Wednesday, April 27, 2016
Stream 4B - Sustainability Indicators and Metrics
Location: Level 2, Salons 4&5

1:30 pm – 1:50 pm

Can We Still Justify Every Remediation in a Sustainability Context: A Social Cost Benefit Analysis

Thomas De Romagnoli and Pieter Schrooten
ERM

The objective of the presentation is to discuss how to better balance the costs and benefits of soil remediation so a more sustainable outcome can be attained for society.

Abstract

The Flanders soil legislative framework is currently mainly driven by resolving (theoretical) human health effects, at an estimated total cost of over €7 billion for contaminations created before 1995. However, the health effects related to soil contaminations in Flanders are considered limited to the extent that these effects are not taken into account when determining the overall environmental health effects in the Flemish region. Is the cost for remediation therefore still justifiable for society?

Although on certain sites contamination clearly creates risks for human health, the question is if the current soil policy is not too stringent, as it results in costs per Disability-Adjusted Life Years (DALY's) well above any international standard. Even in some cases the current policy results in certain contaminations being targeted for policy reasons only, not even considering human health or environmental impact. Taking into account other benefits (e.g., preservation of greenfields, real estate pricing, etc.) might increase the overall value of remediation. Creating a partnering between the controlling administration, the industries and the communities can result in a more focused approach to where remediation is more beneficial and, as such, more justifiable to society.

The costs for soil clean-up are often limited to only the financial aspect of the works themselves. On the other hand remedial works may also have a significant impact on the environment. Based on a 2010 study performed by VITO (Flemish Institute for Technological Research), 73% of the health effects related to environmental disturbances in the Flemish region are related to particulate matter (PM). This relates to 80,000 DALY's. Approximately 50% of the PM emissions in Flanders is related to industrial processes and road transport. As many remedial works include extensive works, heavy fuel consuming machines and significant soil transport volumes, the remedial sector therefore also accounts for part of the production of particulate matter, which accounts for the creation of human health costs.

The current policy leads to a biased estimation of the health benefits, neglecting human health costs related to remedial works. This presentation will further discuss how to better balance the costs and benefits of soil remediation so a more sustainable outcome can be attained for society.

2:00 pm – 2:20 pm

Application of Sustainability Metrics to In-situ Remediation "Scale-Up" Planning at an Alabama Manufacturing Facility

Michael Smilley[1] and Colleen Liddell[2]
[1]Golder Associates Ltd.
[2]Ford Motor Company

The objective of the presentation is to provide an approach for integrating sustainability into remediation scale-up planning at a manufacturing facility in Alabama. Using GoldSET® software, a step-by-step process will be illustrated by which sustainability metrics, alongside technical factors, are evaluated to assist with remedy selection.

Abstract

The emphasis on sustainable site remedies is an important shift in the environmental industry that has occurred over the last decade. Evaluating sustainability indicators (e.g., environmental, social and economic) during the project planning stages, alongside technical factors, can reduce remediation costs, streamline project permitting, and improve corporate image with key stakeholders. During remediation design, sustainability metrics favourably differentiate in-situ treatment remedies from active remedies, like pump and treat. However, the comparison of similarly implemented in-situ technologies (e.g., zero valent iron [ZVI] versus biostimulation) is not straightforward. Each injected remediation substrate has a unique environmental footprint, social impact and economic burden

associated with the transportation to the site and the energy/waste generated during production. These "off-site" contributions from the reagent are typically the largest component of a comparative sustainability evaluation for in-situ remedies.

An in-situ remedy comparative sustainability evaluation was performed at an Alabama manufacturing facility, active between 1957 and 1992, where chlorinated volatile organic compounds (CVOCs) were released into groundwater. The facility currently operates a groundwater extraction system under a voluntary clean-up program to alleviate risks to downgradient receptors and remove CVOC mass. Initially a component of the system removed DNAPL however mass removal rates decreased significantly once DNAPL was removed. The current pump and treat system, while required by the regulatory agency, is unsustainable from an economic and environmental perspective. Pilot studies have been performed to evaluate the potential effectiveness of in-situ remedies which can adequately manage the risks to receptors, achieve project objectives and meet regulatory requirements. Based on these pilot tests, three in-situ technologies (i.e., ZVI, in-situ bioremediation [ISB] and in-situ chemical oxidation [ISCO]) have proven effective at treating chlorinated CVOCs to low levels. An evaluation of the future "scale-up" of these remedies was then performed. GoldSET©, a sustainability decision support tool, was used to evaluate the site specific strengths and weaknesses of these remediation options with respect to environmental, social and economic dimensions.

In addition to evaluating qualitative environmental, social and economic factors for each remediation technology, the evaluation highlighted the sustainability implications of different reagent residence times (injection frequencies), injection methods and efficiency factors (e.g., microbial efficiency, ZVI efficacy, etc.) used during remedy design. Those design factors with the greatest contribution to the total required reagent volume were scrutinized and re-evaluated. These data will be used to select a remedy for scale-up and iteratively evaluate sustainability metrics during remediation.

2:30 pm – 2:50 pm

Quantifying Global Impacts to Society from the Consumption of Natural Resources During Environmental Remediation Activities

Melissa Harclerode[1,2], Pankaj Lal[1], Michael E. Miller[2]
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The objective of the presentation is to showcase how the social cost benefit analysis (SCBA) methodology can be used to quantify global impacts to society from the consumption of natural resources during remediation activities.

Abstract

Environmental remediation activities often require the management of large volumes of water and the consumption of significant amounts of local natural resources, including energy and fossil fuels. An environmental footprint analysis is a common method to evaluate environmental implications (e.g., greenhouse gas emissions and energy utilized) of clean-up approaches. Presently, these footprint tools used do not associate the environmental implications with global impacts. Life cycle impact assessment (LCA) tools make the link between environmental metrics and global impacts. However, detailed LCA is rarely applied to remediation projects, thereby assessments using footprint tools are missing the link between clean-up activities (e.g., resource consumption) and global impacts. In this presentation, the environmental footprint analysis method has been extended to integrate the social cost of environmental metrics (e.g., carbon emissions and energy utilized) to quantify global impacts (e.g., contributions to climate change) from remedial activities. Quantification of these global damages in monetary terms provides a measurement tool and an argument for more vigilant environmental stewardship that can be appreciated by a broad swath of society.

The case study site is a former aircraft parts manufacturing facility which caused chlorinated solvent contamination in soil and groundwater beneath the building. A groundwater pump-and-treat (P&T) system was initially installed, followed by its gradual phase out with concurrent phase in of in-situ bioremediation. P&T systems are the selected clean-up remedy for a majority of contaminated legacy sites in the United States. The industry needs to reconsider long term operation of P&T systems and potential phase out scenarios to reduce natural resource consumption, subsequent global impacts and project implementation cost. The case study evaluates the monetized societal benefits from quantifying carbon emission impacts of the proposed clean-up approaches and alternative scenarios. Our results suggest societal impacts based on monetized carbon emissions can be reduced by 27% by optimizing the remediation processes. Technologies that reduce costs borne by society have long term, beneficial supply chain impacts including reduced taxpayer and federal funds required to address global damages. The sensitivity analysis results elucidate how variation in carbon prices (including market and externality costs) and discount rates can influence clean-up decisions for remediation projects. As shown in this study, careful consideration should be taken when choosing a carbon price and discount rate for a social cost benefit analysis (SCBA). The carbon price and discount rate should be representative of the environmental metrics being used and project

objectives. We suggest using a lower discount rate for a remediation project SCBA to incorporate intergenerational and cumulative impacts represented by environmental metrics. Since an absolute market for carbon currently does not exist, we suggest conducting a sensitivity analysis using various market values or calculating an average market value representative of the project's regional characteristics and stakeholders' sustainability objectives.

This study presented a simplified approach towards an integrated sustainability assessment for remediation projects, thus enabling stakeholders to move towards the triple bottom line of clean-up activities with fairly simple calculations free from expensive, specialized software.

3:30 pm – 3:50 pm

Comparison of Different Tools and Assessment Methodologies for Evaluating the Environmental Footprint of Clean-up Options

Renato Baciocchi[1], Giulia Costa[1], Chiara Di Mambro[1], Flavia Polli[1], Andrea Forni[2]
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[2]Consultant

The objective of the presentation is to discuss the comparison of different tools and different assessment methodologies for the evaluation of the environmental footprint of selected clean-up options, making reference to a site-specific case study.

Abstract

In the framework of sustainable remediation, the clean-up strategy is defined relying on a holistic assessment of the different available options, which considers and properly balances the expected impact on the three pillars of sustainability: society, economy and environment. The decision on the relative importance to give to each of the three pillars is a key one in the overall sustainability appraisal process and shall be agreed on by the stakeholders involved. It is very important to base this decision on a robust and transparent assessment of the impacts on the individual sustainability aspects. As far as the environmental sustainability is concerned, different simplified tools, characterized by a limited set of indicators to assess the environmental footprint, are available for assessing the environmental footprint of clean-up options, especially in the USA. A more detailed estimation of the environmental footprint of a clean-up option can be provided by tools based on the life cycle assessment (LCA) approach, which allows the estimation of the impact on different midpoints and endpoints of a huge number of processes. The main drawback of this approach is that it requires very detailed data on the option to be assessed and also that the evaluation of the impacts can be carried out using different set of indicators, each one characterized by different impact categories and also by different methodologies for converting the data inventory into impacts. The limited impact categories of the simplified tools, and the somehow excessive complexity of LCA, pose a question on the robustness of the methodology to achieve a fair assessment of the environmental sustainability.

In order to gain more insight on this issue, we will present the results of an on-going activity aimed at the comparison of different tools for the evaluation of the environmental footprint of selected clean-up options. To this aim, a site characterized by groundwater contamination by chlorinated solvent was selected as case study. Different clean-up options were considered, including in-situ chemical oxidation (ISCO) and enhanced reductive dechlorination (ERD). The tools employed for the assessment were: SEFA (Spreadsheets for Environmental Footprint Analysis) and SimaPro 8 (EcoInvent 3) using two different impact assessment methodologies: IMPACT 2002+ and CML-IA. The results obtained suggest that the LCA results obtained using the two methodologies may differ or not, depending on the impact category considered. For instance, for "ozone layer depletion" and "global warming" the results were the same for both methodologies, leading to lower impacts for ERD and ISCO, respectively. On the other hand, for "acidification" a higher impact was calculated for ISCO using the IMPACT2002+ methodology, whereas ERD was more impacting using the CML-IA methodology. The impacts on categories related to toxicity effects (on human or environmental receptors) were hard to compare and explain, suggesting that probably these indicators should be considered with great care before being considered. The overall evaluation of the impacts using IMPACT2002+ showed that ISCO is environmentally more sustainable than ERD. This result is in agreement with those obtained using the SEFA simplified tool, but not with those obtained with LCA using the CML-IA methodology.

This result suggests that more efforts are needed to develop a robust and reliable methodology for estimating the environmental footprint of clean-up options. This shall probably also include a clear separation between the local and global impacts. For now, we suggest avoiding basing the overall assessment only on the results of one tool, but possibly to use different tools of different complexity and with different assessment methodologies, comparing and somehow integrating their results.

4:00 pm – 4:20 pm

Sustainability Performance Indicators, Remedial Option Analysis and Project Optimization

John Dewis[1] and Raman Birk[2]
[1]Arcadis Canada Inc.
[2]Public Services and Procurement Canada

The objective of the presentation is to demonstrate how sustainability performance indicators can be incorporated into decision matrices to create more sustainable remediation solutions and to optimize the environmental and social components of remediation programs.

Abstract

Remediation programs consist of planning stages, or remedial option analysis, which can include a decision matrix incorporating sustainability values and weight them against other project aspects. All remediation programs will have limitations and requirements. Project limitations are those aspects of the project that create time, cost, location and resource barriers to sustainability. Project requirements are those aspects of a project that must not be altered by sustainability values such as regulatory compliance. Beyond these sustainability values can be incorporated into remediation programs. In order to quantify sustainability values, sustainability performance indicators can be constructed through dialogue with property owners, managers and custodians. Sustainability performance indicators provide a means to quantify and compare sustainability indicators such as greenhouse gas emissions, local involvement and waste reduction. Examples of sustainability performance indicators include calculating greenhouse gas emission per unit of treatment for remediation projects, comparing greenhouse grass emissions between options, weighting local work force involvement, waste reduction strategies and quantifying program greenhouse gas emission reductions in terms of internal emission offsets. The outcome and benefits of incorporating sustainability values can be increased local involvement, a smaller environmental footprint and increased buy in by stakeholders. Remedial programs can be optimized through tracking sustainability indicators and identifying synergies where incorporating sustainability values in a remedial approach or work aspect results in a net decrease in cost. Examples of this are fuel or waste reduction strategies. Case studies include projects conducted by Public Works and Government Services Canada (PWGSC) along the Alaska Highway in northern British Columbia (BC). In these locations greenhouse gas emission associated with treatment of contaminated soil have been reduced through application of innovative remediation methods and waste reduction strategies.

In contrast, a sustainability value may increase project costs but achieve an increase in a sustainability indicator. An example of this is multiple viable transportation options for a disposal scenario such as trucking, rail and barging which have different costs and different greenhouse gas emission. Sustainability indicators can be used to estimate the emissions per unit of transportation and compare this against cost. In a scenario of increase cost, with decrease greenhouse gas emission, the increased cost may be evaluated in terms of 'tonnes of emission' and compared to current emission credit trading markets to justify an internal project offset. Sustainability Performance can also be used during a remediation construction phase to track and further optimize a program. Case studies include projects conducted by PWGSC at the Whitehorse airport and Watson Lake Airports in the Yukon and northern BC. At land treatment facilities, machine fuel consumption was compared to the progression of soil treatment over time, in terms of 'greenhouse gas emissions/tonne of treated soil'. Performance indicators can then be used to monitor treatment while reducing machine time to optimal levels. In this way, soil treatment is optimized for fuel input. These performance indicators can then be shared and compared with alternate remediation methods.

In closing, sustainability performance indicators can be used during remediation option analysis to weigh sustainability values and during construction phase to optimize remediation programs. They provide quantification tools to help custodians determine to most sustainable remediation solutions.

4:30 pm – 4:50 pm

A Holistic Approach to Site Assessment of Former Landfill and Sustainable Remediation

Jane Oakeshott, ERM

The objective of the presentation is to discuss how, through engagement with regulators and exploration of options, a detailed site specific QRA was adopted to support retention and redistribution of all onsite materials to facilitate development of a landfill while also adopting a sustainable remediation strategy.

Abstract

The restoration of a 60 Ha historical landfill site close to Heathrow airport is being undertaken to enable the site to be redeveloped as a Rail Freight Interchange. To facilitate the production of a development platform, a large scale earthworks cut and fill operation was proposed involving 610,700 m^3 of excavation and a net import requirement of approximately 240,800 m^3 of materials to make up formation levels and for piling mat use. Following site investigation and initial generic risk assessment, the initial regulatory position was that remediation and/or removal of all excavated material as waste was required. Given the large volumes, this approach was evidently highly unsustainable and would generate significant environmental impact, particularly if quarried aggregates were used to make up the shortfall between excavated and fill requirements.

The UK Sustainable Remediation Forum (SuRF-UK) provides an authoritative framework for assessment of remediation in the UK, adopting a lifecycle approach so that sustainability can be considered at the earliest stages and embedded within the decision making process. The principles of this approach were applied to the site with an emphasis on the use of a risk-based approach to minimise to the extent practicable the requirement for remedial works while ensuring continued protection of human health and the environment while balancing the environmental, social and economic factors.

Looking at the site holistically led to better decision-making regarding characterisation, risk assessment and remediation. The site is large and as landfill, the potential source is also large. While site investigation is important in characterising the source, due to the size and the inherent heterogeneity given its provenance, it is not practicable or cost-beneficial to isolate or delineate individual sources or hot spots. Furthermore, the existing context indicated negligible impact on the adjacent watercourse and little impact on the surrounding aquifer. Generic quantitative risk assessment (QRA) was used to screen out most contaminants but concentrations of ammoniacal nitrogen in groundwater within the landfill remained a concern to the regulator. A detailed site specific probabilistic QRA showed that the potential risk to groundwater from leaching of re-deposited and in-situ material will likely be significantly diminished and below assessment criteria, post development, given the reduced infiltration (and migration) due to the relatively high proportion of hardstanding associated with the scheme. Agreement was also reached with the regulators to import suitable former waste materials under a recovery permit to avoid use of virgin aggregates. A semi-quantitative assessment was undertaken to further demonstrate the benefits of the adopted sustainable approach.

Through engagement with regulators and exploration of options, the detailed site-specific QRA was adopted to support retention and redistribution of all onsite materials and to import recovered materials to facilitate development, while also adopting a sustainable remediation strategy. Landfills cannot necessarily be regarded as conventional contaminated sites but on a larger scale; a different angle on site characterisation and risk assessment may be required.