

Sustainability studies of commonly used remediation technologies in Alberta

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Abstract

Sustainability concept is aimed, among other things, at avoiding the use/release of hazardous substances/waste. However, inevitable release of hazardous waste does occur. When it occurs, the responsible party is required to initiate cleanup activities that will ensure the protection of public health and the environment. A wide variety of techniques is available and more are being developed to effectively carry out such cleanup. The availability of many remediation techniques necessitates the choice of an option or combination of options. The determination of what techniques are appropriate for a given situation has been essentially based on site, soil and waste characteristics. But in view of the various efforts being made at ensuring the sustainability of our industrial activities, this paper is focused on the sustainability of the commonly used remediation technologies in Alberta. In this study, remediation technologies such as land farming, biopiling, composting, bioventing, biosparging, air sparging, and air venting were compared in terms of their technical suitability, economic justification, environmental friendliness and social acceptability under a given set of decision scenarios.

It is believed that this paper will be helpful to remediation technology developers and decision makers in taking holistic view at remediation technologies in order to ensure the development and choice of sustainable remediation technologies, thereby fulfilling the goal of meeting the present need without jeopardizing the capability of the future generations in meeting their own needs.

Keywords: Sustainability, Sustainable development; Remediation; Remediation technologies

Introduction

Remediation has been defined by Alberta environment as the removal or neutralization of chemical substances from a site to mitigate or prevent any adverse effects. The need for remediation is a consequence of the failure of our past industrial activities which is known to be unhealthy for humans and injurious to ecosystem welfare. Attempts to correct past mistakes has resulted in the development of remediation technologies. Today, varieties of techniques are available and many more are being developed to effectively carry out the cleanup. The availability of many remediation techniques necessitates the choice of an option or combination of options. The determination of what techniques are appropriate for a given situation has been essentially based on site, soil and waste characteristics. But in view of the various efforts being made by various sectors of our economy in imbibing the concept of sustainability, it is considered worthwhile that we examine the sustainability of various remediation technologies being used in Alberta today.

Sustainability has been defined by the World Bank as a process or condition that can be maintained indefinitely without progressive diminution of valued qualities inside or outside the system in which the process operates or the condition prevails.

The debate over sustainability as an issue in development started over a decade ago [Brundtland (1990, p.24)]. The concept of sustainability begun to assume a central place in science and technology policy discussions as world wide environmental problems increasingly become matters of general public concern. It has generated a lot of research interest and policy discussions on the meaning, measurability and feasibility of sustainable development [Carpenter (1995); Carpenter (1998); Van Pelt (1993)]. According to Carpenter, the disagreements has not only involve what exactly is to be sustained (for example, is sustainable economic development different from sustainable growth?) but also what are the appropriate levels of such sustainability. Furthermore, there have also been disputes over legitimate methodologies for setting sustainability levels in general, along with basic methodological issues over what would count as acceptable standards of proof that sustainability has been achieved. Despite the ambiguity in the concept of sustainability, the issue of sustainability has prompted policy-makers to formulate new strategies for achieving a balanced economic and technological pathway that would safeguard our precious environment, not only here and now, but also elsewhere and in the future [Nijkamp and Vreeker, (2000)]. Ensuring sustainability is a universal challenge faced by all, whether in the business world, government, or non-governmental organisation. The concept of sustainability and its application to various areas of human activities is becoming widespread in the manufacturing and service industry. Foreign policies are also emphasizing the concept of sustainability in evaluating developmental assistance (Danida, 2001). Remediation industry cannot afford to be left behind. More importantly as the industry is directly involved in working with/for the environment.

The need for sustainability assessment of remediation technologies

Sustainability has been found to be context-specific and may be determined by needs and opportunities in a given region as part of a broader spatial system. It is therefore necessary to put this concept in perspective with regard to remediation technologies. Though sustainability is aimed at avoiding the use/release of hazardous substances/waste, it is a common knowledge that there may be some exemptions due to service requirements. Furthermore, inevitable release of hazardous waste does occur. When it occurs, the responsible party is required to initiate cleanup activities that will ensure the protection of public health and the environment. In view of the various efforts being made at ensuring the sustainability of our industrial activities and the huge amount of money that is spent in correcting these mistakes of the past make, it necessary to evaluate its effectiveness of our remediation technologies and to prevent repetition of the same mistake that brought about the need to carry out remediation in the first instance.

This paper is a report on the first stage of the sustainability studies of commonly used remediation technologies in Alberta. Its aim is the promotion of movement toward sustainability of remediation technologies at the provincial level and promotion of research networks/cooperation between stakeholders in updating the proposed sustainability indicators for remediation technologies used the province.

It articulates the sustainability factors in the remediation industry and puts forward a multi-pronged approach to addressing the issue. In this study, remediation technologies such as land farming, biopiling, composting, bioventing, biosparging, air sparging, and air venting is being studied and compared in terms of their technical suitability, economic justification, environmental friendliness and social acceptability.

The Concept of Sustainability

Sustainability is a concept aimed at enhancing environmental protection, techno-efficiency, greater effectiveness, predictability, accountability and clarity of environmental management. It has three dimensions, namely: economic sustainability, environmental sustainability, and social justice and equity (Fig. 1). Each of these aspects of sustainability can then be assessed in terms of criteria and indicators for measuring progress to the attainment of set goals in this area and for a specific region and/or sector of the economy.

Measurement parameters

Since the beginning of the debate over sustainability as an issue in the eighties, the public has become more and more aware of the evolving environmental problems resulting from the development and use of technologies. Governments, the public and other stakeholders has found it necessary to establish landmarks for measuring our progress towards sustainability. Efforts have since then been devoted to how to measure the sustainability of our industrial activities. These efforts have brought together nations and industrial

groups at various locations in attempts to ensure sustainable use of our resources. Because parameters for assessing the sustainability of a technology or an activity is generally peculiar to the economic sector and the environment of its operations, it is essential to articulate indicators and establish criteria for remediation industry, and consequently organized them into the three main pillars of sustainability.

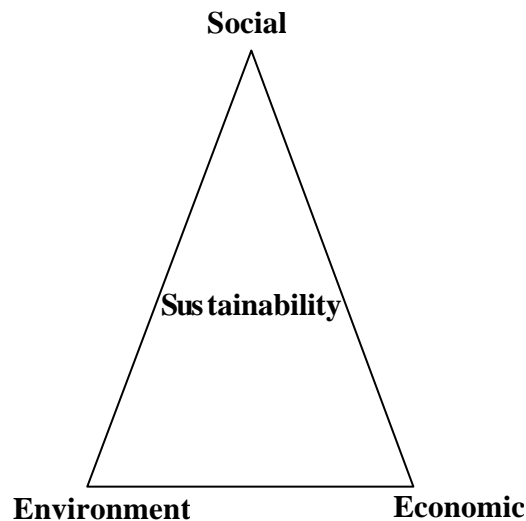


Figure 1: An illustration of the triple bottom line of sustainability

Indicators of sustainability

Indicator has been defined as "a system of measures that would provide a sound basis for decision-making and a means of measuring progress towards sustainable development" [Pasho, 1998]. It is something that helps us understand where we are, which way we are going and how far we are from where we want to be. Furthermore, it alerts us to a problem before it gets too bad and helps us recognize what needs to be done to fix the problem

Moreover, according to McCann (1998), there are a number of questions to be answered, namely:

- How do we develop sets of indicators that address all three dimensions of sustainable development - environmental, social and economic?
- How many indicators should we develop?
- How can indicators best be integrated?

These questions are best answered through the cooperation and deliberation of all the stakeholders involved. However, it is important to ensure that the indicators are relevant,

based on accessible data, and convey to decision-makers and society the information that is readily understandable. In addition, the selection of a set of indicators should at once meet tests of scientific accuracy as well as the needs of decision-makers and the interests of stakeholders” [McCann, 1998].

On the basis of the overview of the commonly used remediation technologies in Alberta, they are characterized as follows:

Economic Sustainability:

This was evaluated in terms of costs and benefits to the private and the public institutions and the community:

Costs

- Development costs
 - » Equipment/Facility construction
 - » Expert/Consultation charges
- Operating and maintenance costs
 - » Energy and other resource requirement
 - » Salaries and wages
- Decommissioning costs

Benefits

- Meaningful employment opportunities
- Innovation and technology improvement
- Maintenance of physical and social infrastructure,
- Knowledge assets for future generations.

Ecological Sustainability:

Ecological sustainability of a remediation technology can be evaluated in terms of:

- Detoxification or media changes
- Effectiveness
 - » Clean up time
 - » Clean up capability/efficiency
- Resource consumption
- Maintainability

Social Sustainability:

This is measured in terms of how technology affects the way of life/ecosystem welfare of the community living in the area and how easy the technical crew can install and operate the technology. This is indexed as follows:

- Ease of development/operation
- Cultural impact
- Recreation
- Human Health
- Noise
- Odor
- Biodiversity

Comparative analysis

A heuristic evaluation model was developed to compare land farming, biopiling, composting, bioventing, biosparging, air sparging, air venting, thermal desorption solvent extraction and treatment wetlands were compared in terms of their technical suitability, economic justification, environmental friendliness and social acceptability. It is a fuzzy multi-criteria evaluation model based on the hybridization of conjunctive method, value analysis method and fuzzy singleton. The preliminary result is shown in table 1. Details on the development of this model and description of each of the remediation technologies will be reported in another paper that is being put together.

Table 1: Preliminary result of qualitative comparison of some the remediation technologies' sustainability

Remediation technology	Economic assessment	Ecological assessment	Social impact
Land farming	1.5	1.5	2
Biopiling	2	1	2
Composting	1.5	1	1
Bioventing	2	2	2
Biosparging	2	1.5	1.5
Airsparging	1.5	3	2.5

Preference: High -- 1; Average --- 2; and Low --- 3

This result shows an overall preference for composting followed by biopiling and biosparging. The study is in progress.

Conclusion

This paper has laid a foundation for the sustainability studies of remediation technologies in Alberta. The criteria and indicators listed are still subject to improvement. Effort is underway in assembling the stakeholders together to discuss and fine-tune these criteria. We are at the consultation stage and we will hopefully come up with relevant, reliable, accessible, and understandable indicators suitable for the remediation industry in Alberta.

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