Sustainable Remediation Tool (SRT)

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Abstract:
Consideration of sustainability factors is becoming increasingly important in the environmental decision-making process. The U.S. Air Force, through the Air Force Center for Engineering and the Environment (AFCEE), desires to incorporate sustainability into Air Force remediation practices. For this reason, the Sustainable Remediation Tool (SRT) was developed to estimate metrics used to evaluate environmental restoration technologies. The SRT, based on the Microsoft Excel platform, provides an easy-to-use mechanism for remediation professionals to incorporate sustainability concepts while avoiding time-consuming hand calculations.

The SRT is designed to serve two general purposes: i) as a planning tool for future implementation of remediation technologies at a particular site, and ii) as an evaluation tool to optimize remediation systems already in place. The SRT allows users to estimate sustainability metrics for specific technologies. The technologies currently included in the version released in May 2009 are: i) Excavation, ii) Soil Vapor Extraction, iii) Pump and Treat, and iv) Enhanced Bioremediation.

The SRT applies a broad, system view and a limited life-cycle assessment-style approach to integrate the different and competing factors involved in remedy selection. The SRT allows the user to choose either a simplified (Tier 1) analysis or a more complex, site-specific (Tier 2) level of evaluation. After the user enters site information appropriate to the desired evaluation tier, the SRT estimates key system components and materials used. These intermediate calculations are based on rules of thumb or algorithms widely used in the environmental industry or developed by the design team. The user may override some of the calculated values in Tier 1, while Tier 2 allows the user much more flexibility in tailoring the calculations to a particular site. Finally, the SRT reports sustainability metrics as outputs. To allow the user to compare remediation options easily, soil and groundwater remediation technologies are displayed side-by-side. Other innovations include: (1) scenario planning (e.g., to account for different futures for carbon offset costs); (2) reporting of metrics in traditional units (e.g., tons CO_2 emissions) as well as values converted into a common unit for easier comparison; and (3) using a consensus-building virtual meeting room where stakeholders can weigh the importance of different sustainability metrics.

The SRT is the product of a collaborative effort of three engineering consulting firms, AFCEE, and over 20 sustainable remediation experts who served as peer-reviewers. Designed to be a public domain tool, it is now available at no charge to any interested parties. Work on the SRT is continuing, with four more remediation technologies and new sustainability metrics being added to the tool in the next release scheduled for late 2009. The new technologies include: thermal treatment, MNA, chemical oxidation, and permeable reactive barriers.

INTRODUCTION

There is increasing interest in incorporating sustainability concepts into a wide range of economic and social processes, including environmental remediation. While both the private and public sectors are placing increased emphasis on ”sustainable remediation”, the U.S. government has been particularly active developing and promoting sustainable remediation.

For example, the U.S. federal government agencies were directed by Executive Order 13423, issued in January 2007 to comply with the following policy:

> *It is the policy of the United States that Federal agencies conduct their environmental…and energy-related activities…in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.*
>
> *…“sustainable” means to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations of Americans* (3922-3923).

More recently, an October 2009 Executive Order instructs all U.S. Government agencies to *”…focus on integrating achievement of sustainability goals with agency mission and strategic planning to optimize performance and minimize implementation costs. Each agency will develop and carry out an integrated Strategic Sustainability Performance Plan that prioritizes the agency’s actions toward the goals of the Executive Order based on lifecycle return on investments.”*

Examples of goals from this recent Executive Order are for federal agencies to:

- *“set a 2020 greenhouse gas emissions reduction target within 90 days;*
- *increase energy efficiency; reduce fleet petroleum consumption;*
- *conserve water;*
- *reduce waste;*
- *support sustainable communities; and*
- *leverage Federal purchasing power to promote environmentally-responsible products and technologies.”*

Policies to operate in a sustainable manner leaves government environmental restoration professionals with the need for tools to help develop sustainable remediation practices.

What is Sustainable Remediation?

In the United States, a group of environmental professionals interested in sustainable remediation initiated the Sustainable Remediation Forum (SURF) in 2006. SURF has developed a comprehensive, working description of sustainable remediation:

While 'sustainability' is often associated with reducing the global effects of greenhouse gases generated by an industry or activity, SURF chose to take a broader view. SURF considers sustainable remediation practices to not only include those that reduce global impacts such as greenhouse gases, but those that also consider how to reduce local atmospheric effects, as well as potential impacts on worker and community safety or on the consumption of other natural resources that might be attributable to remediation activities. (SURF, 2009)

In practice, sustainable remediation requires developing non-traditional decision-making metrics. Traditional remediation decision-making involves evaluation of risk reduction, cost, ability to comply with regulations, implementability, and other factors. New sustainability metrics that have been proposed in SURF meetings include: carbon dioxide emissions; change in resource and ecosystem service; worker safety; energy use; water use; and other factors.

Estimation of these new metrics can involve new types of scientific/engineering calculations that require non-traditional data input and detailed knowledge of sustainable remediation principles and practices. To help make this computation of metrics easier for the environmental community, several groups have developed calculators and tools to make sustainable remediation practices more accessable. This paper describes one such tool, the Sustainable Remediation Tool (SRT), developed by team of remediation experts and funded by the U.S. Air Force (AFCEE, 2009). This easy-to-use tool is designed to provide remediation professionals with a way to consider the sustainability of various remediation technologies while circumventing time-consuming hand calculations of these metrics.

METHODS

Platform

The SRT is built on the Microsoft Excel 2003 platform, allowing the user to choose the level of effort and detail appropriate for the project at hand. Tier 1 (simplest tier) calculations are based on rules of thumb that are widely used in the environmental remediation industry. Tier 2 calculations are more detailed and incorporate more site-specific factors. Use of Tier 1 is most appropriate before a feasibility study (FS) has been performed, as FS-derived information would provide enough detail for a Tier 2 evaluation. A user might also choose Tier 1 rather than Tier 2 if a quickly executed evaluation (e.g. 1 - 2 hours) is required or if general comparisons between remediation technologies are appropriate. Conversely, a user might choose to proceed to a Tier 2 evaluation if very detailed site data is available or if optimization of an existing system is needed.

Metrics

Calculations based on contaminant type are output in the form of sustainability metrics. These metrics are:

- Carbon dioxide emissions to atmosphere;
- Total energy consumed;
- Technology cost;

- Safety/Accident risk; and
- Change in natural resource service.

New metrics being added in the upcoming release of the tool are: Nitrogen oxides (NOx), Sulfur oxides (SOx), and Particulate Matter (PM10).

All metrics are reported in natural units (e.g. tons CO_2, Megajoules of energy, etc.) but can also be viewed as "normalized" metrics, which are values from natural units converted to US dollar values.

Architecture

The SRT is based on a technology-centric architecture, where a user selects a particular remediation technology to evaluate, enters input data, and then reviews results for the sustainability metrics. Currently four remediation technologies are available in the SRT, with four more to be added in the next release scheduled for late 2009:

Soil Technologies

- excavation
- soil vapor extraction (SVE)
- <coming soon> thermal treatment

Groundwater Technologies

- pump and treat
- enhanced bioremediation
- <coming soon> in situ chemical oxidation
- <coming soon> permeable reactive barrier
- <coming soon> monitored natural attenuation/long-term monitoring

After choosing whether to evaluate soil or groundwater, the user is directed to three types of screens: Input, Technology, and Output. The Input screen for either soil or groundwater gathers general information used for all technologies, such as description of the contamination present and general site specifics (see Figure 1). The Input screen is followed by Technology screens displaying system design and materials and consumables (see Figure 2). Finally, the user is directed to the Output screens. Throughout the tool, there are direct user inputs as well as defaults and calculated values based on rules of thumb or algorithms. Many of the calculated values can be overridden by the user, if more site-specific data are available.

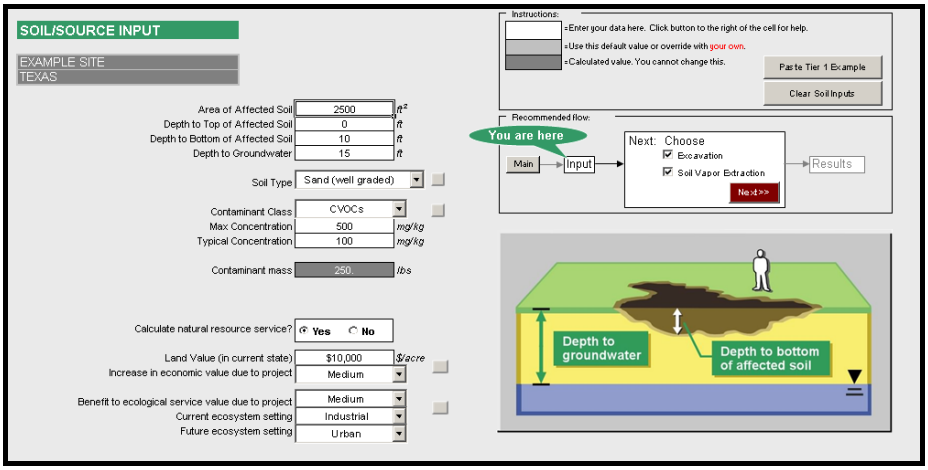

FIGURE 1. Example input soil screen.

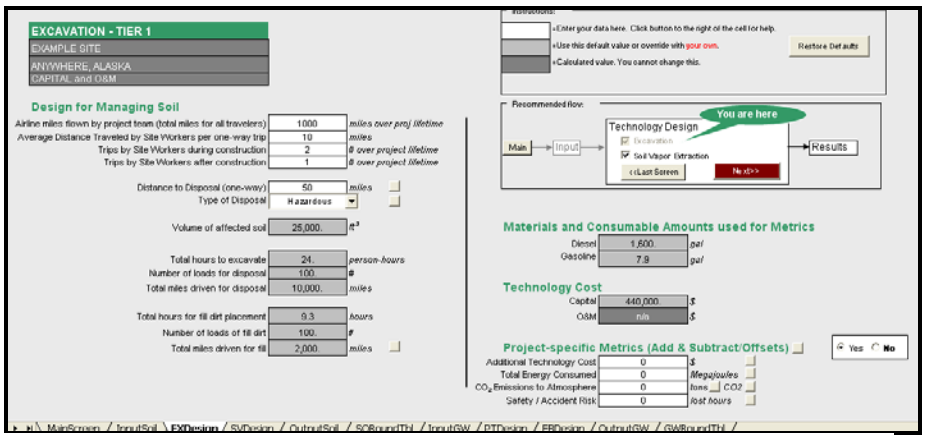

FIGURE 2. Example technology screen in excavation module.

RESULTS

The SRT generates quantitative results for each technology selected for all of the metrics relevant for that technology (see Figure 3). The results are provided in two forms:

- As non-normalized units (where each metric is shown in a different unit)
- As normalized units (where selected metrics are converted to monetary units, in this case U.S. dollars). Display in normalized units is a user option.

For example, carbon emissions are reported in non-normalized units of metric tons. To normalize this metric, an offset cost (in units of dollars per metric ton) is used to convert carbon emissions to dollars. By converting this and other metrics to a common unit (dollars), the user has another perspective with which to compare the results between different types of metrics, as well as between different technologies.

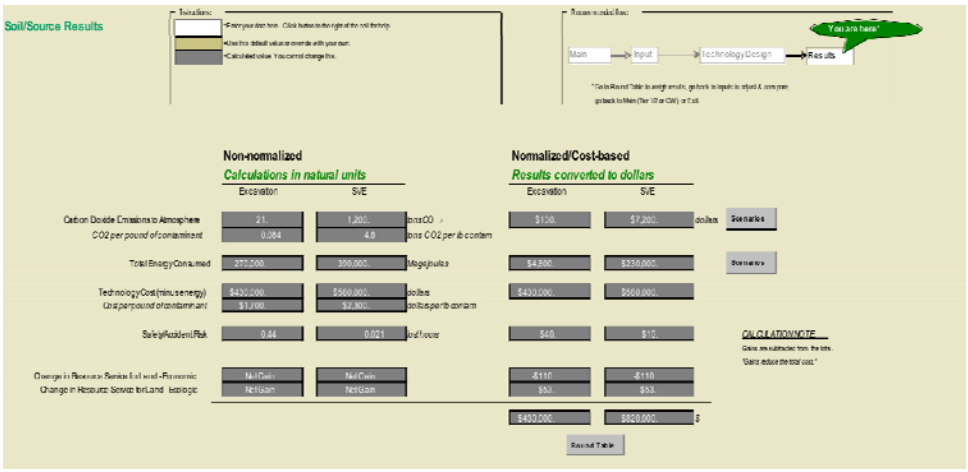

FIGURE 3. Example output screen showing results for five sustainability metrics.

A special feature of the SRT is the ability to do scenario planning, where changes in certain metrics (such as carbon offset costs and energy costs) can be entered into the tool. With this feature, users can visualize normalized costs for the different metrics under vastly different economic and environmental conditions than what we face today. For example, users can choose to evaluate the sustainability of a long-term project (such as monitored natural attenuation remedy) under a "carbon-constrained world" scenario, where offset costs are assumed to increase by 15% per year.

A third feature is the use of a consensus-building virtual meeting room where stakeholders can weigh the importance of different sustainability metrics. This feature allows a group of stakeholders to move towards a consensus in remedy selection or optimization.

CONCLUSIONS

The Sustainable Remediation Tool (SRT) is designed to help users incorporate sustainable remediation practices into remediation projects and decision-making. A free, public domain tool based on the Microsoft Excel platform, the SRT reports sustainability metrics (carbon emissions, NOx emissions, SOx emissions, particulate emissions, economic cost, energy consumption, safety / accident risk, and change in resource service from land and/or groundwater), organized by environmental media so that soil or groundwater technologies can be compared side-by-side. Other key features of the tool include:

- Tier 1 (simple) and Tier 2 (complex) options
- Conversion of all metrics to a consistent set of units (for example, converting carbon dioxide emissions to life-cycle costs using existing carbon offset costs established by carbon trading markets);

- Use of Scenario Planning, where different futures for carbon offset costs and energy costs are presented to the users (for example, the user can view the results of the sustainability calculations for either a “Business as Usual” scenario, or a “Carbon Constrained World” scenario);
- Use of a consensus-building virtual meeting room, where different stakeholders can weigh the importance of different sustainability metrics (For example, one stakeholder might weigh traditional economic cost as the most important metric, while another stakeholder might weigh carbon emissions as the most important metric.)

For more information on the SRT, visit AFCEE’s Sustainable Remediation page at http://www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremediation/index.asp. The SRT is available to the public at no charge.

To obtain a free copy, send a request to afcee.td.awag@brooks.af.mil.

REFERENCES

Air Force Center for Engineering and the Environment, 2009. Sustainable Remediation Tool User Guide, AFCEE, May 2009.

Ellis, D. and P. Hadley, 2009. Sustainable Remediation White Paper Integrating Sustainable Principles, Practices, and Metrics Into Remediation Projects. Remediation, Summer 2009.