Re-Water Corporation

Project no:		1	
Registration title: (Max 150 characters)		Development of a water-quality plant system to detect and prevent spillage and flow offsite	
Date updated:		9 April 2015	
Project manager:		Jane Doe	
Start date (original):	01 July 2013	**Finish date (expected):**	30 June 2014

1. Background and technical objectives (Max 4000 characters)

Re-Water Corporation provides consultation, design, construction, and process optimization to the water and wastewater industry. The organization now provides recycled-water validation services for new and existing water-reuse schemes across America.

The overarching objective of this project is to design and develop a water-quality system to detect contaminated storm water and prevent spillage and flow offsite.

Specific technical objectives of developing the water-quality system:

- Design and develop analytical sensors to monitor, detect and extract data related to the chemical properties of contaminations in waste-water streams—the focus will be mainly on storm water.
- Develop a human machine interface (HMI) and control parameters to control the hardware components of the system—this needed to also allow users to switch between various screens related to equipment setup and the various accessing of data logging.
- Design and develop programmable logic controller (PLC) as part of control parameters.
- Develop the programmable coding for the PLC, which can be manipulated by users depending on site requirements and water data–monitoring requirements.
- Design and develop hydraulics.
- Design and develop electrical components—to be low voltage across various circuit boards.

2. New knowledge generated (Max 4000 characters)

Current knowledge:

Re-Water's review and analysis of competing products in the market show what no other similar system exists. The closest is competitor is Permeate Partners; however, its products are water and waste-water treatment while Re-Water focuses on environmental-based products. Many technical details that differentiate Permeate Partners' products from Re-Waters are not commercially available.

Overarching new knowledge to be generated:

In the form of a new water-quality system that monitors, collects and interprets data about contaminated storm water.

Specific new knowledge to be generated from the project:

- Understanding of how to design and develop a control mechanism (programmable logic controller) to allow operators to reconfigure the coding within the system obtain required data/information (e.g. time of day to monitor waste streams, reduction of sample size), depending on site requirements.
- Understanding of how to design and develop analytical sensors that can more accurately capture the data related to the contaminations within storm water. Specifically, data related to the chemical breakdown of the substance.
- Understanding of how to design and develop low-voltage circuit boards to ensure non-

interference with the flow and sample collection of storm water.

3. Outcomes of design and development are unknown/uncertain **(Max 2000 characters)**

Specific technical challenges and unknown outcome of core activities:

- Being able to access and collate samples of storm water in a large pipe: an 800 millimeter diameter; the large space means that extract storm water efficiently and sufficiently is negatively impacted.
- To establish a suitable environment for the data/sample-collection equipment to be stationed in. The environment must be water tight, air tight, and gas tight; however, at the same time, air needed to be circulated around the pipe and keep the moisture out to ensure it does not negatively affect (i.e. corrosion) the electrical equipment inside the pipe to, therefore, prolong the longevity of the equipment. The environment in which the electrical data-collection equipment is installed in is quite adverse—usually in marine environments, where there is exposure to salt air, salt, and high humidity.
- The development of the HMI presents the technical challenge of developing software that is able to compute and handle the complex mathematical and scientific processes of sampling storm water while being easy to use for operators. That is, the front interface needs to be simplified as much as possible without it affecting its data-handling performance.

4. Research and development activities

The company believes its water-quality system can be achieved by conducting the following stages of experimental activities:

- Background research to evaluate current knowledge gaps and determine feasibility.
- Design and development of a series of prototypes to achieve the technical objectives.
- Trials and analysis of data to achieve results that can be reproduced to a satisfactory standard and to test the hypothesis.
- Ongoing analysis of customer or user feedback to improve the prototype design.

R&D activities description (Max 2000 characters)	**Start date** (Original)	**End date** (Expected)
Background research of the water-quality plant system • Literature search and review. • Market analysis and review, including competing products, benchmarking of best available solutions. • Consultation with industry professionals and potential customers to determine the level of interest and commercial feasibility of such a project. • Preliminary equipment and resources review with respect to capacity, performance and suitability for the project. • Consultation with key component/part/assembly suppliers to determine the factors they consider important in the design, and to gain an understanding of how the design needs to be structured accordingly.	**Jul 2013**	**Jun 2014**

R&D activities description (Max 3000 characters)	**Start date** (Original)	**End date** (Expected)
Design of the water-quality plant system Hypothesis: Designing a water-quality system with improved hydraulics, user-friendly PLC, and seven analytical sensors will produce a system that more accurately detects the contamination substances (type and chemical properties) in storm water and, therefore, allow operators to prevent spillage and flow offsite. Design processes, methodologies and key observations: The designs of the control narrative, hydraulics, processes and controls, PLC, analytical sensors, and electrical components began with basic hand sketches a drawings; this then lead to line drawings in AutoCAD. Finally, the design was progressed and finalized in SolidWorks. Subsequently, a process and instrumentation diagram (PID) of the components was constructed to show how all components (e.g. pipes, valves, electrical controls, distribution) interrelate and to provide a holistic view of operations. Once the sketches, drawings and 2D computer designs were completed, they were transferred into SolidWorks to be converted into 3D models to the exact specifications stated. Due to the ability to change the coding in the PLC (i.e. increased latitude), manipulation of the equipment has been made simpler—e.g. to monitor at different times, to obtain a sample for longer. A lot of other design changes—particularly reiterations with the 3D modelers. Major changes to the design of the plant/system and its components resulted from the finding that the organization could use the information generated in the water samples taken to conduct various other activities, specifically: • Instead of simply opening a valve and concluding that it is contamination free and allowing it to flow through, the valve can instead be closed and the water retested—in other words, the sample can be tested more frequently, instead of only once, to increase validity in test results. • Re-Water concluded that the data obtained from contamination analysis of the water samples could be cross-correlated with the site manifest—i.e. determine where the contamination of the water was originating from at the site. This correlation can be sent as a message through the existing communication systems, such as email and SMS. • Each revision/reiteration was tested—each time improvements were made to the design, a new set of drawings were required. Conclusion: Re-Water designed many versions of components and the overall system as a whole to avoid potential technical issues in the development phase; however, to prove that its theoretical concepts can operate in the intended application, it needed to develop and construct prototypes for chemical testing.	**Jul 2013**	**Jun 2014**

Prototype development and testing of the water-quality plant system Hypothesis: Developing, constructing and testing a prototype of a water-quality system with improved hydraulics, user-friendly PLC, and seven analytical sensors will produce a system that more accurately detects the contamination substances (type and chemical properties) in storm water and, therefore, allow operators to prevent spillage and flow offsite. Development, experimentation or performance testing and key observations: • Development of a prototype and manufacturing was conducted by an external manufacturer. • Development of the HMI and control parameters: about 10 pages. Went back a few times to get it correct. • The sensors (about six) on the prototype were found to have made more sense (regarding the data obtained) when combined as opposed to when they were operating independent of each other. That is, they provide clearer indication about contamination physical properties and chemical values, which therefore allows Re-Water to more accurately identify the type of contamination within the storm water. The combined sensors could detect more accurately milk types: for example, differentiate flavored milk from regular milk due to the increased dissolved content in the former. Initially, Re-Water wanted to use these analytical sensors to only detect and monitor contaminated storm water; however, based on their performances, the organization believe they can also be used as diagnostic sensors; that is, rather than simply displaying data, it can also interpret the data. • Testing: random contamination substances (the main ones being syrup [high in sugar content], water- and oil-based paint, light kerosene, paint solvents, wine, washing powder/liquid) were inserted through the main pipe that runs through the system. Once the substances were inserted, the pipe is sealed off and is screened and analyzed; the numbers resulting from the screening are recorded. Between each waste stream, a solution material that Re-Water knew the physical and chemical characteristics of to clean out the pipes; afterwards, another test cycle is conducted using various other contamination substances. • Re-Water chose this cross-section of contamination mainly to replicate—as much as possible—the typical contamination within a real-world storm water drainage system. Conclusion: Re-Water now has a patent on the design and overall product. Re-Water has a list of additional sites for which to install this system; a couple of ports considered. Orders have been placed to build the prototypes. Even though it is now in the commercialization stage, however, the organization still aims to continually improve it as feedback is received. Future improvements relate to adding more analytical sensors to produce more detailed technical breakdown of the contamination. In addition, an increase in the size of the sample tank (from 180L to 360L) to extract larger samples to, therefore, achieve repeatable values.	**Jul 2013**	**Jun 2014**

R&D activities description (Max 2000 characters)	Start date (Original)	End date (Expected)
Feedback R&D of the water-quality system • Ongoing analysis and testing to improve the efficiency and safety of the project. • Ongoing development and modification to interpret the experimental results, and draw conclusions that serve as starting points for the development of new hypotheses. • Commercial analysis and functionality review.	**Jul 2013**	**Jun 2014**

5. Plant and facilities

The research and development is undertaken at Re-Water's facilities in XXXXXX, USA.

6. Substantiation

Please be aware that, under the current legislation, you must be able to provide evidence to substantiate your R&D activities. In the event of an IRS audit, this documentation may be required to prove that the R&D activities were eligible and took place in a systematic progression of work. We strongly recommend that you store this evidence in a safe place.

Yes / No / Not applicable	Type of substantiation
Y	Literature review
Y	Background research
Y	Meeting notes or minutes or progress reports
Y	Project records / laboratory notes
NA	Design documents for system architecture and source code
Y	Conceptual sketches
Y	Design drawings
Y	Photographs / videos of various parts or components
Y	Photographs / videos of various stages of build / assembly / testing
Y	Photographs / videos of initial or intermediate prototypes
Y	Photographs of completed models
Y	Prototypes
NA	Screenshots of various build versions / final version
Y	Testing protocols

Y	Results or records of analysis from testing / trial runs
	Records of resource allocation / usage logs
	Staff time sheets
	Tax invoices
	Patent application number