Web Platform (Dashboard)

The DESSIN web platform is the essential tool for the user to monitor and administer the sewer mining system. Because of its responsive components, the user can have access to the tool through various devices which have Internet browsers of different form factors (i.e. Desktop PCs, Tablets and Smart Phones). In the next paragraphs we will describe the functionalities of the Dashboard and the interaction with the SOS/SES client.

Login

The first page of the Dashboard is the Login page, where the User/Operator inserts his/her credentials to enter the tool. This is a secured functionality using OAuth2 protocol [9]. OAuth2 allows user's account information to be used safely, without displaying the user's password. OAuth acts as a mediator on behalf of the end user, providing the service with an access token that authorizes specific account information to be shared. Therefore, if credentials are correct, the user/operator will have access to specific functionalities of the platform, depending on his/her role (simple user, operator, administrator, etc.).

Figure 3: Web Platform UI Login Screen

Live Measurements

The user is able to monitor in real-time the water features/characteristics of the sewer mining system's sensors as shown in Figure 4. Characteristics include: Turbidity, Temperature, Conductivity, pH, BOD, Ammonium, etc. The user can select specific "locations" of the tank providing measurements (e.g. Membrane Tank, Aeration Tank) to be displayed, and specific sensors to be monitored. Gauge charts, showing the current value of each measurement, are displayed and graphs showing all selected measurements grouped by water characteristic. This is very helpful for the user/operator of the system, because he/she can simply compare values of the same water characteristic, as it is displayed on one graph.

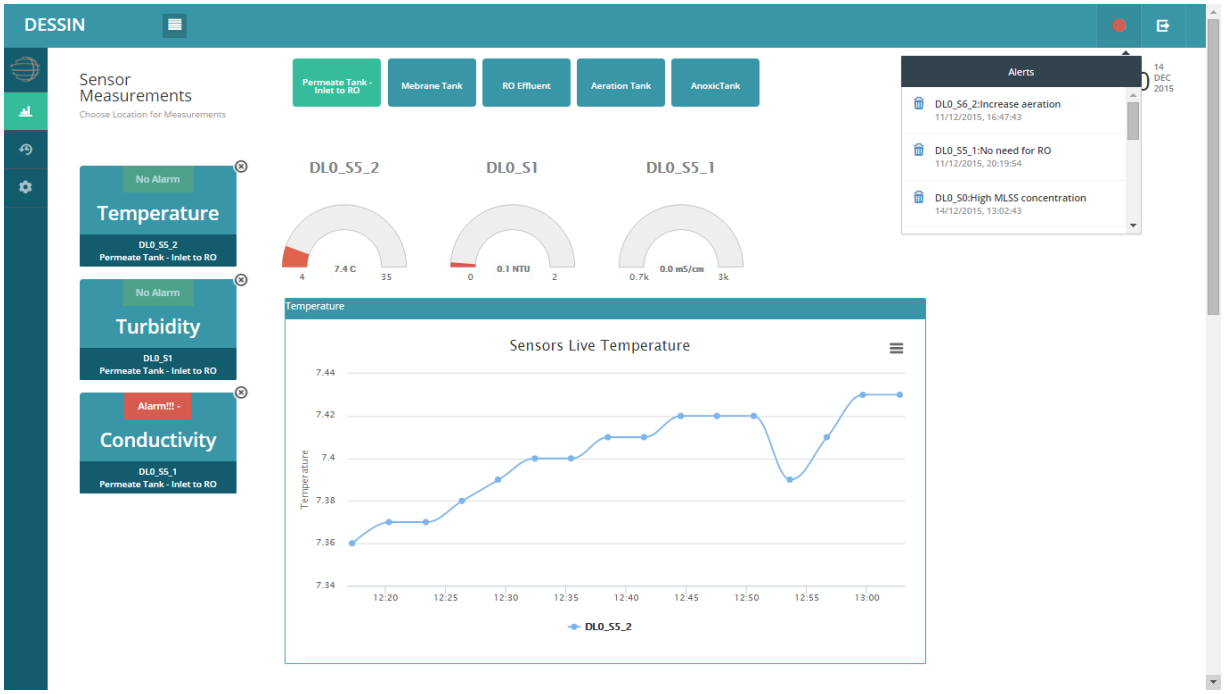

Figure 4: Web Platform Live Data Screen

Historical Data

The user can monitor water features/characteristics for a specific period of time (Today, Yesterday, Last 7 days, This month, Last month and Custom range) as indicated in Figure 5. Just as in the Live Measurements screen, the user can select specific tank "locations" of measurements to be displayed and specific sensors to monitor. Graphs are displayed, showing all selected measurements grouped by the same type of water characteristic.

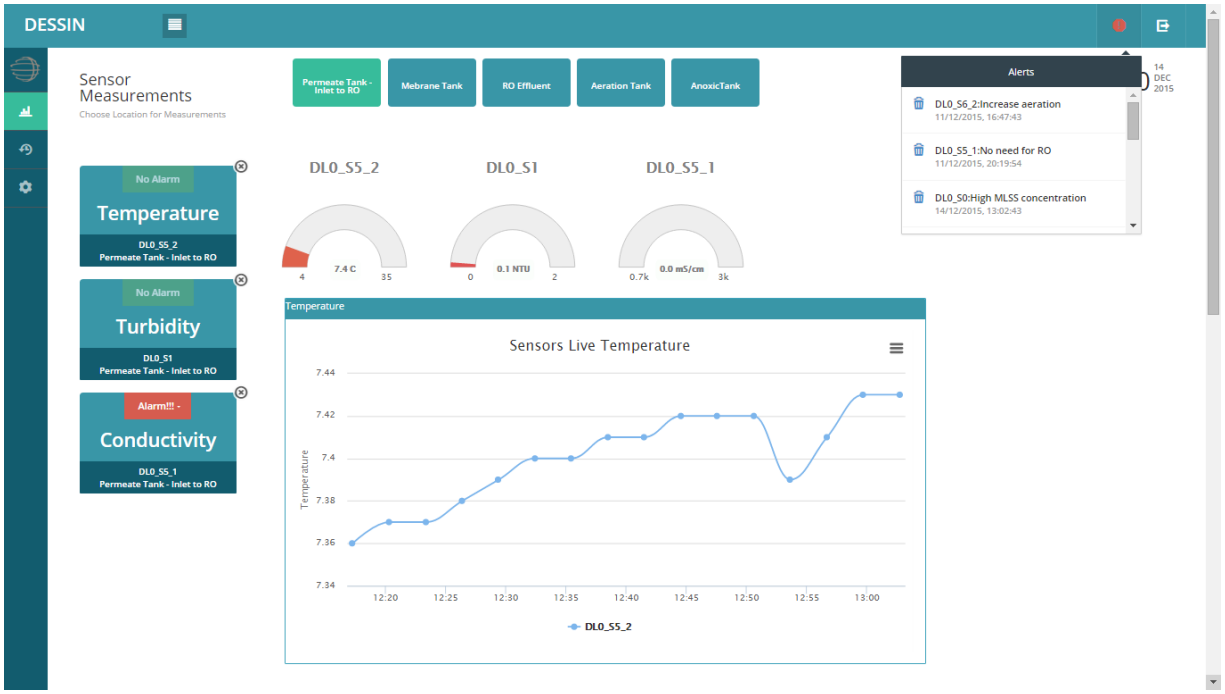

Figure 5: Web Platform Historical Data Screen

Alerts/Events Notification Feature

The platform has an embedded real-time alerting feature, which displays all the messages/notifications of the alert/event. Every message includes information such as the time of the event, the name of the sensor and the description or action that should be taken (Figure 6).

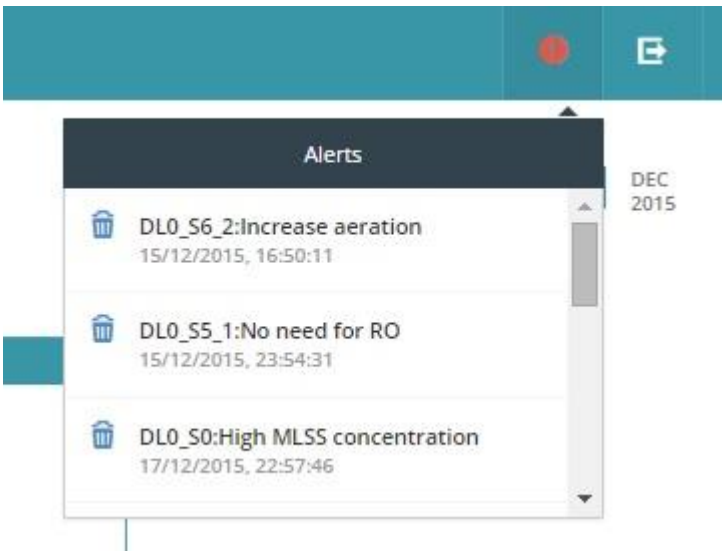

Figure 6: Alert/Event Notification Feature

Printing and Exporting Features

The user/operator of the system has the ability to print every selected chart, or export to different image formats (PNG, JPEG, SVG), save it to PDF document, but most importantly, to save all the values of the graph in CSV or EXCEL format as highlighted in Figure 7.

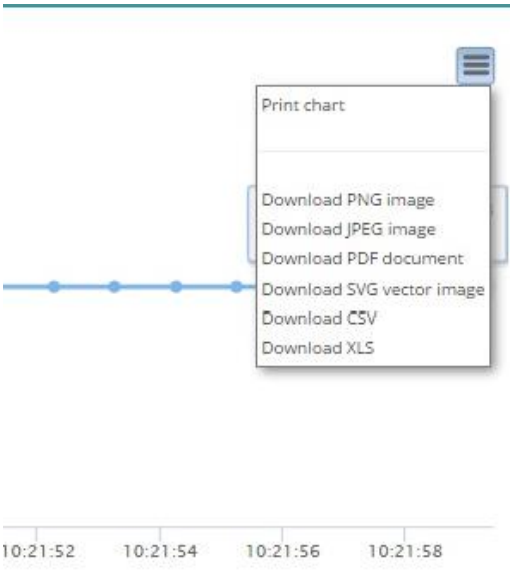

Figure 7: Printing and Exporting Features

Configuration Settings

This page includes the configuration of the MODBUS configuration parameters. This is a screen to which only administrators have access, so it is not visible to other users. The administrator has the ability to add/update or reset the configuration settings of the MODBUS controller as illustrated in Figure 8.

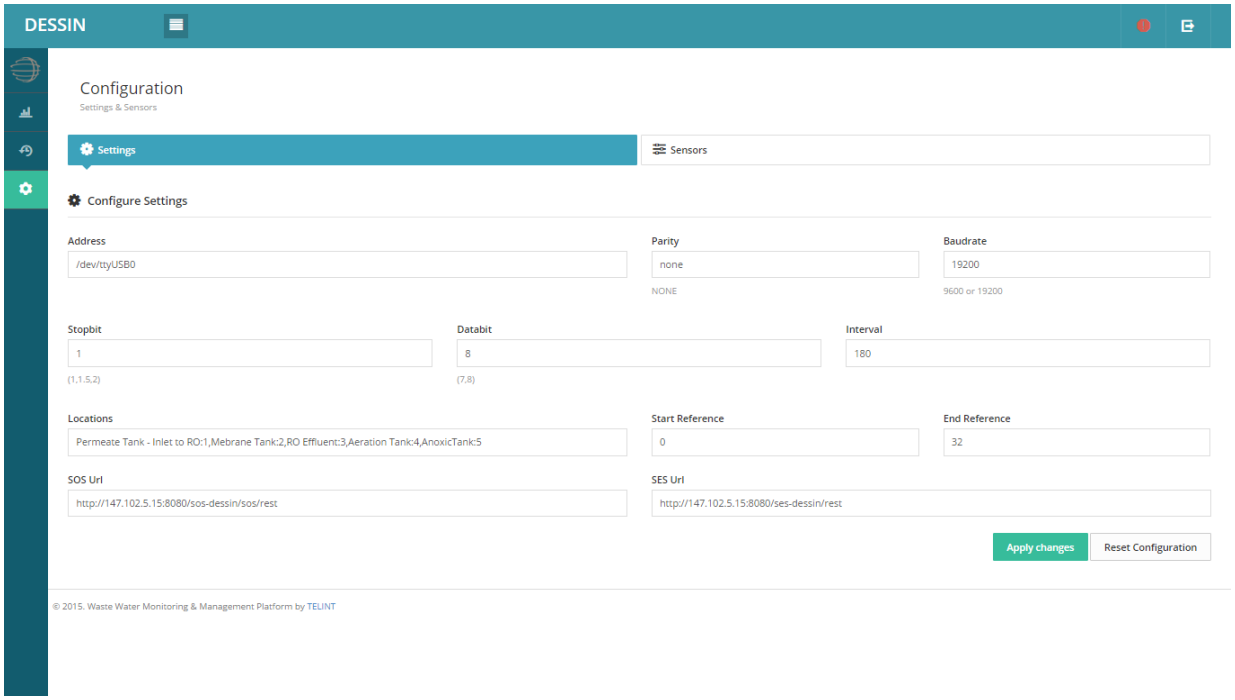

Figure 8: Configuration Settings screen

Sensors Configuration

This is a screen for configuring the sensors of the system. It is also an administrator-only protected screen. The administrator can monitor all sensors of the system (Figure 9), having the ability to search for specific sensor and group by specific parameters. Other features of this page, is the ability of the administrator to add a new sensor (Figure 10), delete a selected sensor or update a selected sensor (Figure 11).

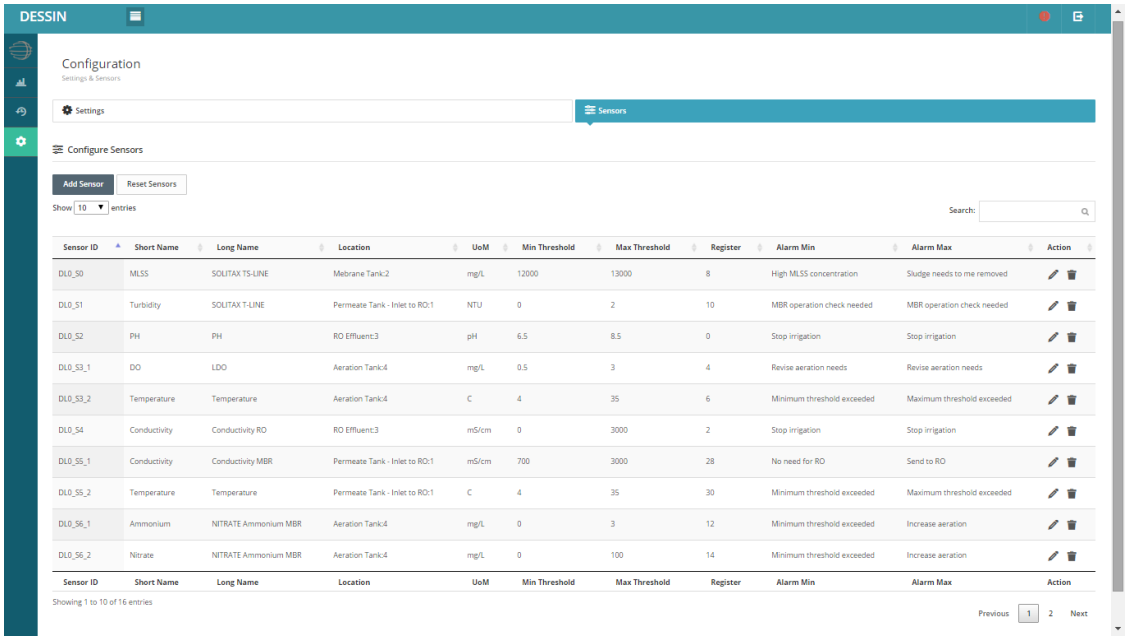

Figure 9: List all sensors feature

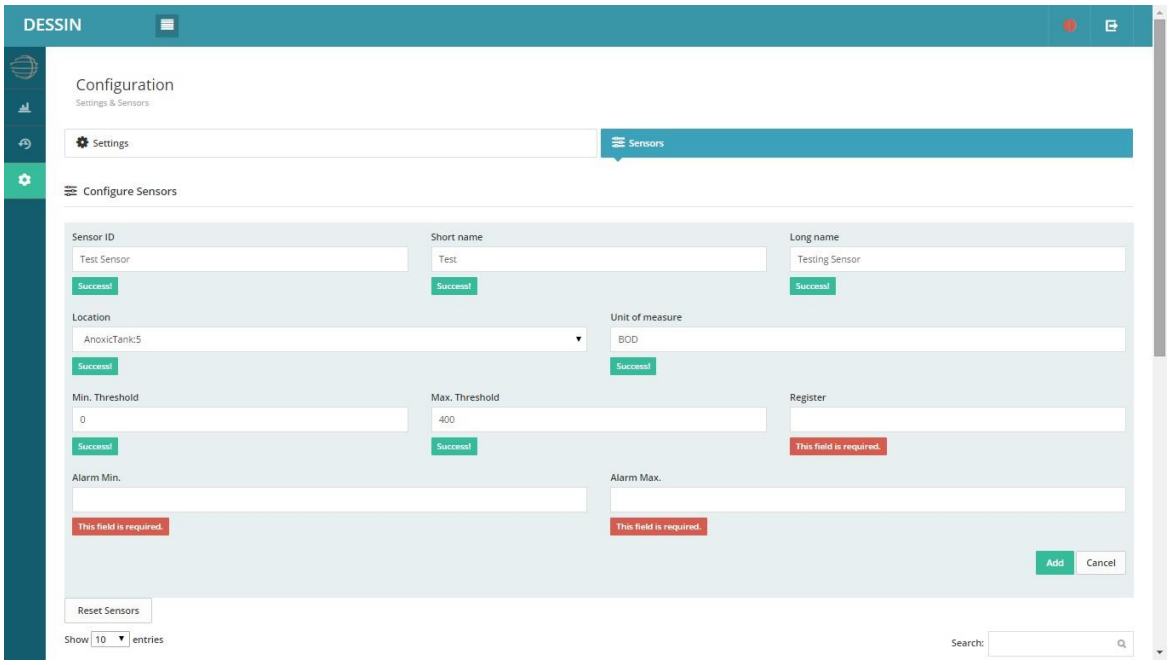

Figure 10: Add new sensor feature

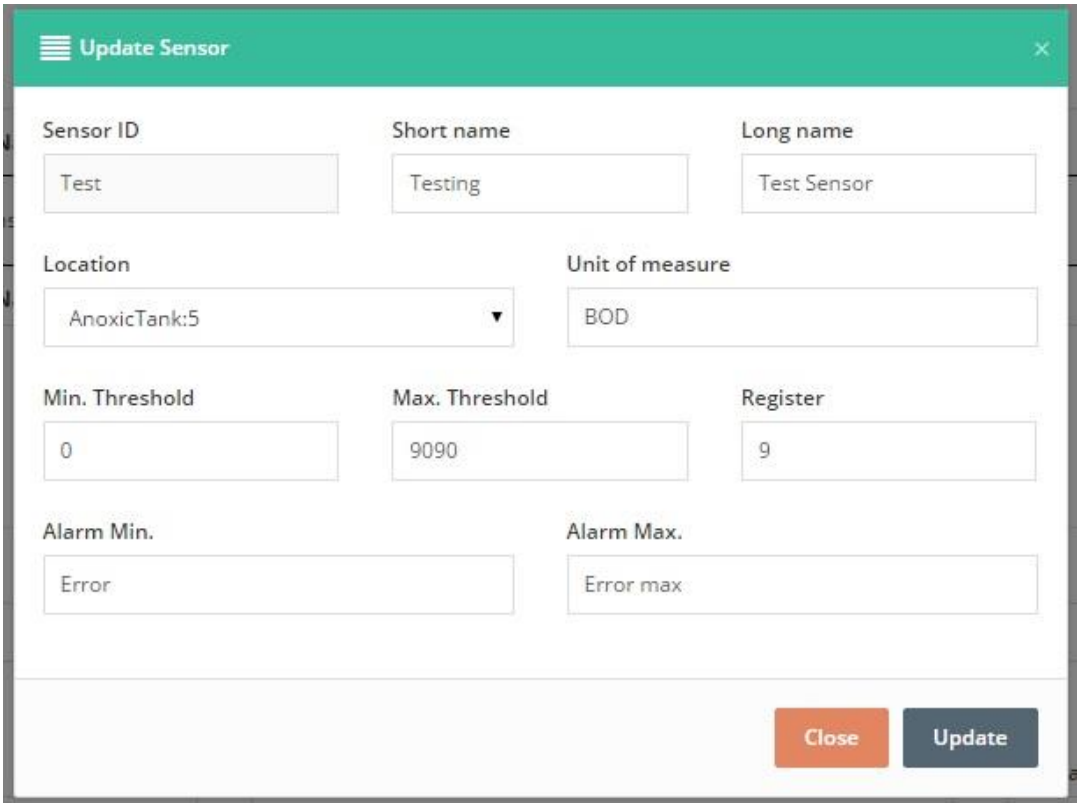

Figure 11: Update selected sensor feature

Figure 12 depicts the aforementioned functionalities/features in a detailed flow chart.

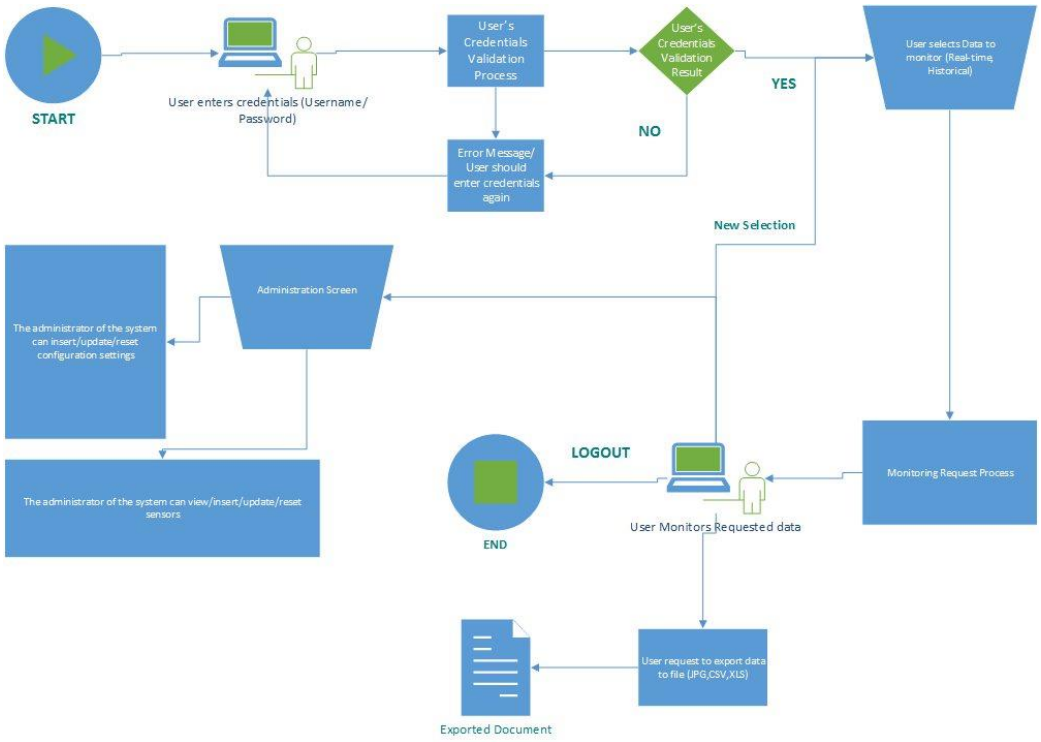

Figure 12: Web Platform (Dashboard) User Control Flow

Table 20 describes the most important functions and interactions with SOS/SES of the Web platform.

Table 20: Web Platform Engine Functions

Function Name	Function Description
"/rest/sensors/location" getSensorsObject	An HTTP request to get all sensors and group them by location. Each sensor can have multiple measurements. This is a decoded message received from SOS.
" /rest/sensors/observations/ sensorsList/dateFrom/dateTo" getSensorObservationById	An HTTP request to get specific sensors measurements for a selected period of time and group them by measurement type. Each sensor can have multiple measurement types. This is a decoded message received from SOS.
"/rest/receiveWeb" receiveWebMessage	An HTTP request to receive all the events/alerts from SES. This is a decoded SES message.

3 Conclusions

This report provides a textual description of the actual Deliverable D34.2 which is the demonstrated "Software/Hardware Platform for Monitoring and Control of Small Packaged Plants for Urban Sewer Mining", whose corresponding ICT Platform components and design is extensively described in Deliverable D22.2.

The actual plant in KEREFYT, the Sanitary Engineering Research and Development Centre of EYDAP, is fully functional and currently in operation for testing and demo purposes.

As the problem of water scarcity in urban environments is continuously increasing in severity, the DESSIN Sewer Mining technology will serve to alleviate issues in this area by extracting and treating waste water from sewers, and using this water for irrigation purposes.

The benefits of the unit's size, autonomy and ease of installation, will allow the unit's placement in close proximity to water use, and will render the installation very discrete. The end result will be the creation of more parks in urban environments without the spending of additional water for their maintenance, leading to a more improved quality of urban life.

Sensor XML file:

```
    <?xml version="1.0" encoding="UTF-8"?>
    <sosREST:Sensor xmlns:sosREST="http://www.opengis.net/sosREST/1.0">
      <sml:System xmlns:swes="http://www.opengis.net/swes/2.0" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe/1.0.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:sos="http://www.opengis.net/sos/3.0"
xmlns:sml="http://www.opengis.net/sensorML/1.0.1">
        <sml:keywords>
          <sml:KeywordList>
            <sml:keyword>foi_DL0_S0</sml:keyword>
            <sml:keyword>o_DL0_S0</sml:keyword>
            <sml:keyword>DL0_S0</sml:keyword>
            <sml:keyword>op_DL0_S0</sml:keyword>
            <sml:keyword>MLSS</sml:keyword>
            <sml:keyword>SOLITAX TS-LINE</sml:keyword>
          </sml:KeywordList>
        </sml:keywords>
        <sml:identification>
          <sml:IdentifierList>
            <sml:identifier name="uniqueID">
              <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:uniqueID">
                <sml:value>DL0_S0</sml:value>
              </sml:Term>
            </sml:identifier>
            <sml:identifier name="longName">
              <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:longName">
                <sml:value>SOLITAX TS-LINE</sml:value>
              </sml:Term>
            </sml:identifier>
```

```
    <sml:identifier name="shortName">
      <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:shortName">
        <sml:value>MLSS</sml:value>
      </sml:Term>
    </sml:identifier>
    <sml:identifier name="Offering for DL0_S0">
      <sml:Term definition="urn:ogc:def:identifier:OGC:offeringID">
        <sml:value>o_DL0_S0</sml:value>
      </sml:Term>
    </sml:identifier>
  </sml:IdentifierList>
</sml:identification>
<sml:validTime>
  <gml:TimePeriod>
    <gml:beginPosition>2015-12-10T08:47:07.519Z</gml:beginPosition>
    <gml:endPosition indeterminatePosition="unknown"/>
  </gml:TimePeriod>
</sml:validTime>
<sml:capabilities name="InsertionMetadata">
  <swe:SimpleDataRecord>
    <swe:field name="sos:ObservationType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement</swe:value>
      </swe:Text>
    </swe:field>
    <swe:field name="sos:ObservationType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CategoryObservation</swe:value>
      </swe:Text>
    </swe:field>
    <swe:field name="sos:ObservationType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CountObservation</swe:value>
```

```
      </swe:Text>
    </swe:field>
    <swe:field name="sos:ObservationType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_TextObservation</swe:value>
      </swe:Text>
    </swe:field>
    <swe:field name="sos:ObservationType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_TruthObservation</swe:value>
      </swe:Text>
    </swe:field>
    <swe:field name="sos:featureOfInterestType">
      <swe:Text>
        <swe:value>http://www.opengis.net/def/samplingFeatureType/OGC-OM/2.0/SF_SamplingPoint</swe:value>
      </swe:Text>
    </swe:field>
  </swe:SimpleDataRecord>
</sml:capabilities>
<sml:capabilities name="featuresOfInterest">
  <swe:SimpleDataRecord>
    <swe:field name="featureOfInterestID">
      <swe:Text definition="http://www.opengis.net/def/featureOfInterest/identifier">
        <swe:value>foi_DL0_S0</swe:value>
      </swe:Text>
    </swe:field>
  </swe:SimpleDataRecord>
</sml:capabilities>
<sml:capabilities name="observedBBOX">
  <swe:DataRecord>
    <swe:field name="observedBBOX">
      <swe:Envelope definition="urn:ogc:def:property:OGC:1.0:observedBBOX" referenceFrame="4326">
        <swe:lowerCorner>
```

```
        <swe:Vector>
          <swe:coordinate name="easting">
            <swe:Quantity axisID="x">
              <swe:uom code="degree"/>
              <swe:value>0.0</swe:value>
            </swe:Quantity>
          </swe:coordinate>
          <swe:coordinate name="northing">
            <swe:Quantity axisID="y">
              <swe:uom code="degree"/>
              <swe:value>0.0</swe:value>
            </swe:Quantity>
          </swe:coordinate>
        </swe:Vector>
      </swe:lowerCorner>
      <swe:upperCorner>
        <swe:Vector>
          <swe:coordinate name="easting">
            <swe:Quantity axisID="x">
              <swe:uom code="degree"/>
              <swe:value>0.0</swe:value>
            </swe:Quantity>
          </swe:coordinate>
          <swe:coordinate name="northing">
            <swe:Quantity axisID="y">
              <swe:uom code="degree"/>
              <swe:value>0.0</swe:value>
            </swe:Quantity>
          </swe:coordinate>
        </swe:Vector>
      </swe:upperCorner>
    </swe:Envelope>
  </swe:field>
```

```
  </swe:DataRecord>
</sml:capabilities>
<sml:capabilities name="offerings">
  <swe:SimpleDataRecord>
    <swe:field name="Offering for DL0_S0">
      <swe:Text definition="http://www.opengis.net/def/offering/identifier">
        <swe:value>o_DL0_S0</swe:value>
      </swe:Text>
    </swe:field>
  </swe:SimpleDataRecord>
</sml:capabilities>
<sml:contact>
  <sml:ContactList>
    <sml:member>
      <sml:ResponsibleParty>
        <sml:individualName>TBA</sml:individualName>
        <sml:organizationName>52North</sml:organizationName>
        <sml:positionName>TBA</sml:positionName>
        <sml:contactInfo>
          <sml:phone>
            <sml:voice>+49(0)251/396 371-0</sml:voice>
          </sml:phone>
          <sml:address>
            <sml:deliveryPoint>Martin-Luther-King-Weg 24</sml:deliveryPoint>
            <sml:city>Münster</sml:city>
            <sml:postalCode>48155</sml:postalCode>
            <sml:country>Germany</sml:country>
            <sml:electronicMailAddress>info@52north.org</sml:electronicMailAddress>
          </sml:address>
          <sml:onlineResource xlink:href="http://52north.org/swe"/>
        </sml:contactInfo>
      </sml:ResponsibleParty>
    </sml:member>
```

```
    </sml:ContactList>
  </sml:contact>
  <sml:inputs>
    <sml:InputList>
      <sml:input name="input_op_DL0_S0">
        <swe:ObservableProperty definition="op_DL0_S0"/>
      </sml:input>
    </sml:InputList>
  </sml:inputs>
  <sml:outputs>
    <sml:OutputList>
      <sml:output name="output_op_DL0_S0">
        <swe:Quantity definition="op_DL0_S0">
          <swe:uom code="mg/L"/>
        </swe:Quantity>
      </sml:output>
    </sml:OutputList>
  </sml:outputs>
  <sml:parameters>
    <sml:ParameterList>
      <sml:parameter name="min">
        <swe:Quantity>
          <swe:value>12000</swe:value>
        </swe:Quantity>
      </sml:parameter>
      <sml:parameter name="max">
        <swe:Quantity>
          <swe:value>13000</swe:value>
        </swe:Quantity>
      </sml:parameter>
      <sml:parameter name="location">
        <swe:Text>
          <swe:value>Mebrane Tank:2</swe:value>
```

```
              </swe:Text>
            </sml:parameter>
          </sml:ParameterList>
        </sml:parameters>
      </sml:System>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/self" href="http://147.102.5.15:8080/sos-
dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/sensor-delete" href="http://147.102.5.15:8080/sos-
dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/sensor-update" href="http://147.102.5.15:8080/sos-
dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/features-get" href="http://147.102.5.15:8080/sos-
dessin/service/rest/features?procedures=DL0_S0" type="application/gml+xml"/>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/observations-get" href="http://147.102.5.15:8080/sos-
dessin/service/rest/observations?procedures=DL0_S0" type="application/gml+xml"/>
      <sosREST:link rel="http://www.opengis.net/sosREST/1.0/property-get" href="http://147.102.5.15:8080/sos-
dessin/service/rest/properties/op_DL0_S0" type="application/gml+xml"/>
    </sosREST:Sensor>
```

Observation xml :

```
<?xml version="1.0" encoding="UTF-8"?>
<sosREST:ObservationCollection xmlns:sosREST="http://www.opengis.net/sosREST/1.0"
xmlns:om="http://www.opengis.net/om/2.0" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <sosREST:Observation>
    <om:OM_Observation gml:id="o_C7852BF6B771BDB0A69F23FB0C040D1552DED2F9">
      <gml:identifier codeSpace="java.util.UUID">02fa193b-be2c-4b7c-9bc8-25586e1057e1</gml:identifier>
      <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement"/>
      <om:phenomenonTime>
        <gml:TimeInstant gml:id="phenomenonTime_121869">
          <gml:timePosition>2015-12-01T00:01:15.000Z</gml:timePosition>
        </gml:TimeInstant>
```

```
      </om:phenomenonTime>
      <om:resultTime xlink:href="#phenomenonTime_121869"/>
      <om:procedure xlink:href="DL0_S0"/>
      <om:observedProperty xlink:href="op_DL0_S0"/>
      <om:featureOfInterest xlink:href="foi_DL0_S0"/>
      <om:result xmlns:ns="http://www.opengis.net/gml/3.2" uom="mg/L" xsi:type="ns:MeasureType">2.35</om:result>
    </om:OM_Observation>
    <sosREST:link rel="http://www.opengis.net/sosREST/1.0/self" href="http://147.102.5.15:8080/sos-
dessin/service/rest/observations/02fa193b-be2c-4b7c-9bc8-25586e1057e1" type="application/gml+xml"/>
    <sosREST:link rel="http://www.opengis.net/sosREST/1.0/observation-delete" href="http://147.102.5.15:8080/sos-
dessin/service/rest/observations/02fa193b-be2c-4b7c-9bc8-25586e1057e1" type="application/gml+xml"/>
    <sosREST:link rel="http://www.opengis.net/sosREST/1.0/feature-get" href="http://147.102.5.15:8080/sos-
dessin/service/rest/features/foi_DL0_S0" type="application/gml+xml"/>
    <sosREST:link rel="http://www.opengis.net/sosREST/1.0/sensor-get" href="http://147.102.5.15:8080/sos-
dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
  </sosREST:Observation>
</sosREST:ObservationCollection>
```

Subscription xml:

```
<?xml version="1.0" encoding="UTF-8"?>
<sesREST:Subscribe xmlns:sesREST="http://www.dessin-project.eu/sesREST/1.0">
<wsnt:Subscribe xmlns:wsnt="http://docs.oasis-open.org/wsn/b-2" xmlns:wsa="http://www.w3.org/2005/08/addressing">
    <wsnt:ConsumerReference>
        <wsa:Address>http://localhost:8082</wsa:Address>
    </wsnt:ConsumerReference>
    <wsnt:Filter>
      <wsnt:TopicExpression Dialect=   "http://docs.oasis-open.org/wsn/t-
1/TopicExpression/Simple">General</wsnt:TopicExpression>
    </wsnt:Filter>
</wsnt:Subscribe>
</sesREST:Subscribe>
```

Alarm xml:

```
<?xml version="1.0" encoding="UTF-8"?>
<sesREST:Notify xmlns:sesREST="http://www.dessin-project.eu/sesREST/1.0" xmlns:dessin="http://www.dessin-
project.eu/dessin/1.0" >
 <wsnt:Notify xmlns:wsa="http://www.w3.org/2005/08/addressing"
    xmlns:wsnt="http://docs.oasis-open.org/wsn/b-2">
            <wsnt:NotificationMessage>
                <wsnt:Topic Dialect="http://docs.oasis-open.org/wsn/t-1/TopicExpression/Simple">
       General </wsnt:Topic>
                <wsnt:Message>
             <dessin:Alarm>
                    <dessin:Sensor id="DL0_S0"/>
                    <dessin:AlarmType>LEAK</dessin:AlarmType>
                    <dessin:TimeOfAlarm>2015-09-24T12:54:00</dessin:TimeOfAlarm>
                    <dessin:ReasonForAlarm>high MLSS concentration</dessin:ReasonForAlarm>
             </dessin:Alarm>
                </wsnt:Message>
            </wsnt:NotificationMessage>
        </wsnt:Notify>
</sesREST:Notify>
```

Locations JSON Object (SOS decoded)


```
{"AnoxicTank:5":[{"id":"DL0_S7_1","shortName":"Nitrate","longName":"NITRATE
MBR","locationFullName":"AnoxicTank:5","location":"AnoxicTank","locationOrder":5,"min":"0.5","max":"2.0","outputList":[
{"SensorID":"DL0_S7_1","Uom":"mg/L","ObservedProperty":"op_DL0_S7_1"}],"inputList":[{"observedProperty":"op_DL0_S7_1","
sensorID":"DL0_S7_1"}],"parameterList":[]},{"id":"DL0_S7_2","shortName":"Chloride","longName":"NITRATE
MBR","locationFullName":"AnoxicTank:5","location":"AnoxicTank","locationOrder":5,"min":"0.0","max":"2000.0","outputList
":[{"SensorID":"DL0_S7_2","Uom":"mg/L","ObservedProperty":"op_DL0_S7_2"}],"inputList":[{"observedProperty":"op_DL0_S7_2
","sensorID":"DL0_S7_2"}],"parameterList":[]},{"id":"DL0_S7_3","shortName":"Temperature","longName":"Temperature","loca
tionFullName":"AnoxicTank:5","location":"AnoxicTank","locationOrder":5,"min":"4.0","max":"35.0","outputList":[{"SensorI
D":"DL0_S7_3","Uom":"C","ObservedProperty":"op_DL0_S7_3"}],"inputList":[{"observedProperty":"op_DL0_S7_3","sensorID":"D
L0_S7_3"}],"parameterList":[]}],"Aeration
```

Tank:4":[{"id":"DL0_S3_1","shortName":"DO","longName":"LDO","locationFullName":"Aeration Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"0.5","max":"3.0","outputList":[{"SensorID":"DL0_S3_1","Uom":"mg/L","ObservedProperty":"o
p_DL0_S3_1"}],"inputList":[{"observedProperty":"op_DL0_S3_1","sensorID":"DL0_S3_1"}],"parameterList":[]},{"id":"DL0_S3_
2","shortName":"Temperature","longName":"Temperature","locationFullName":"Aeration Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"4.0","max":"35.0","outputList":[{"SensorID":"DL0_S3_2","Uom":"C","ObservedProperty":"op_
DL0_S3_2"}],"inputList":[{"observedProperty":"op_DL0_S3_2","sensorID":"DL0_S3_2"}],"parameterList":[]},{"id":"DL0_S6_1"
,"shortName":"Ammonium","longName":"NITRATE Ammonium MBR","locationFullName":"Aeration Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"0.0","max":"3.0","outputList":[{"SensorID":"DL0_S6_1","Uom":"mg/L","ObservedProperty":"o
p_DL0_S6_1"}],"inputList":[{"observedProperty":"op_DL0_S6_1","sensorID":"DL0_S6_1"}],"parameterList":[]},{"id":"DL0_S6_
2","shortName":"Nitrate","longName":"NITRATE Ammonium MBR","locationFullName":"Aeration Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"0.0","max":"100.0","outputList":[{"SensorID":"DL0_S6_2","Uom":"mg/L","ObservedProperty":
"op_DL0_S6_2"}],"inputList":[{"observedProperty":"op_DL0_S6_2","sensorID":"DL0_S6_2"}],"parameterList":[]},{"id":"DL0_S
6_3","shortName":"Potassium","longName":"NITRATE Ammonium MBR","locationFullName":"Aeration
Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"0.0","max":"1000.0","outputList":[{"SensorID":"DL0_S6_3","Uom":"mg/L","ObservedProperty"
:"op_DL0_S6_3"}],"inputList":[{"observedProperty":"op_DL0_S6_3","sensorID":"DL0_S6_3"}],"parameterList":[]},{"id":"DL0_
S6_4","shortName":"Chloride","longName":"NITRATE Ammonium MBR","locationFullName":"Aeration
Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"200.0","max":"2000.0","outputList":[{"SensorID":"DL0_S6_4","Uom":"mg/L","ObservedPropert
y":"op_DL0_S6_4"}],"inputList":[{"observedProperty":"op_DL0_S6_4","sensorID":"DL0_S6_4"}],"parameterList":[]},{"id":"DL
0_S6_5","shortName":"Temperature","longName":"Temperature","locationFullName":"Aeration Tank:4","location":"Aeration
Tank","locationOrder":4,"min":"4.0","max":"35.0","outputList":[{"SensorID":"DL0_S6_5","Uom":"C","ObservedProperty":"op_
DL0_S6_5"}],"inputList":[{"observedProperty":"op_DL0_S6_5","sensorID":"DL0_S6_5"}],"parameterList":[]}],"Mebrane
Tank:2":[{"id":"DL0_S0","shortName":"MLSS","longName":"SOLITAX TS-LINE","locationFullName":"Mebrane
Tank:2","location":"Mebrane
Tank","locationOrder":2,"min":"12000.0","max":"13000.0","outputList":[{"SensorID":"DL0_S0","Uom":"mg/L","ObservedProper
ty":"op_DL0_S0"}],"inputList":[{"observedProperty":"op_DL0_S0","sensorID":"DL0_S0"}],"parameterList":[]}],"RO
Effluent:3":[{"id":"DL0_S2","shortName":"PH","longName":"PH","locationFullName":"RO Effluent:3","location":"RO
Effluent","locationOrder":3,"min":"6.5","max":"8.5","outputList":[{"SensorID":"DL0_S2","Uom":"pH","ObservedProperty":"o
p_DL0_S2"}],"inputList":[{"observedProperty":"op_DL0_S2","sensorID":"DL0_S2"}],"parameterList":[]},{"id":"DL0_S4","shor
tName":"Conductivity","longName":"Conductivity RO","locationFullName":"RO Effluent:3","location":"RO
Effluent","locationOrder":3,"min":"0.0","max":"3000.0","outputList":[{"SensorID":"DL0_S4","Uom":"mS/cm","ObservedProper
ty":"op_DL0_S4"}],"inputList":[{"observedProperty":"op_DL0_S4","sensorID":"DL0_S4"}],"parameterList":[]}],"Permeate

Tank - Inlet to RO:1":[{"id":"DL0_S1","shortName":"Turbidity","longName":"SOLITAX T-LINE","locationFullName":"Permeate Tank - Inlet to RO:1","location":"Permeate Tank - Inlet to RO","locationOrder":1,"min":"0.0","max":"2.0","outputList":[{"SensorID":"DL0_S1","Uom":"NTU","ObservedProperty":"op_DL0_S1"}],"inputList":[{"observedProperty":"op_DL0_S1","sensorID":"DL0_S1"}],"parameterList":[]},{"id":"DL0_S5_1","shortName":"Conductivity","longName":"Conductivity MBR","locationFullName":"Permeate Tank - Inlet to RO:1","location":"Permeate Tank - Inlet to RO","locationOrder":1,"min":"700.0","max":"3000.0","outputList":[{"SensorID":"DL0_S5_1","Uom":"mS/cm","ObservedProperty":"op_DL0_S5_1"}],"inputList":[{"observedProperty":"op_DL0_S5_1","sensorID":"DL0_S5_1"}],"parameterList":[]},{"id":"DL0_S5_2","shortName":"Temperature","longName":"Temperature","locationFullName":"Permeate Tank - Inlet to RO:1","location":"Permeate Tank - Inlet to RO","locationOrder":1,"min":"4.0","max":"35.0","outputList":[{"SensorID":"DL0_S5_2","Uom":"C","ObservedProperty":"op_DL0_S5_2"}],"inputList":[{"observedProperty":"op_DL0_S5_2","sensorID":"DL0_S5_2"}],"parameterList":[]}]}

Events JSON Object (SES decoded)

0: {

"uuid": "fb9d8555-f3f2-429f-bf6f-0927ef263b70"

"sensor_id": "DL0_S6_2"

"alarmType": "Threshold"

"timeOfAlarm": "2015-12-15T16:50:11"

"reasonForAlarm": "Increase aeration"

}-

1: {

"uuid": "1eb09d2d-1a36-466f-b032-ca65f2df75d9"

"sensor_id": "DL0_S5_1"

"alarmType": "Threshold"

"timeOfAlarm": "2015-12-15T23:54:31"

"reasonForAlarm": "No need for RO"
}-
2: {
"uuid": "e15b15be-3327-44e6-b080-f08fdf3f1e53"
"sensor_id": "DL0_S0"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T22:57:46"
"reasonForAlarm": "High MLSS concentration"
}-
3: {
"uuid": "02e0d924-f050-4ec4-9ce4-a90ea6550654"
"sensor_id": "DL0_S6_4"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T22:57:46"
"reasonForAlarm": "No need for RO"
}-
4: {
"uuid": "216cb13c-aa34-41fb-9591-d352cc62af40"
"sensor_id": "DL0_S3_1"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T22:51:42"
"reasonForAlarm": "Revise aeration needs"
}-

```
5:  {
"uuid": "820ea0af-21d1-4f91-9cae-0a0b9dda72fd"
"sensor_id": "DL0_S7_1"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T15:19:49"
"reasonForAlarm": "Decrease recirculation"
}-
6:  {
"uuid": "75289338-f050-4c04-9260-9d85c0412f48"
"sensor_id": "DL0_S7_3"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T20:59:35"
"reasonForAlarm": "Minimum threshold exceeded"
}-
7:  {
"uuid": "85a47f4d-5dbd-415c-91ff-0b73281cbaac"
"sensor_id": "DL0_S6_5"
"alarmType": "Threshold"
"timeOfAlarm": "2015-12-17T22:51:43"
"reasonForAlarm": "Minimum threshold exceeded"
}-
8:  {
```

"uuid": "6a4407c1-2da7-4628-ad5c-743001f474ca"

"sensor_id": "DL0_S6_1"

"alarmType": "Threshold"

"timeOfAlarm": "2015-12-14T00:54:44"

"reasonForAlarm": "Increase aeration"

}

ANNEX II – SensorML Example Highlighting Important Metadata

```
1. <?xml version="1.0" encoding="UTF-8"?>
2. <sosREST:Sensor xmlns:sosREST="http://www.opengis.net/sosREST/1.0">
3.   <sml:System xmlns:swes="http://www.opengis.net/swes/2.0" xmlns:xlink="http://www.w3.org/1999/xlink"
   xmlns:gml="http://www.opengis.net/gml" xmlns:swe="http://www.opengis.net/swe/1.0.1"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:sos="http://www.opengis.net/sos/3.0"
   xmlns:sml="http://www.opengis.net/sensorML/1.0.1">
4.     <sml:keywords>
5.       <sml:KeywordList>
6.         <sml:keyword>foi_DL0_S0</sml:keyword>
7.         <sml:keyword>o_DL0_S0</sml:keyword>
8.         <sml:keyword>DL0_S0</sml:keyword>
9.         <sml:keyword>op_DL0_S0</sml:keyword>
10.          <sml:keyword>MLSS</sml:keyword>
11.          <sml:keyword>SOLITAX TS-LINE</sml:keyword>
12.        </sml:KeywordList>
13.      </sml:keywords>
14.      <sml:identification>
15.        <sml:IdentifierList>
16.          <sml:identifier name="uniqueID">
17.            <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:uniqueID">
18.              <sml:value>DL0_S0</sml:value> <--- SensorID --->
19.            </sml:Term>
20.          </sml:identifier>
21.          <sml:identifier name="longName">
22.            <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:longName">
23.              <sml:value>SOLITAX TS-LINE</sml:value> <--- Sensor Long Name --->
24.            </sml:Term>
25.          </sml:identifier>
26.          <sml:identifier name="shortName">
27.            <sml:Term definition="urn:ogc:def:identifier:OGC:1.0:shortName">
28.              <sml:value>MLSS</sml:value> <--- Sensor Short Name --->
29.            </sml:Term>
```

```
30.           </sml:identifier>
31.           <sml:identifier name="Offering for DL0_S0">
32.             <sml:Term definition="urn:ogc:def:identifier:OGC:offeringID">
33.               <sml:value>o_DL0_S0</sml:value>
34.             </sml:Term>
35.           </sml:identifier>
36.         </sml:IdentifierList>
37.       </sml:identification>
38.       <sml:validTime>
39.         <gml:TimePeriod>
40.           <gml:beginPosition>2017-03-16T11:20:37.838Z</gml:beginPosition>
41.           <gml:endPosition indeterminatePosition="unknown"/>
42.         </gml:TimePeriod>
43.       </sml:validTime>
44.       <sml:capabilities name="InsertionMetadata">
45.         <swe:SimpleDataRecord>
46.           <swe:field name="sos:ObservationType">
47.             <swe:Text>
48.               <swe:value>http://www.opengis.net/def/observationType/OGC-
   OM/2.0/OM_Measurement</swe:value>
49.             </swe:Text>
50.           </swe:field>
51.           <swe:field name="sos:ObservationType">
52.             <swe:Text>
53.               <swe:value>http://www.opengis.net/def/observationType/OGC-
   OM/2.0/OM_CategoryObservation</swe:value>
54.             </swe:Text>
55.           </swe:field>
56.           <swe:field name="sos:ObservationType">
57.             <swe:Text>
58.               <swe:value>http://www.opengis.net/def/observationType/OGC-
   OM/2.0/OM_CountObservation</swe:value>
59.             </swe:Text>
60.           </swe:field>
61.           <swe:field name="sos:ObservationType">
62.             <swe:Text>
```

```
63.             <swe:value>http://www.opengis.net/def/observationType/OGC-
    OM/2.0/OM_TextObservation</swe:value>
64.           </swe:Text>
65.         </swe:field>
66.         <swe:field name="sos:ObservationType">
67.           <swe:Text>
68.             <swe:value>http://www.opengis.net/def/observationType/OGC-
    OM/2.0/OM_TruthObservation</swe:value>
69.           </swe:Text>
70.         </swe:field>
71.         <swe:field name="sos:featureOfInterestType">
72.           <swe:Text>
73.             <swe:value>http://www.opengis.net/def/samplingFeatureType/OGC-
    OM/2.0/SF_SamplingPoint</swe:value>
74.           </swe:Text>
75.         </swe:field>
76.       </swe:SimpleDataRecord>
77.     </sml:capabilities>
78.     <sml:capabilities name="featuresOfInterest">
79.       <swe:SimpleDataRecord>
80.         <swe:field name="featureOfInterestID">
81.           <swe:Text definition="http://www.opengis.net/def/featureOfInterest/identifier">
82.             <swe:value>foi_DL0_S0</swe:value>
83.           </swe:Text>
84.         </swe:field>
85.       </swe:SimpleDataRecord>
86.     </sml:capabilities>
87.     <sml:capabilities name="observedBBOX">
88.       <swe:DataRecord>
89.         <swe:field name="observedBBOX">
90.           <swe:Envelope definition="urn:ogc:def:property:OGC:1.0:observedBBOX"
    referenceFrame="4326">
91.             <swe:lowerCorner>
92.               <swe:Vector>
93.                 <swe:coordinate name="easting">
94.                   <swe:Quantity axisID="x">
```

```
                    <swe:uom code="degree"/>
                    <swe:value>0.0</swe:value>
                  </swe:Quantity>
                </swe:coordinate>
                <swe:coordinate name="northing">
                  <swe:Quantity axisID="y">
                    <swe:uom code="degree"/>
                    <swe:value>0.0</swe:value>
                  </swe:Quantity>
                </swe:coordinate>
              </swe:Vector>
            </swe:lowerCorner>
            <swe:upperCorner>
              <swe:Vector>
                <swe:coordinate name="easting">
                  <swe:Quantity axisID="x">
                    <swe:uom code="degree"/>
                    <swe:value>0.0</swe:value>
                  </swe:Quantity>
                </swe:coordinate>
                <swe:coordinate name="northing">
                  <swe:Quantity axisID="y">
                    <swe:uom code="degree"/>
                    <swe:value>0.0</swe:value>
                  </swe:Quantity>
                </swe:coordinate>
              </swe:Vector>
            </swe:upperCorner>
          </swe:Envelope>
        </swe:field>
      </swe:DataRecord>
    </sml:capabilities>
    <sml:capabilities name="offerings">
      <swe:SimpleDataRecord>
        <swe:field name="Offering for DL0_S0">
          <swe:Text definition="http://www.opengis.net/def/offering/identifier">
```

```
131.             <swe:value>o_DL0_S0</swe:value>
132.           </swe:Text>
133.         </swe:field>
134.       </swe:SimpleDataRecord>
135.     </sml:capabilities>
136.     <sml:contact>
137.       <sml:ContactList>
138.         <sml:member>
139.           <sml:ResponsibleParty>
140.             <sml:individualName>TBA</sml:individualName>
141.             <sml:organizationName>52North</sml:organizationName>
142.             <sml:positionName>TBA</sml:positionName>
143.             <sml:contactInfo>
144.               <sml:phone>
145.                 <sml:voice>+49(0)251/396 371-0</sml:voice>
146.               </sml:phone>
147.               <sml:address>
148.                 <sml:deliveryPoint>Martin-Luther-King-Weg 24</sml:deliveryPoint>
149.                 <sml:city>Münster</sml:city>
150.                 <sml:postalCode>48155</sml:postalCode>
151.                 <sml:country>Germany</sml:country>
152.                 <sml:electronicMailAddress>info@52north.org</sml:electronicMailAddress>
153.               </sml:address>
154.               <sml:onlineResource xlink:href="http://52north.org/swe"/>
155.             </sml:contactInfo>
156.           </sml:ResponsibleParty>
157.         </sml:member>
158.       </sml:ContactList>
159.     </sml:contact>
160.     <sml:inputs>
161.       <sml:InputList>
162.         <sml:input name="input_op_DL0_S0">
163.           <swe:ObservableProperty definition="op_DL0_S0"/>
164.         </sml:input>
165.       </sml:InputList>
166.     </sml:inputs>
```

```
    <sml:outputs>
      <sml:OutputList>
        <sml:output name="output_op_DL0_S0">
          <swe:Quantity definition="op_DL0_S0">
            <swe:uom code="mg/L"/>  <--- Unit Of Measurement  --->
          </swe:Quantity>
        </sml:output>
      </sml:OutputList>
    </sml:outputs>
    <sml:parameters>
      <sml:ParameterList>
        <sml:parameter name="min">
          <swe:Quantity>
            <swe:value>7000</swe:value> <--- Minimum Acceptable Value --->
          </swe:Quantity>
        </sml:parameter>
        <sml:parameter name="max">
          <swe:Quantity>
            <swe:value>10000</swe:value> <--- Maximum Acceptable Value --->
          </swe:Quantity>
        </sml:parameter>
        <sml:parameter name="location">
          <swe:Text>
            <swe:value>Mebrane Tank:4</swe:value> <--- Position Of the sensor Inside the tank --->
          </swe:Text>
        </sml:parameter>
      </sml:ParameterList>
    </sml:parameters>
  </sml:System>
  <sosREST:link rel="http://www.opengis.net/sosREST/1.0/self" href="http://147.102.5.15:8080/sos-dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
  <sosREST:link rel="http://www.opengis.net/sosREST/1.0/sensor-delete" href="http://147.102.5.15:8080/sos-dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
  <sosREST:link rel="http://www.opengis.net/sosREST/1.0/sensor-update" href="http://147.102.5.15:8080/sos-dessin/service/rest/sensors/DL0_S0" type="application/gml+xml"/>
```

```
199.   <sosREST:link rel="http://www.opengis.net/sosREST/1.0/features-get"
   href="http://147.102.5.15:8080/sos-dessin/service/rest/features?procedures=DL0_S0"
   type="application/gml+xml"/>
200.   <sosREST:link rel="http://www.opengis.net/sosREST/1.0/observations-get"
   href="http://147.102.5.15:8080/sos-dessin/service/rest/observations?procedures=DL0_S0"
   type="application/gml+xml"/>
201.   <sosREST:link rel="http://www.opengis.net/sosREST/1.0/property-get"
   href="http://147.102.5.15:8080/sos-dessin/service/rest/properties/op_DL0_S0"
   type="application/gml+xml"/>
202. </sosREST:Sensor>
```

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