COMPETITION: Mobuoy Road Waste Remediation SBRI
Reference: SBRI_DA_313_009

SBRI End of Phase 1 Report Form

NOTE: The Authority reserves the right to amend this form and/or issue additional guidance notes on how it should be completed during the duration of the project.

This Report is the contractor's opportunity:-

- to describe the work undertaken during the project, what outputs were obtained and why these are relevant to the objectives of the Competition

- to explain and prove expenditure; and

- to develop a comprehensive report for contractor's to share with their stakeholders and those that may help further commercialisation pursuant to the terms of the contract.

The Authority may use the Report as part of the assessment for any Phase 2; it is therefore important that contractors complete the form as completely as possible.

The Report will be considered to be confidential and commercially sensitive by the Authority and its contents (other than the response to Section 5) will not be disclosed to third parties other than in accordance with the terms of the contract.

The Report must be submitted via **MobuoyRoadSBRI@sibni.org** within 14 days of the completion, or termination, date. The contractor is reminded that completion of this report is a contractual obligation and forms part of the payment terms. The report should be completed by the lead contractor, with input from any sub-contractors or project partners as appropriate. Please answer, wherever possible, on behalf of the business units, divisions, or companies which were involved in the work. If this is not possible (as a result of merger or acquisition, for example), please specify the organisation to which your answers refer.

Please answer the questions fully, but keep your answers succinct and no longer than necessary to provide a clear explanation. When describing technical solutions, please regard your audience as being someone familiar with the technology, but not an expert. The report may be done in narrative alone, however diagrams or pictures may be annexed to the Report where these aid clarity Please limit your response to a total of **ten sides of A4** plus **an additional limit of ten sides for any supporting diagrams or pictures**. (Please keep to a maximum limit of 5MB per email when submitting supporting information).
Because the true impact of an R&D project often takes several years to emerge, InnovateUK and the Authority may approach you for up to six years after project completion to follow up on the questions in this report. Your co-operation with any such follow up work is greatly valued.

1. Details

Registered Company Name: Agri-Food & Biosciences Institute

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Project Reference: SBRI 508164 - Exploration & Evaluation of Filter Material for Leachate Treatment

Total Contract Cost: (£s) [redacted]

Start Date: 1st November 2016 End Date: 30th April 2017

2. At the outset of the project what were your aims and objectives?

The overriding Aim and Objective of this project was to conduct the "Exploration & Evaluation of Filter Material for the Treatment of Leachate" (ie explore the potential for pre-treatment filtration of leachate prior to discharge to the environment or to further phyto-treatmentsuch as Willow bio-filtration schemes. Essentially this involves the searching for and sourcing of materials within reasonable geography that are likely to have some potential filtration efficacy. This was done in consultation with Swedish experts who have found sustainable natural solutions over the decades to many identical problems and in doing so to learn and apply the LAQUA Protocol (Appendix **Fig 1.);** the methodology by which the effectiveness of leachate treatment is measured in Sweden where the implementation of this technology is relatively commonplace. As far as AFBI is concerned, and our thoughts regarding the potential implementation of this technology, the use of Artemia as biological toxicity indicator was a novel aspect. The Inorganic and Organic Chemistry was relatively standard however given that leachates can contain a complex matrix and high levels of 100s of toxic organics and heavy metals, which may have combined effects, the use of a biological toxicity test would seem a good indicator of any improvements to the toxicity of leachate.

A further overarching intention was to assess the potential of these filters to manage the more potent waste waters from landfills (the technology is also applicable to waste waters from other sources such as car washes, airports, scrap-yards; anywhere where difficult wastewaters exist and which might contain toxic elements) prior to phyto-treatment using crops such as specifically bred willow clones for ligno-cellulosic biomass production. There was also the intention (at project submission stage) that project 508164 should be complementary to project 508163 which explores the potential of SRC [redacted]; essentially how SRC willow plantation should be implemented in terms of location, sizing, interception or point source use and if possible likely efficacies.

Viewing the Mobuoy site as a catalyst to the development and exploration of sustainable remediation and leachate management solutions, it was also an aim of the project to address the requirments for leachates to be sustainably managed on site and not tankered off to sewage treatment works (incorporating high carbon and financial costs for many decades or longer and causing functional issues at the treatment works and quality issues in the sludge if destined for agriculture!!) in which case suitable and fit-for-purpose Gentle Remediation Options (GMOs) for treatment must be established on site (such as sustainable filtration and phyto-remediation solutions).

3. Please provide a summary of the outputs of the project and relate these to the original objectives. How do the outputs address the requirements of this competition? What are the recommendations?

The original objectives of this project were to **(1)** Source and Investigate, through experimentation, the efficacy of locally and sustainably sourced natural filter media materials to reduce the concentrations of polluting metals and organics and potential environmental pollution of leachates emanating from landfills.

Materials
A range of filter media resources were obtained through several sources including International Synergies and these are summarised in **Table 1.** In order to narrow down the selection of materials to those with most potential for good filtration performance, batch screening tests were conducted.

Leachates
An assessment of leachate from different sources was also carried out as a steady supply of an appropriately toxic leachate would be essential to the operation of the filtration columns. [redacted] summary of sources and selected analytical results are shown in **Table 2** which illustrates the variation of the leachates [redacted]

It was decided to progress the study with untreated leachate sourced from Ballynacarrick landfill as we could access the required quantities and any changes in pollution and toxicity could be measured analytically. Ballynacarrick leachate (1600) – both filtered and unfiltered - were analysed by mass spectrometry for a range of organic contaminants, 62 pesticides, 24 polycyclic aromatic hydrocarbons (PAHs) and 7 polychlorinated biphenyls (PCBs). Two pesticides and 14 PAHs were detected in the unfiltered samples whilst lower levels of one of the pesticides and two of the PAHs were detected in the filtered leachates (**Table 3**). This suggests that the majority of the compounds are associated with the particulate matter in the leachate samples. Leachate obtained from two pumps (1 and 5) gave a 100% immobility effect at 95% leachate concentration for both pumps and this was still high (100% /69%for pumps 1 and 5 respectively at 71% leachate concentration). [redacted]

Batch Screening Tests
The test method was a modified version of British standard BS EN 12457-2:2002. Potential individual peat and ash material and peat/ash mixtures were shaken for 24 hours with untreated leachate (code 1705) at a ratio of 10L/kg. The samples were then centrifuged and filtered before analysis [redacted] Material mixes were as summarised in **Table 4.** Shaking with ash material alone had little effect [redacted] in the leachate. However all the peat material and the peat/ash mixtures showed reductions [redacted]. The ash materials also had little impact upon [redacted] of the leachate whereas the peat material substantially reduced [redacted]. The peat/ash mixtures (shake 8-15), although higher than the peat material alone, had lower [redacted] than the original leachate. [redacted] were slightly reduced in some locally sourced materials and mixtures. Interestingly the Swedish standard material (D2102, shake 16) had higher [redacted] than the local materials. These results show that there is potential for locally sourced materials to act a filter to reduce/remove contaminants. The peat/ash mixture is crucial for the filtration system as essentially the peat will remove [redacted] and the ash will remove the [redacted]. The batch test is only an indicator that adsorption will occur. It can reasonably be expected that much greater reductions will be achieved in a column test. The resulting data from the Batch Screening tests is presented in **Table 5.** This also illustrates the effect on metal concentrations with reductions for many of them. The mixes highlighted in purple were used to inform the most promising materials and mixes to bring forward to the column test phase.

Column Testing
This has been the most critical part of this project and in many ways is the culmination of a lot of the work to this point. Ideally this experiment should continue for many more months however it has been possible to obtain approximately seven weeks data during the course of the SBRI project. The column testing equipment was set up as illustrated in **Fig 2** with the chosen filtration media being

- Column 1: Standard D2102 ash and peat (commercial functional Swedish blend)
- Column 2: Ash 1710 (EOW ash) + Peat 1613
- Column 3: Ash 1710 (EOW ash) + Peat 1613
- Column 4: Ash 1614 (Clinker ash) + Peat 1613
- Column 5 : Ash 1615 (Fly ash) + Peat 1613

A standard untreated leachate (obtained in sufficient and consistent quantity & quality) was applied in two separate batches (week 1 to 2 and week 3 to 7) to columns 1, 2, 4 & 5. An artificial leachate (prepared to contain a wide range of [redacted] was applied to column 3. The raw leachate was analysed at the same time as the column effluents to account for any changes in the leachate composition. This was because (1) the leachate was separated into two batches as outlined above and (2) due to the presence of particulate matter in the leachate which may settle there may be a variation in the [redacted] applied to the columns over time. A visual demonstration of the action of a batch filtration experiment using locally sourced materials showing the removal of coloured organic material is shown in **Fig 3**.

Column Filtration Results

Trace Elements
Generally speaking all the columns have performed well over the test period in reducing levels of the trace elements (**Fig 4**). All the columns have reduced [redacted] below our detection limits by the final week of the study. [redacted] have also been well reduced. [redacted] was not present in the raw leachate but was tested via the artificial leachate. Artificial Leachate Column - Column 3 (1710) reduced [redacted] levels in the artificial leachate to below our detection limits even though the initial levels for all elements apart from [redacted] were appreciably higher than that of the standard leachate. [redacted] levels were also reduced to near the detection limits.

[redacted]
Due to the source of the ashes (derived from Coal Combustion Processes), it was expected that a level of [redacted] Flushing" might be encountered during the trials and indeed it was. The metalloid arsenic, is a natural pollutant found in coal deposits and subsequently may end up in coal ash deposits. [redacted] were initially high for columns with the ashes 1710 & 1615 (columns 2, 3 and 5) but low for the column containing ash 1614 (column 4). Even by week 4, [redacted] were still comparatively high for columns 2, 3 and 5, with column 4 having the lowest level. At this stage however it appeared that the [redacted] levels were starting to reduce. By week 7, the initial elevated levels of [redacted], from columns 2 & 5, have gradually been reduced from [redacted] respectively in the filtrates. And although the levels were higher for the column 3 (artificial leachate) at week 4 (the last week measured for this column), this column was started about 1 week behind it's equivalent untreated leachate column" (column 2) - so these [redacted] would also be expected to continue to decrease as was found for column 2 (week 7) (**Table 6**)

These results agree with the initial batch testing results, which highlighted potential leaching of [redacted] from the 3 peat filtration mixes tested (1615+1613 >1710+1613 >1614+1613). Filters functioning in the field would preferably utilise low [redacted] (further opportunity for materials search) or if necessary, be pre-leached via filtrate recycling (leading to the creation and filtration removal of [redacted] salts within the filter) removing them from environmental discharge to a water body.

[redacted]

(a) Raw leachate
Both batches of standard untreated leachate were analysed for the presence of [redacted] prior to column filtration - all were below the detection limit. Further analysis of the leachate post

column filtration (columns 1,2,4 and 5) was therefore unnecessary.

(b) Artificial leachate

Previous results using the Ballynacarrick leachate (1600) had demonstrated that the majority of the organic contaminants found were associated with the particulate matter and therefore are likely to be physically retained at the head of the column. Therefore an artificial leachate containing [redacted] was prepared to study the ability of the columns to remove any [redacted] that may be present in solution. These compounds were not found in the leachate after treatment by column 3 demonstrating the ability of the column to remove these compounds in the aqueous phase. These results clearly demonstrate that the columns produced from locally sourced material offer potential for the efficient removal of organic contaminants from leachate.

Another main output of the project was **(2)** To Enact the "LAQUA PROTOCOL" methodology developed by "Laqua" 1997-1999 in co-operation Kristianstad University of Sweden, essentially the addition of toxicity testing using the brackish water crustacean Artemia Salina as the test organism. This was a new methodology for AFBI so much effort and time went into the learning and refining of the necessary techniques.

Further Determinants

Fig 5 Illustrates that over the duration of the column filtration period, no real changes on pH were found for the untreated leachate. All column filtered leachates were around pH 7 (neutral) at the end of week 4. Column 5 was initially more acidic but increased from pH 4 (wk1) to 7(wk3). pH of artificial leachate was low (pH<3) but after column 3 treatment, it was nearly neutral demonstrating the potential of the columns to reduce acidity. Column 2 & 3 (EOW ash) show a continuing decrease in conductivity. Columns 4&5 show a slight continuing increase. All columns had lower conductivity than the untreated leachate at the end of week 4.

Column 1 reduced the COD value the most. Where COD values after column treatment are higher than the untreated leachate this is most likely due to natural leaching of organic material from the peat. This was originally expected and will reduce with time. Column 1 has been running since beginning of January whereas the others have been running since beginning of March.

Biological Toxicity Results

There is an apparent progression through the weeks of diminishing biological toxicity as illustrated by the Artemia Salina test. It is clear that early in the experiment (week 3) Column 1 (Swedish peat/ash) mix was demonstrating a very strong reduction in filtrate toxicity (**Fig 6**). This column had been used in previous experimentation so had time to settle and adapt to the leachate being filtered. The locally sourced materials do show potential however LAQUA AB have been working on these technologies for much longer than AFBI (only a few months !!) and have had the opportunity to explore and source a far wider range of products and as such have settled on some very effective materials. By week 7 however there appears also to be some very effective toxicity reduction demonstrated by all the columns. Biological toxicity (at 95% leachate) was reduced from 100% for untreated leachate to between 73 to 8% after column treatment. Biological toxicity (at 89% leachate) was reduced from 77%

to between 20 and 1% In order from best to worst columns followed the order 2, 4, 1, 5. This held true at all the tested leachate concentrations. By week 7 columns 2 and 4 are as effective as the Swedish column for reducing the [redacted] **(Fig 6**). Although the local materials sourced thus far are causing important reductions in toxicity it may be that further investigation of local resources may reveal even better filtration efficacies.

Recommendations

There is strong evidence that some of the materials which were batch tested and then went on to Column Filtration testing are functioning well as filtration media.

It would be recommended that

1) These columns are allowed to run for a duration of time yet to show statistically that these results are significant and durable (some inroads into doing this has already begun).
2) Further exploration of other ash materials is conducted (some inroads into this has already begun); as they may be even more effective at leachate filtration.
3) The final stage of this project was to extend the column filtration work to investigate the filtration materials using a pilot batch experimentation setup and it is recommended that this work should be taken forward. These IBC 1m^3 (cipax plastic container filter) pilot trial systems have been prepared, equipment procured, the peat substrate obtained however the final selection of the combined material depends on the results from the column work and further data would be valuable before this next stage is finalised. This step will evaluate the chosen ash/peat mixes, with (a) Control tried and tested Swedish ash/peat mix, (b) Locally sourced N.Irish mix 1 & (c) Locally sourced N.Irish mix 2. It would be intended that these trials run for at least a year to provide as much data as possible
    a. A preference to generate more Column Filtration data before finally mixing the substrate
    b. This will be set up at a landfill site however final Regulatory permission is still pending and further meetings are required to finalise this.
4) Consideration is given to the potential of a peat filter of this sort for the Mobuoy site to treat [redacted] in conjunction with on-going testing via column filtration and pilot scale testing as well as new material searches. Materials are currently available (eg Swedish materials as per column 1) but also other materials are available with emerging filtration efficiency (columns 2, 4 & 5).
5) It is recommended that these filters be run in conjunction with SRC willow biofiltration to manage the filtrate giving rise to zero direct discharge to any waterbodies.

4. Describe any changes to the original application. What was the reason for these changes? Please include any circumstances that aided or impeded the progress of the project and the actions taken to overcome them.

- In the original application it was intended to use leachates collected from the Mobuoy site. It turned out that this was not really possible [redacted] In order to try to gain some continuity of results, a supply of fairly standard leachate with low variability would have been better. We made the decision mid project (once this was known) to source leachate from a different site. Again there were several sources available so a number were analysed to make the decision which one to progress with. This provided a consistent leachate sample for proper evaluation of the materials and columns.
- In the original application it was not intended to run batch testing prior to deciding which materials to include in the column experiments. This step was subsequently advised by the senior chemists and Swedish experts as being an effective way to indicate the materials which would be most likely to perform well in the columns. The need for this step was very much as a result of our success in obtaining a wide and varied selection of potential substrate materials (Appendix **Table 1**). This process informed how we proceeded to the column stage.

Other than the above, there were essentially no real changes made to the original application. As with a lot of research, in many ways this project has given rise to as many questions as it has attempted to try to answer, such as....

- If we are seeing a level of effectiveness of certain peats and ash material, wouldn't it be worth searching further for other materials which might be even better?
- Although our primary goal was to source materials from the island of Ireland widening the search to the whole of the UK may increase our chances of finding even more effective materials.

5. Please provide a brief, public facing description of the project objectives, work completed and the most significant outcomes of your work. The Authority reserves the right to amend the description before publication if necessary, but will consult you about any changes.

The general aim of this proposal was to take the initial steps to replicate some of the successful Swedish implementations of landfill leachate management. These solutions are currently operating in Scandanavia however they require redesigning, materials sourced and confidence gained in order for them to be implemented in N.Ireland.

The original objectives of this project were to search for, source and investigate, through experimentation, the efficacy of locally and sustainably sourced natural filter media materials to reduce the concentrations of polluting metals and organics and potential environmental pollution of leachates emanating from landfills. Another objective of the project was to demonstrate the "LAQUA PROTOCOL" methodology developed by "Laqua" 1997-1999 in co-operation with Kristianstad University of Sweden, essentially the biological toxicity testing using the brackish water crustacean Artemia Salina as the test organism.

A number of materials have been sourced and the selection and batch testing of the filter media have resulted in columns of filter mixes which are giving rise to the removal of organic contaminants in the liquid (and solid) phase, the reduction of metals and other inorganics and reductions in biological toxicity over a duration of time.

Highlights and inferences

- All ash materials were able to reduce [redacted] to below detectable limits
- Reductions in many of the metals [redacted] were observed in the column testing using untreated and artificial leachates (all metals).
- A peat/ash mixture is essential for the column work as
  - the peat will remove metal contaminants and
  - the ash organic contaminants.
- There have been some elevations in [redacted] which were anticipated due to the sources of the raw recyclable materials, however, the tests are showing that these levels are reducing. Filters functioning in the field would preferably utilise low [redacted] ashes (further opportunity for materials search) or if necessary current materials could be pre-leached via filtrate recycling (leading to the creation and filtration removal of As salts within the filter removing them from environmental discharge to a water body). Some of the higher levels of [redacted] This is

expected and has been reducing with time.

- Column 4 has reduced the [redacted] of untreated leachate by ~90% and reduced the levels of [redacted] below detectable levels with decreases also observed in [redacted]
- The potential for a range of organic contaminants associated with both the particulate and liquid phases to be removed from leachate has been demonstrated.
- These results show that there is the potential for locally sourced materials to be incorporated into sustainable filtration systems to reduce/remove contaminants and in doing so reduce the biological toxicity of the filtrate as detected by Artemia test of the LAQUA Protocol. These types of system are currently in use in Sweden under the approval of the Swedish EPA for managing waste waters from not only landfills but also yards, airports, waste sites and car washes etc...
- Examples of the success of this work are

Country	Site	Landfill type	Size m^2	Annual volume (m^3)	Year	Description
Sweden	Stena Recycling	Car scrap	800	50 000	2002	Result of research project KK Stena Laqua.
Sweden	Renova	New landfill	120	15 000	2003	Non organic waste
Norway	Stena Recycling	Industrial process water	15	1 300	2005	Container solution icy to move
Finland	Stena Recycling OY	Car scrap	240	18 000	2004 2016	Expansion of site 2016
Sweden	30 car wash	Washing water	2,4-100	400-12 000	2005-2016	Spin off from KK Stena Laqua
Sweden	Washing water Samhall Akalla	Industrial process water	16	1 200	2012	
Sweden	Arlanda Airport	Die icing water	2000	180 000	2014-2015	Removing of Cd
Sweden	SKM Vänersborg	Run-off water from scrap yard	200	5-12000	2015	Protect Göta älv as it's the main source of drinking water to Göteborg city

6. Describe the innovative aspects of the work including any new findings or techniques.

The overarching aim of this proposal was to take the initial steps to replicate some of the successful Swedish implementations of landfill leachate management here in N.Ireland. There has not been a great deal of interest nor apparent demand for developing sustainable treatment technologies for leachate management; in fact from a regulatory point of view, we are starting from a very low acceptance base.

The innovation present in this project has been the sourcing and testing of a number of potential locally sourced materials for their effect of filtering pollutants from landfill leachates. It is clear from the column filtration results that some of the materials seem to be effective in this goal. This is illustrated not only by the removal of [redacted] but also the Artremia test indicating a reduction in [redacted], possibly as a result of the removal of [redacted]. This analytical procedure has been innovative for AFBI.

The filtration rates used for the column application rates are 130 l/m^2/day. This has worked well, has been sustainable, has not led to clogging or overflow and if scaled up to a 1000m^2 peat filter, this has potential to treat 40,000 to 50,000 m^3/year of leachate. Experience in Sweden with these applications have shown success with even higher application rates (up to 500 l/m^2/day with rest periods) [redacted]

New Techniques and Standard Operating Procedures

- Filter material screening test - 24 hours batch test for landfill leachate
- [redacted]
- Filter material screening test - Column filtering test for landfill leachate and
- Determination of Chemical Oxygen Demand of landfill leachate

7. Please give a description of how funds were spent with reference to the original budget and explain any significant variations.

The main variation between the original budget and how the funds were spent was with regards to staff time and associated overheads. This is mainly attributed to the extra "Batch Testing" step not initially foreseen but which made the project far more focussed up to the choice of Column Filter Materials. There was a shortfall in the T&S spend as a result of AFBI staff providing the necessary hospitality (accommodation, meals, transport, pickups, drop-offs) when Swedish staff visited N.Ireland as well as the Kristianstad University visit, planned for the beginning of January, being called off due to sickness and hospitalisation. This saving went somewhat towards the extra staff costs we encountered.

[redacted]

8. Describe any potential long-term collaborations/partnerships entered into. Please list the company and the role they played in the project.

It is clear that a long term partnership between AFBI, Laqua MD and Resourceful Organics has been strengthened further. As a result of this project we have also developed a working relationship and a strategic development progress MOU with Bord na Mona with specific interest in developing sustainable filters but also in progressing the linkage with willow crops and their ultimate use for Bioenergy. Bord na Mona has been extremely helpful in providing varied quantities of many different types of materials. Not just materials produced for the market but also waste materials from peat product manufacture. We have had several different suppliers of other raw materials and relationships with these companies will develop further as we progress the findings and successes from this SBRI project. We have also entered into the following collaboration with QUB ([redacted] who are also SBRI Mobuoy funding beneficiaries. We coordinated sampling rounds with and shared expertise/ experience. We intend to submit an industrial NERC CASE innovation application for a PhD project by July 2017 that could combine our technologies into a single system for landfills. We see this linkage as a strong candidate for a phase 2 [redacted]

9. Please describe how your company has gained from this project. What new business opportunities have been created? Do you expect your company to grow as a result of this project?

Outside of this SBRI but with reference to it, AFBI has also commenced a further project in conjunction with two landfill companies and 3 SMEs all with the intention of managing leachates. We have a partnership agreement with these companies.

AFBI is also pursuing the second stage of an Interreg VB-NWE bid to facilitate the development and demonstration of Gentle Remediation Options on sites such as Mobuoy. There are eight SMEs and research institutions incorporated within this bid. AFBI is in discussions with NIEA on this opportunity.

We don't specifically expect AFBI to grow as a result of this project but we would hope to be able

to contribute to the developments at Mobuoy as well as other sites in the future.

10. Describe the potential for exploiting the work. Please identify any new IP which has been filed or for which filing is anticipated.

For many years now, AFBI and other government and state entities have worked with LAQUA Treatment AB of Sweden. Laqua has many years experience in designing, developing and delivering sustainable waste water management solutions. In recent years, LAQUA has developed sustainable waste water management systems in N.Ireland (and RoI) in several sectors including municipal waste water (NIWater and RoI Local Authorities) and the agri-food sector. Although no commercially functioning filters have to this point been installed by Laqua, Laqua has been working with it's agency companies in order to demonstrate the environmental and cost effective benefits of said technologies. However until recently it has appeared that neither the commercial need nor the regulatory landscape were present. This is potentially now changing and as such Laqua in conjunction with AFBI and Resourceful Organics is poised to develop this product line in conjunction with local NI based Environmental Technology Companies.

It is proposed that this commercialisation route will continue while branching out into the management of landfill leachate. Again in Sweden, LAQUA has developed over thirty leachate management schemes where Landfill leachate is currently being successfully recycled via peat filtration and SRC willow systems. The treatment systems operate under the guidance of the Swedish EPA. Ireland's climate is arguably even more suitable for the practice. Many landfills are located in remote areas some distance away from sewage treatment works and sewer connections. In these situations landfill leachate management on-site, using robust, environmentally sustainable, cost effective, low energy & manpower options may be favoured. Leachate management by natural and sustainable locally sourced peat/ash filters followed by willow short rotation coppice (SRC) is believed to match these requirements.

LAQUA has worked with NI Companies and local employment to market, sell and implement these technologies into the waste water treatment sector in NI/RoI and GB and this activity will continue in order to implement these technologies, the success criteria of which could be excellently demonstrated by this SBRI competition.

Furthermore, Laqua (as well as a number of other SMEs) is currently collaborating with AFBI and other research institutes in Belgium, France and Germany (as well as others) to develop sustainable leachate management technologies further. This aligns well with requirements for the Circular Economy and proposals/recommendations within the DAERA "Sustainable Land-Use Strategy for N.Ireland". A commercial off-shoot of this venture would be Laqua and associated NI Environmental Technology Companies, developing further a complete "Circular Economy" implementation of waste effluents (such as leachate) to utilisation - in this case filtration and resulting Macronutrient recycled to SRC willow coppice for energy generation and ash reuse for fertilisation or manufacture of "designer" geoploymers .