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Dear Dr Duer

Preparation for the first meeting of the Conference of the Parties to the Minamata Convention. Submission Related to Article 12 - Contaminated sites.

This letter presents information collated from work being carried out for a UK funded project¹ in Colombia on *Strategies for rehabilitating mercury-contaminated mining lands for renewable energy and other self-sustaining re-use strategies*. Conducted in cooperation with the Colombia Ministries of Environment and Mining, the project concludes in early 2017. The project is developing a general brownfields re-use strategy along with site specific testing of low input remediation for soils from two villages in Colombia impacted by mercury contamination. We believe this information will be useful to inform the development of draft guidance related to management of mercury contaminated land.

This letter summarizes two reports under development for the project. The information attached to this letter has two parts:

- 1) A briefing about the beneficial services obtained from the restoration of brownfield sites, such as mercury impacted land, for “soft” re-uses (i.e. non-built re-use). Such services can enhance the overall value of such sites and, therefore, improve a case for funding or investment.
- 2) A briefing on low impact or “gentle” remediation techniques and how these can be used to manage risks of land contaminated with metals. Such low input remediation techniques are not only cheaper, but are also highly compatible with soft re-use of land.

This project is being conducted by an international consortia including:

- r3 environmental technology ltd, UK (www.r3environmental.com) with a team including two leading UK experts on brownfields re-use and land restoration (Prof Paul Bardos, www.linkedin.com/in/paulbardos, and Prof Andy Cundy <https://www.linkedin.com/in/andy-cundy-73668817>; along with US associates Ms Barbara Maco, www.linkedin.com/in/barbara-maco-mba-6a183013, an experienced practitioner regarding renewables on brownfield land; and Dr. Walter Kovalick, www.linkedin.com/in/walter-kovalick-63944858, who was the principal author of a report for the World Bank on contaminated land management for low and middle income countries.)
- r3 Environmental Technology Colombia SAS (www.r3environmental.com.co), and

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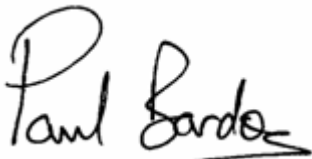
- Land Trust, UK (www.thelandtrust.org.uk) a charity set up by government to support community led re-use of long term brownfield sites in the UK; and
- C-CURE Solutions Ltd (www.ccuresolutions.com) a spin out company from two UK research establishments which has developed innovative, low input remediation technologies based on biochar.

On behalf of the project team, I hope that this information is of interest to the Conference of the Parties. Please identify the UK Foreign Commonwealth Office Colombia project and our team in any citations.

In 2017, we will provide you with a formal project report including citations about the technology trials and the framework guidance which we are developing. We believe this final report is likely to be of interest to the upcoming conference in 2017. We hope to be continuing our initiative in the field in Colombia next year if we can make suitable proposals for funding.

In the interim, if you have any questions, on behalf of our team, please do not hesitate to contact me.

Yours sincerely



Prof Paul Bardos
Project Leader.

Encl: technical annexes.

Annex 1 Soft Re-Use of Mercury Impacted Land

Brownfields re-use is considered “hard” for purposes such as for housing, business parks or infrastructure. Alternatively, there are “soft” end uses, such as for green space or renewable energy purposes such as the production of biomass. Soft re-uses are those where the soil remains unsealed and its functionality is either maintained or enhanced (Cundy *et al.* 2013). Most attention tends to be paid to built re-use. However, built re-use is seldom likely to be a viable proposition for land affected by mining in Colombia which could be remote from settlement or in areas of limited economic demand for hard re-use options. However, soft end uses can provide services from a restoration project. Depending on design, some examples of these “project services” are:

- Provision of open space such as parkland, for local communities, which brings benefits for well-being, health, leisure and a sense of place;
- Providing green infrastructure and services such as those related to water protection, improvement of air quality, providing shade and encouraging habitat and wildlife;
- Supporting the renaissance of and innovations in urban gardening, community gardens and urban farming;
- Suppling renewable energy and other environmental services (such as sustainable urban drainage).

Some services may generate revenue in their own right, some may be important assets to support societal development, and some may have direct or indirect benefits on the value of local land or local economy (e.g. providing local energy supply or other environmental services). Restoration projects that deliver a broad range of services have both improved overall sustainability and enhanced economic value.

A project service is an explicitly recognised and designed in outcome of a restoration project. To achieve the delivery of the service some form of *intervention* is needed, for example, remediation or soil improvement.

The Brownfield Opportunity Matrix (BOM) is intended to assist national policy advisors and also local project designers and local decision-makers in identifying options for developing the greatest overall value from the “soft” (i.e. non built) re-use of brownfield/contaminated land. This guidance is a simple matrix screening tool to help developers and decision-makers involved in brownfields identify what services they can get from soft reuse interventions for their site, how these interact, and what the initial default design considerations might be: the “Brownfield Opportunity Matrix” (BOM). It follows on from a major European Commission research project funded under their Framework 7 programme: HOMBRE (Holistic Management of Brownfield Restoration (www.zerobrownfields.eu)). It is a simple tool to show how services can be connected with interventions and *vice versa*. In addition, it provides a checklist to determine the range of possible services that could be provided, and the minimum (or optimum) number of interventions necessary to do this.

Box 1: Potential Services from Soft Re-uses of Brownfield Land

<ul style="list-style-type: none"> • Site value uplift / value uplift of surroundings / • Renewable energy generation <ul style="list-style-type: none"> – Biomass based – Geothermal – Wind & Solar • Renewable material generation • Greenhouse gas mitigation (carbon offset revenue?) • Synergies with waste processing and re-use, leachate management • Shielding / soundscaping • Flood management – link with “Sustainable Urban Drainage Systems” 	<ul style="list-style-type: none"> • Amenity and leisure • Urban climate management (such as mitigation of urban heat island effect) • Air quality management • Habitat and conservation • Improved soil and water resources • Improved health and well-being • Opportunities for education • Community involvement • <i>Ecological system services</i>
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The BOM is available in the original English language version (Bardos *et al.* 2016) and will be available in a version adapted by this project for circumstances in Colombia and written in Spanish.

- The original BOM is available for download and use from HOMBRE’s “Brownfield Navigator” page (http://bfm.deltares.nl/bfn/site/index.php/standard/bfn_home). The *Brownfield Navigator* is an online environment which accompanies and supports decision makers through the different management phases in the land cycle which also includes tools for describing and note taking on a geo-spatial basis the various interventions and their opportunities.
- The Colombian Spanish Language version will be available in early 2017..

The BOM is a simple tool which sets out which services are delivered by particular interventions, using a simple colour coding for each intersection of a possible intervention with a possible service, as follows:

- Deep green: this intervention generally directly delivers this service;
- Light green: there is potentially a direct or associated service benefit--depending on site specific circumstances;
- Blue: while there is potentially a direct service benefit, there is the possibility that this intervention could be antagonistic to the service, depending on site specific circumstances; therefore, an appropriate site specific management and design needs careful consideration;
- Amber: the intervention is generally antagonistic to the service in question, so some form of mitigation would be needed.

As illustrated in Figure 1 (below), viewing across a row, from a particular intervention, it is possible to see how this intervention can deliver (or may impede) services across a broad range of categories. Looking at rows together allows a range of services to be maximised across two or more interventions. In both cases the decision is simply based on the range of colours: maximising the green intersections. Where there are blue or amber intersections then a more detailed consideration of the nature of the site and the nature of the intervention is needed. A very detailed “informational” version of the BOM provides supporting information and links to further citations and examples to facilitate this. The informational BOM is also available from http://bfm.deltares.nl/bfn/site/index.php/standard/bfn_home. However, as part of the FCO supported project, the goal has been to provide an abbreviated version to use as a starting point for design discussions in Colombia. Although a detailed informational version in Spanish would be a large undertaking, it may be justified in a follow on project depending on the interest in the abbreviated BOM tool (i.e.a proof of concept).

The BOM is organised using a hierarchy of categories of services and interventions, as listed in Table 1. The simple BOM provides some additional guidance in each green or blue coloured intersection cell between intervention and service. This comprises a case study to illustrate the interaction between intervention and service and a web-link to further information about the case study. In this way users can directly migrate to examples of particular interventions and services that interest them (see Figure 1). In the Colombia adapted version additional case study information has been provided to give links to more local examples, even if these are still only at a “pilot” stage.

Table 1: The overarching services and interventions considered within the Brownfield opportunity matrix

Services	Interventions
<ul style="list-style-type: none"> • Soil Improvement • Water Resource Improvement • Provision of Green Infrastructure • Risk Mitigation of Contaminated Soil and Groundwater • Mitigation of Human Induced Climate Change (global warming) • Socio-Economic Benefits 	<ul style="list-style-type: none"> • Soil Management • Water Management • Implementing Green Infrastructure • Gentle Remediation Options • Other Remediation Options • Renewables (energy, materials, biomass) • Sustainable Land Planning and Development

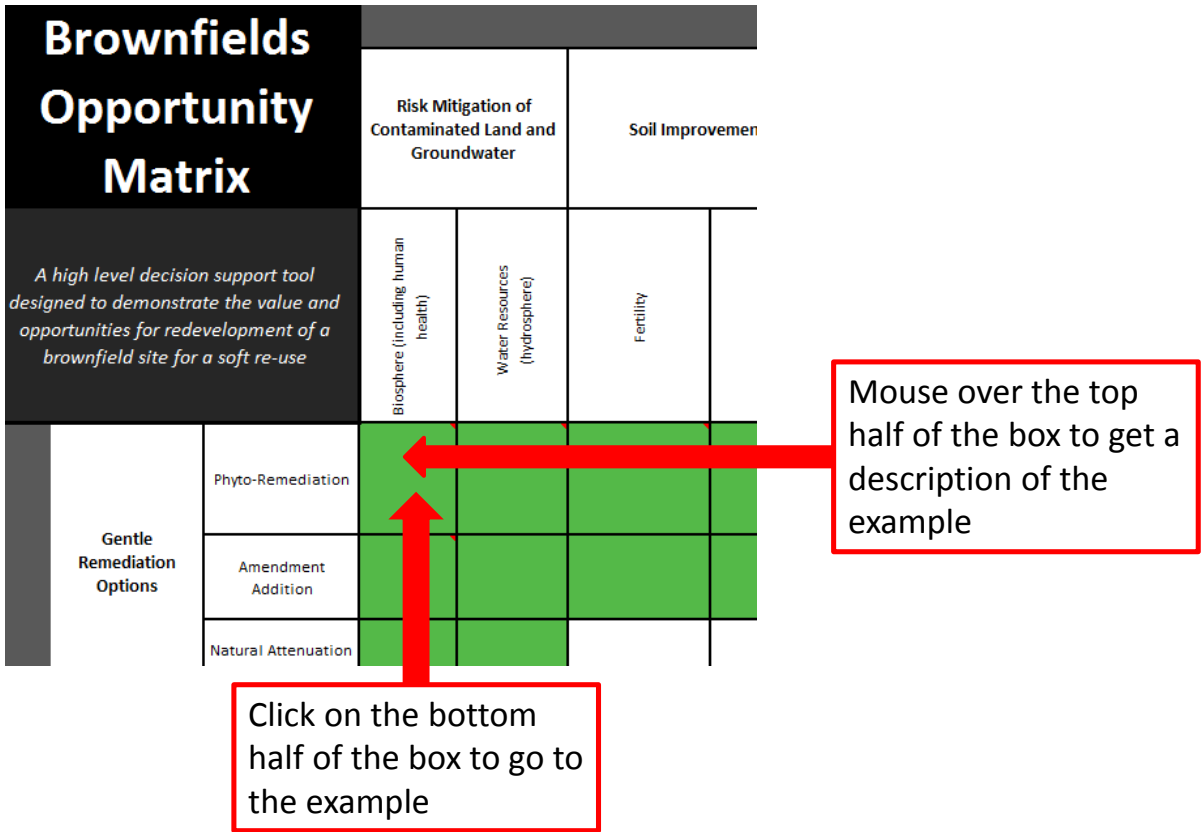


Figure 1 View of the simplified Brownfield Opportunity Matrix.

Reference:

Bardos, P., Jones, S., Stephenson, I., Menger, P., Beumer, V., Neonato, F., Maring, L., Ferber, U., Track, T. and Wendler, K. (2016) Optimising Value from the Soft Re-use of Brownfield Sites. Science of the Total Environment 563-564 pp 769-782 DOI 10.1016/j.scitotenv.2015.12.002. <http://dx.doi.org/10.1016/j.scitotenv.2015.12.002>

Annex 2 Soft Re-Use of Mercury Impacted Land

Where brownfield or marginal land is contaminated, then the risks of that contamination need to be assessed to determine if any form of management (such as remediation) is needed. Risks might be posed to human health or the wider environment, i.e. water, ecology (Defra 2011, Nathanail and Bardos 2004). For a contamination risk to be present three components need to be in place: a source of hazardous substances, a receptor that might be affected by them, and a pathway that links the source to the receptor (as illustrated in Figure 2). This combination is called a *contaminant linkage* or a *pollutant linkage*. In the majority of developed countries the process of land contamination is one of *Risk Based Land Management* (Veger et al. et al. 2002) to a lesser or greater extent (Nathanail et al. 2014). Extensive guidance has been developed in several countries: in the UK, this high level guidance for this is contained in a series of Model Procedures (Environment Agency and Defra 2004). More recently, with the advent of *sustainable remediation* concepts (Bardos et al. 2016), the new model is *Sustainable Risk Based Land Management*. This approach encapsulates decades of learning from many countries. For example, the first land restoration projects in the UK (the Lower Swansea Valley) began to be planned in the 1950s. Countries at the beginning of the development of contaminated land management policies and frameworks can benefit from this learning and avoid considerable costs and many technical mistakes. For example, a recent UK *Prosperity Fund* project has encapsulated this learning for China (Coulon et al. 2016).

Risk management is the process of assessing risks and deciding what needs to be done about them; that is, whether the risk is significant and, if so, whether it needs to be mitigated by some form of remediation intervention. The structure of contaminant linkages also indicates the principle points of intervention that can be used to manage risks (Nathanail et al. 2007), as follows:

- At the level of the source; for example, as a source removal action
- At the level of the pathway; for example, managing the spreading of a groundwater plume, including by *monitored* natural attenuation
- At the level of the receptor; for example, by dense planting to prevent human access or by some form of planning (institutional) control to limit the allowable use of the land (e.g. not for housing with gardens).

A risk management approach may integrate interventions at different levels. For example, partial source removal for pathway management to deal with residual contamination may be combined with additional protection via a planning control (e.g. restrictions on use of water from particular boreholes). Figure 2 gives examples of these interventions in a gentle remediation context.

A special case exists for land where biomass is produced. Biomass itself may become a pathway for spreading contamination to other people, even for non-food crops, depending on how and where the biomass is utilised. This situation may (1) render biomass unsuitable for use, (2) suitable for use only in controlled facilities, such as waste to energy facilities, or (3) necessitate mitigation measures, such as the use of *in situ* stabilisation to reduce plant uptake. (Andersson-Sköld et al 2014, Jones et al. 2016).

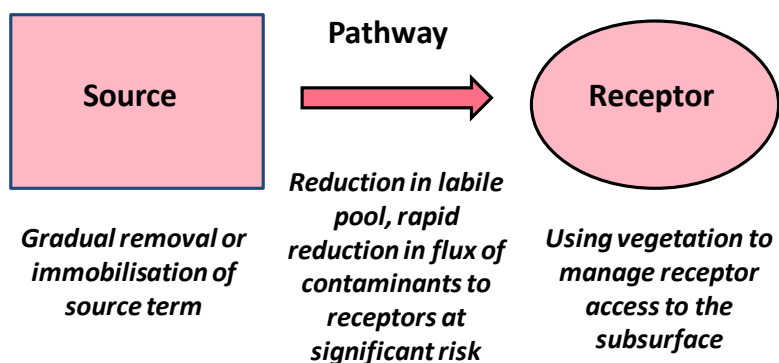


Figure 2 A contaminant linkage, and different gentle remediation interventions at the level of source, pathway and receptor.

Conventional approaches to remediation have focussed mainly on containment, cover and removal to landfill (or “dig and dump”). From the late 1990s onwards there has been a move towards treatment-based remediation strategies, using *in situ* and *ex situ* treatment technologies such as soil washing, “pump and treat” of contaminated groundwater, coupled with the widespread adoption of a risk-based approach to contaminated land management. Recently, building on earlier ideas about low input approaches, the concept of Gentle Remediation Options (GRO) has emerged. GRO are defined (e.g. Cundy *et al.* 2013) as risk management strategies/technologies that result in a net gain (or at least no gross reduction) in soil function as well as risk management. This emphasis on maintenance and improvement of soil function means that they have particular usefulness for maintaining biologically productive soils, which is important where a “soft” end use for a site (such as urban parkland, biomass/biofuels production, etc.) is being considered (Cundy *et al.* 2016). This section provides technical guidance on a range of key GROs based on outputs from the European Commission Framework 7 research project (Gentle Remediation of Trace Element Contaminated Land (www.greenland-project.eu) and the HOMBRE project mentioned above, supplemented by information from the US EPA on phytotechnologies for remediation (<https://clu-in.org/techfocus/default.focus/sec/Phytotechnologies/cat/Overview>).

GROs encompass a number of technologies including:

- The use of plant, fungal microbiological processes for removal, degradation or immobilisation of contaminants; and
- In situ stabilization (using biological or chemical processes; for example, sorption to biochar) or extraction of contaminants.

Biologically productive soils include those used for agriculture, habitat, forestry, amenity, and landscaping, and, therefore, GROs will tend to be of most benefit where a “soft” end use of the land is intended.

Gentle remediation options are best deployed to remove the labile (or bioavailable) pool of inorganic contaminants from a site (e.g. phytoextraction), remove or degrade organic contaminants (e.g. phytodegradation), protect water resources (e.g. rhizofiltration), or stabilise or immobilise contaminants in the subsurface (e.g. phytostabilisation, in situ immobilisation/phytoexclusion). These approaches can be tailored along contaminant linkages as suggested above.

The GREENLAND project developed a simple and transparent decision support framework for promoting the appropriate use of gentle remediation options and encouraging participation of stakeholders, supplemented by a set of specific design aids for use when GRO appear to be a viable option (Cundy *et al.* 2015). The framework is presented as a three phased model or Decision Support Tool (DST), in the form of a Microsoft Excel-based workbook, designed to inform decision-making and options appraisal during the selection of remedial approaches for contaminated sites. It can be downloaded from www.greenland-project.eu.

Intelligently applied GRO can provide: (a) rapid risk management via pathway control, through containment and stabilisation, coupled with a longer term removal or immobilisation/isolation of contaminants (Cundy *et al.* 2016); and (b) a range of additional economic (e.g. biomass generation), social (e.g. leisure and recreation) and environmental (e.g. CO₂ sequestration, water filtration and drainage management, restoration of plant and animal communities) benefits. Phytoremediation techniques involving *in situ* stabilisation of contaminants or gradual removal of the labile (i.e. bioavailable or easily-extractable) fraction of contaminants present at a site can be durable solutions as long as land use and land management practice does not undergo substantive change causing shifts in pH, Eh, plant cover etc. This requirement, suggests that some form of institutional or planning control may be required. The use of institutional controls over land use, however, is a key element of urban remediation using conventional technologies (e.g. limitation of use for food production), so any requirement for institutional control and management with phytoremediation continues a long established precedent.

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